Australia $1.35 Malaysia $4.95 IR £1.26 (inc. VAT)

PRACTICAL
ELECTRONICS

APRIL 1983

85p

DIGIT TALKER

Part One
SOUND SYNTHESIS BOARD

Plus...

PROJECTS · PHASER · CAR WIPER DELAY · **COMPUTING** · INTO THE REAL WORLD III · ULTIMUM – FLOPPY DISC CONTROLLER · MICROBUS **NEWS & FEATURES** · SPACEWATCH · BAZAAR · MICROFILE · SEMICONDUCTOR UPDATE · INDUSTRY NOTEBOOK

Get moving with these new developments in UK Robotics

— advanced electrohydraulic designs for education, industry and now available to the home constructor.

Hebot II is a turtle-type robot which takes programming out of the two dimensional world of the VDU into the real three dimensional world. Given a DC supply of 9-15V it can perform a bewildering number of moves under computer control — forwards, backwards, left and right — with each wheel independently controlled. It has blinking eyes, bleeps with a choice of two tones and has a solenoid operated pen to chart its progress. Touch sensors coupled to its shell return data about its environment to the computer for it to calculate evasive or exploratory action. Hebot II connects directly to an I/O port or alternatively with the universal interface board to the expansion bus of a ZX81 or other computer.

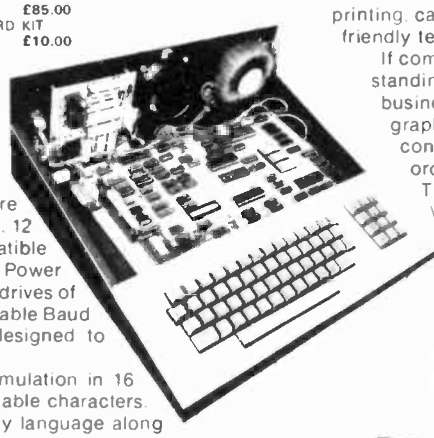
Robotic experience is becoming as essential a subject as computing. MICROGRASP provides the lowest cost means of acquiring that experience but despite its ultra low price the robot has considerable versatility. There are 5 axes each using a servo motor and there is feedback from each of the arm movements. Control is by any computer with an expansion bus - the ZX81 being particularly suitable. Servoing is achieved with hardware on the interface board to keep programming simple and the robot is operated under BASIC commands with no computer specific software required. The interface board is memory mapped using only 64 bytes at any of 1024 switch selectable locations.

MICROGRASP robot kit with power supply	£145.00
Universal computer interface board kit	£48.50
23 way edge connector	£2.50
ZX81 peripheral RAM Pack splitter board	£3.00

MICROGRASP, INTERFACE BOARD AND ZX81

HEBOT KIT £85.00
INTERFACE BOARD KIT £10.00

HEBOT II



Up to the nano-second hard, firm and software developments embodied in a complete system. 12 Mega Hertz 16 bit CPU; 64K upwardly compatible DRAM; separate 16K video DRAM and 24K TI Power Basic with overwrite. Supports up to four Disc drives of mixed type with 16 serial I/O ports. Programmable Baud rate and comprehensive E Bus interface designed to support real world applications.

Very high resolution graphics gives 3D simulation in 16 colours on 36 prioritised planes of user definable characters. Software FORTH coming includes this trendy language along with NOS C/PM.

Hardware components available separately with details in Nov, Dec, and Jan issues of ETI. Software features include: Real time clock, full renumber command, buffered I/O to free machine whilst printing, call to machine code routines, hexadecimal support and user-friendly textual error trapping messages.

If computers interest you then the Cortex will expand your understanding infinitely more than off the shelf machines. Use it in business, education, research or just play with the incredible graphics capability. At Powertran we are using these machines in conventional roles, in product control and R & D. We shall co-ordinate the Cortex user group and distribute software for the TMS 9995 CPU. Complete 16 bit 64K computer kit **£295.00** + VAT. Complete 16 bit 64K computer ready built **£395.00** + VAT

Top of the range is the Genesis P102 which has dual speed control, continuous servo operation and double acting cylinders for increased torque on the wrist and arm rotation joints. The microprocessor based control system has additional memory, position interrogation via the RS232C interface increasing the versatility of computer control and inputs are provided for machine tool interfacing.

6 axis system READY BUILT	£1950.00
Powertran CORTEX 16 bit 64K computer Kit **£295.00** READY BUILT	£395.00

(Electronics Today International December issue on CORTEX)

Example prices and specifications

Genesis S101
Base: 19.5" x 11" x 7.5"
Lifting capacity: 1500gm
Arm lift: 6.6"
Weight: 29Kg

4 axis model in kit form	£425
5 axis model in kit form	£475

Genesis P101
Base: 19.5" x 11" x 7.5"
Lifting capacity: 2000gm
Arm lengths between axles: 14.0"
Weight: 34Kg

6 axis model in kit form	£675

Complete Systems as shown in Photograph on right

Genesis S101

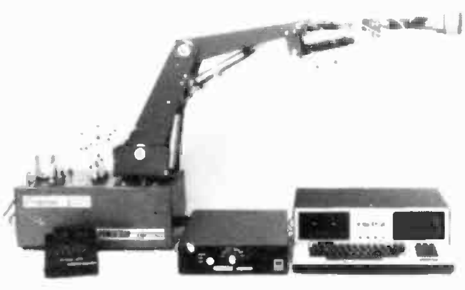
4 axis system in kit form	£681.50
5 axis system in kit form	£737.50
5 axis system Ready Built	£1450

Genesis P101

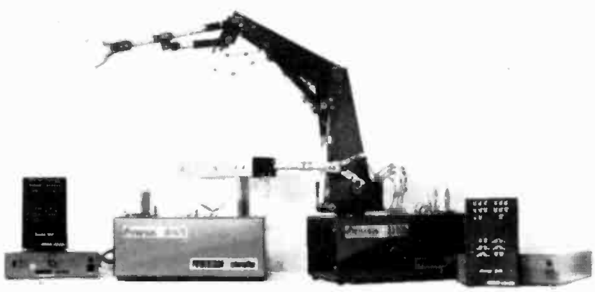
6 axis system in kit form	£945.00
6 axis system Ready Built	£1650

All prices exclusive of VAT

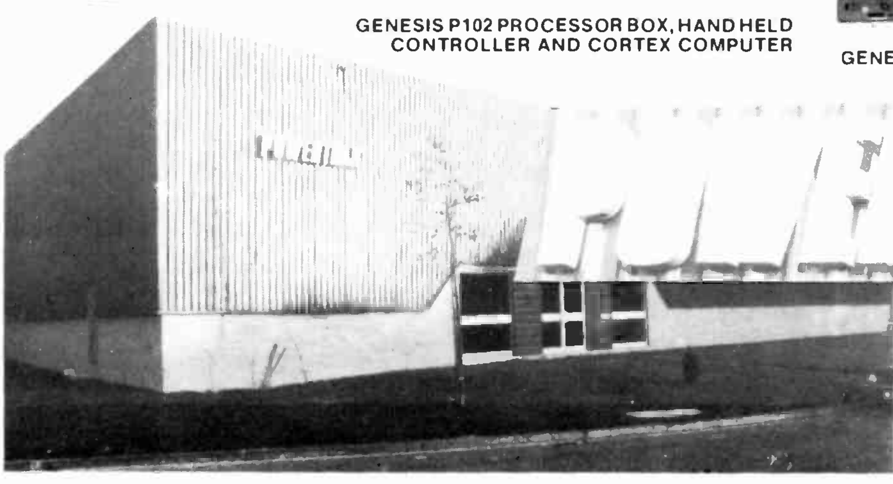
With prices starting below £1,000 the Genesis range of general purpose robots provide a first rate introduction to robotics for both education and industry. Each has a self-contained hydraulic power source, which enables loads of several pounds to be smoothly handled. The system operated from a single phase 240 or 120V AC supply or a 12V DC supply. The machine can be supplied with up to 6 axes each of which is fully independent but capable of simultaneous operation. Position control is achieved by means of a closed-loop feedback system based around a dedicated microprocessor. Movement sequences can be entered, stored and replayed by use of a hand held controller, alternatively the systems can also be interfaced to an external computer via a standard RS 232C link.



GENESIS P102 PROCESSOR BOX, HAND HELD CONTROLLER AND CORTEX COMPUTER



GENESIS S101 AND GENESIS P101 WITH PROCESSOR BOXES AND HAND-HELD CONTROLLERS



WORLD LEADERS IN ELECTRONIC KIT DESIGN AND SUPPLY

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PORTWAY INDUSTRIAL ESTATE
ANDOVER HANTS SP10 3WN
Phone Enquiries (0264) 64455

PRACTICAL
ELECTRONICS

VOLUME 19 No. 4 APRIL 1983

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL SUPPLEMENT

OUR MAY ISSUE WILL BE ON SALE FRIDAY, APRIL 8th, 1983
(for details of contents see page 6/6 of Micro-file)

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WATFORD ELECTRONICS

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POLYESTER CAPACITORS: (Axial Lead) **400V:** 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n, 47n, 68n **16p**; 100n, 150n **20p**; 220n **30p**; 330n **42p**; 470n 52p; 680n **60p**; 1µF **68p**; 2µ2, 4µ7 **85p**. **1000V:** 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n 42p; 47n, 100n **50p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V; 10n, 20n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n, 470n **13p**; 680n **19p**; 1µ **23p**; 1µ5 **40p**; 2µ2 **46p**.

ELECTROLYTIC CAPACITORS (Values in µF). **500V:** 10µF **52p**; 47 **78p**; **63V:** 0·47, 1·0, 1·5, 2·2, 3·3, **8p**; 4·7 **9p**; 10 **10p**; 15, 22 **12p**. 33 **15p**; 47 **12p**; 68 **16p**; 100 **19p**; 220 **26p**; 1000 **70p**; 2200 **99p**; **50V:** 68 **20p**; 100 **17p**; 220 **24p**; **40V:** 6·8 **15p**; 22 **9p**; 33 **12p**; 330, 470 **32p**; 1000 **48p**; 2200 **90p**; **25V:** **50p**; 3300 **76p**; 4700 **92p**; **16V:** 2·5, 40 **8p**; 47, 68, 100 **9p**; 125 **12p**; 220 **13p**; 330 **16p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **36p**; 4700 **79p**.

TAG-END TYPE: 64V: 4700 **245p**; 3300 **198p**; 2200 **139p**; **50V:** 3300 **154p**; 2200 **110p**; **40V:** 4700 **160p**; **25V:** 4700 **98p**; 10.000 **320p**; 15.000 **345p**.

TANTALUM BEAD CAPACITRS:
35V: 0·1µ, 0·22, 0·33 **15p**; 0·47, 0·68, 1·0, 1·5 **16p**; 2·2, 3·3 **18p**; 4·7, 6·8 **22p**; 10 **28p**; **16V:** 2·2, 3·3,**16p**; 4·7, 6·8, 10 **18p**; 15 **36p**; 22 **30p**; 33, 47 **40p**; 100 **75p**; 220 **88p**; **10V:** 15, 22 **26p**; 33, 47 **35p**; 100 **55p**.

POTENTIOMETERS: Carbon Track. 0·25W Log & Linear Values.

500w, 1K & 2K (LIN ONLY) Single	30p
5Kw-2Mw single gang	30p
5Kw-2Mw single gang D/P switch	78p
5Kw-2Mw dual gang stereo	88p

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm track

5Kw-500Kw Single gang	70p
10Kw-500Kw Dual gang	110p

PRESET POTENTIOMETERS

0·1W 50w-2·2M Mini Vert. & Horiz.	7p
0·25W 100w-3·3Mw Horiz. larger	10p
0·25W 250w-4·7Mw Vert.	10p

SILVER MICA (pf)
2, 3·3, 4·7, 6·8, 8·2, 10, 16, 18, 22, 27, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180 **15p each**
220, 250, 270, 330, 360, 390, 470, 600, 800 & 820pF **21p each**
1000, 1200, 1800 **30p each**
3300, 4700 **60p each**

SIEMENS multilayer miniature capacitors.
250V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 8n2, 10n,15n,22n **7p**; 18n, 27n, 33n, 47n **8p**; 39n, 56n, 68n **9p**.
100V: 100n, 120n, **10p**; 150n **11p**; 220n **13p**; 330n **18p**; 470n **23p**;680n**30p**;1µF**34p**;2µ**250p**.

RESISTORS
Hi-stab, Miniature, 5%, Carbon.

	RANGE	Val.	1-99	100+
0·25W	2w2-4 M7	E24	2p	1p
0·5W	2w2-4·M7	E12	2p	1p
1W	2w2-10M	E12	6p	4p
2% Metal Film 10w-1M			6p	4p
1% Metal Film 51w-1M			8p	6p

CERAMIC Capacitors: 50V
Range 1pF to 6800pF **4p**; 10nF, 15n, 33n, 47nF **5p**; 100nf/30V **5p**.

POLYSTYRENE Caps:
10pF to 1nF 8p
1n5 to 12nF 10p

RESISTORS S.I.L. Package:
7 Commoned. 100Ω, 680Ω, 1K, 2K2, 4K7, 10K, 47K, 100K **24p**.
8 Commoned:(9 pins) 150Ω, 180Ω, 270Ω, 330Ω, 1K, 2K2, 4K7, 10K, 22K, 47K, 100K **26p**.

TRANSISTORS

AC125/6	35	BC307B	14	BFX85/86	28	TIP31C	37	2N918	35	2SA671	250
AC127/8	35	BC308B	16	BFX87/88	28	TIP32A	38	2N930	20	2SA715	60
AC141/2	30	BC327/8	15	BFY50/51	23	TIP32C	42	2N1131/2	24	2SC495/6	70
AC176	28	BC337/8	15	BFY52	23	TIP33A	65	2N1303/4/5		2SC1061	250
AC187/8	32	BC441	34	BFY56	32	TIP33C	78	2N1307/8	65	2SC1096	85
ACY17/18	70	BC461	34	BFY64	35	TIP34A	74	2N1613	30	2SC1162	30
ACY19/20	75	BC477/8	40	BFY81	120	TIP34C	88	2N1671B	160	2SC1172	125
ACY21/22	75	BC516/7	40	BFY90	80	TIP35A	110	2N2160	295	2SC1173	125
AD142	120	BC547/8	12	BRY39	40	TIP35C	128	2N2219A/20A/21A/22A	25	2SC1306	100
AD149	79	BC549C	14	BSX20	20	TIP36A	130	2N2369A	18	2SC1307	150
AD161/2	42	BC556/7	15	BSX29	34	TIP36C	140	2N2646	45	2SC1449	85
AF118	95	BC558/9	15	BSY95A	25	TIP41A	50	2N2846	80	2SC1679	190
AF139	40	BCY70	16	BU105	170	TIP41B	52	2N2904A/05A/06A/07A	26	2SC1678	140
AF239	55	BCY71/2	20	BU205	190	TIP42A	55	2N2926G	10	2SC1923	50
BC107/8	10	BD124	115	BU206	200	TIP42B	58	2N3053	26	2SC1945	225
BC107B	12	BD131/2	48	BU208	200	TIP120	70	2N3054	58	2SC1953	90
BC108B	12	BD133	60	MD8001	250	TIP121	73	2N3055	48	2SC1957	90
BC108C	12	BD135	45	MJ2955	70	TIP141	105	2N3442	140	2SC1969	140
BC109	10	BD136/7	40	MJE340	54	TIP142	105	2N3614	199	2SC2028	85
BC109B	12	BD138/9	40	MJE370	100	TIP147	120	2N3615	199	2SC2029	200
BC109C	12	BD140	40	MJE371	100	TIP2955	60	2N3702/3	10	2SC2078	170
BC117/8	20	BD245	45	MJE520	95	TIP3055	60	2N3704/5	10	2SC2091	85
BC140/42	30	BD378	70	MJE2955	99	TIS43	32	2N3706/7	10	2SC2166	165
BC147/8	9	BD434	55	MJE3055	70	TIS44	45	2N3708/9	10	2SC2314	85
BC147B	10	BD695A	125	MPF102	40	TIS88A	50	2N3710	10	2SC2465	125
BC148C	10	BD696A	125	MPF103/4	30	TIS90	30	2N3771	179	2SC2547	30
BC149	9	BDY56	180	MPF105	30	TIS91/93	32	2N3772	195	2SD234	75
BC149C	12	BDY60	160	MPF106	40	VK1010	80	2N3773	210	2SK45	90
BC153/4	27	BF167	29	MPSA05	25	VN10KM	55	2N3819	22	2SK288	225
BC157/8	10	BF177	25	MPSA06	25	VN46AF	78	2N3820	38	2SJ83	225
BC159	11	BF178	30	MPSA12	32	VN66AF	80	2N3822/3	45	2SJ85	225
BC167A	10	BF179	35	MPSA55	30	VN88AF	94	2N3866	90	3N128	112
BC168C	10	BF180	38	MPSA56	30	VN89AF	96	2N3903/4	15	3N140	112
BC169C	10	BF194/5	12	MPSA70	30	ZTX107/8	11	2N3906/5	15	40097	120
BC170	15	BF196/7	12	MPSU02	58	ZTX109	12	2N4037	46	40100	215
BC171/2	11	BF198/9	18	MPSU05	55	ZTX212	28	2N4069	45	40101	130
BC173	11	BF200	30	MPSU06	55	ZTX300	13	2N4427	80	40250	95
BC177/8	16	BF224	25	MPSU52	65	ZTX301/2	16	2N4859	78	40251	150
BC179/81	20	BF244A	28	MPSU55	60	ZTX303	25	2N4871	55	40311	60
BC182/3	10	BF244B	29	MPSU56	60	ZTX304	17	2N5135/6	20	40313	130
BC184	10	BF256B	35	OC23	170	ZTX314	25	2N5172	18	40315	90
BC182L	10	BF257/8	32	OC28/36	220	ZTX320/26	30	2N5179	45	40316	95
BC183L	10	BF259	35	OC41/42	75	ZTX451	23	2N5180	45	40317/20	80
BC184L	10	BF274	42	OC44	75	ZTX341	30	2N5191	75	40360	60
BC186/7	26	BF336	40	OC70	40	ZTX500/1	14	2N5194	80	40361/62	70
BC212/3	10	BF451	35	OC71/72	40	ZTX502/3	18	2N5305	24	40406/7	75
BC212L	10	BF594/5	30	OC76	50	ZTX504	25	2N5457	30	40408	75
BC213L	10	BFR39/40	23	OC81/82	50	ZTX531	25	2N5458/9	30	40411	285
BC214	10	BFR41/79	23	OC83/84	40	ZTX550	25	2N5485	36	40412	90
BC214L	10	BFR80/81	25	OC170/1	50	2N696	30	2N5777	45	40467	130
BC237/8	14	BFR98	105	OC200/2	50	2N697	23	2N6027	32	40468	85
		BFX29/84	28	TIP29A	32	2N698	40	2N6109	60	40594	105
				TIP29C	38	2N699	48	2N6290	70	40595	110
				TIP30A	35	2N706A	19	2SA636	250	40603	110
				TIP30C	37	2N708	19			40673	70
				TIP31A	38	2N914/5	32			40871/2	90

LINEAR IC's

555 CMOS	80	LM311	70	SAB3210	325	ZN423E	130
702	75	LM318	150	SAB3271	485	ZN424E	130
709C 8 pin	35	LM319	215	SAB4209	595	ZN425E-8	345
710	48	LM324	30	SG3402	295	ZN426E-8	300
741	14	LM334Z	90	SL490	350	ZN427E-8	590
747C 14 pin	65	LM335	128	SN76003N	350	ZN428E	410
748C 8 pin	36	LM339	47	SN76013N	350	ZN429E-8	210
753 8 pin	185	LM348	64	SN76023N	350	ZN459	570
810	159	LM349	115	SN76033	350	ZN1034E	200
9400CJ	350	LM358	60	SN76227N	95	ZN1040E	665
AY-1-1320	225	LM377	175	SN76477	420	ZNA234E	850
AY-1-5050	99	LM379	480	SN76488	480		
AY-1-5051	160	LM380	75	SN76660	120		
AY-1-6720	210	LM381N	145	SP8629	299		
AY-3-1270	675	LM382	115	TA7120	125		
AY-3-8910	375	LM384	160	TA7130	125		
AY-3-8912	450	LM386	90	TA7204	195		
AY-5-1230	450	LM387	120	TA7205	175		
AY-5-1317A	630	LM389	95	TA7222	150		
CA3011	130	LM392	60	TAA661A	190		
CA3012	175	LM393	100	TAA700	275		
CA3014	275	LM394CH	290	TAA900	395		
CA3018	86	LM725CN	325	TAD100	159		
CA3019	80	LM733	70	TBA120S	70		
CA3020	210	LM2917	195	TBA540	275		
CA3023	210	LM3302	75	TBA550Q	330		
CA3028A	95	LM3900	50	TBA641-A12/BX1	290		
CA3035	255	LM3909	85	TBA651	190		
CA3036	270	LM3911	125	TBA800	80		
CA3043	275	LM3914	200	TBA810S	95		
CA3045	365	LM3915	200	TBA820	80		
CA3046	70	LM3916	250	TBA920Q	200		
CA3048	220	LM13600	110	TBA990	350		
CA3059	285	LS7220	280	TCA270	350		
CA3075	213	M253AA	1150	TCA280A	220		
CA3080E	70	M51513L	230	TCA940	175		
CA3081	190	M51515L	320	TCA965	145		
CA3086	48	M70681	125	TDA1004	290		
CA3089E	200	MB3712	220	TDA1008	310		
CA3090AQ	375	MB3756	440	TDA1010	198		
CA3123	165	MC1303	98	TDA1022	499		
CA3130	90	MC1304P	260	TDA1024	115		
CA3140	40	MC1310P	150	TDA1034	350		
CA3160	95	MC1445	250	TDA1490	350		
CA3161E	160	MC1455	65	TDA2002	325		
CA3162E	450	MC1458	35	TDA2003	198		
CA3189	200	MC1469	300	TDA2004	495		
CA3240	110	MC1494	694	TDA2006	330		
HA1366	175	MC1495	350	TDA2020	320		
HA1388	255	MC1496L	70	TDA2030	295		
ICL7106	690	MC1596	225	TDB0791	420		
ICL7107	975	MC1648	290	TL061CP	40		
ICL7611	99	MC1709G	90	TL062CP	60		
ICL7660	248	MC3302	90	TL064CN	98		
ICL8038CC	300	MC3340P	120	TL071CP	24		
ICL8211	350	MC3360P	120	TL072CP	45		
ICM7204	550	MC3401	65	TL074CN	100		
ICM7205	1150	MC3403	75	TL081CP	24		
ICM7207	475	MC3405	150	TL082CP	45		
ICM7215	1050	MC3423P	80	TL083CP	75		
ICM7216A	£22	MF10	350	TL084CP	90		
ICM7216B	£22	MFC6040	75	TL091CP	55		
ICM7216C	£22	MK50398	635	TL170	50		
ICM7217A	750	ML924	275	TL430C	90		
ICM7224	785	MSM5526	820	UA2240	120		
ICM7240	300	NE515	275	UA78540	230		
ICM7555	80	NE529	225	UAA170	180		
ICM7556	150	NE531	140	UAA180	180		
LA3350	220	NE543	225	UAA1003-3	935		
LA4031P	240	NE544	210	ULN2003	75		
LA4032	295	NE555	16	ULN2004	75		
LA4400	295	NE556DB	45	ULN2068	290		
LA4422	275	NE558	140	ULN2802	200		
LC7120	350	NE560	325	ULN2804	150		
LC7130	340	NE561	395	ULN2283	100		
LC7137	395	NE562B	410	UPC575	165		
LF347	150	NE564	420	UPC1025H	265		
LF351	48	NE565A	120	UPC1032	95		
LF353	95	NE566	155	UPC1182	270		
LF355	85	NE567	140	UPC1156H	225		
LF356	95	NE570	410	UPC1366	195		
LF357	110	NE571	400	XR2206	300		
LF398	475	NE5532	145	XR2207	375		
LM10	325	NE5534	105	XR2211	575		
LM301A	24	OM335	750	XR2216	675		
LM307	45	RC4136D	60	XR2266	360		
LM308	95	RC4558	45	ZN414	80		
		S566B	225	ZN419CE	180		
		SAB3209	425				

COMPUTER IC's

1702	350	8216	100	Z80CTC	250
1802CP	650	8224	110	Z80ACTC	260
2112-2	250	8226	250	Z80B	875
2114L-300n	90	8228	220	Z80DART	495
2114L-200n	95	8243	270	Z80ADART	550
2147-3	425	8250	850	Z80ADMA	895
2532-3	300	8251A	250	Z80DMA	675
2564	£8	8253	400	Z80P10	260
2708	225	8255	225	Z80AP10	275
2716-5V	225	8256A	£35	Z80S10-1	850
2732	350	8257A	400	Z80AS10	900
2764	575	8259	395		
3242	590	8271	£32		
4027	190	8279	385		
4116-150	85	8284	350		
4116-200	80	8288	£10		
4118-250	325	8T26A	99		
4164-200	425	8T27	150		
4334-3 (CMOS 2114)	325	8T28A	120		
4532-3	350	8T31	350		
4816-100ns	215	8T95N	90		
5101	220	8T97N	90		
6116-150ns	350	9364AP	550		
6116L-120ns	550	9602	220		
6117-100n	490	AM26LS31C	125		
6167-6	795	AM26LS32A	125		
6502 CPU	325	AM26LS33A	125		
6503	600	AY-3-1015	300		
6504-250	550	AY-5-1013	300		
6520	100	AY-5-1350	388		
6522 VIA	295	AY-5-2376	600		
6530 RRIOT	£11	AY-5-3600	750		
6532 RIOT	570	COM8017	275		
6545 CRTC	899	COM8116	700		
6551 ACIA	650	DM8131	275		
6592 PC	£20	DP8304BN	250		
68B54	780	DS3691N	320		
6800	220	DS8820	110		
6802	250	DS8830	110		
6803	850	DS8831	125		
6804	160	DS8832	250		
6805	670	DS88LS120N	275		
6808	520	E9365	$38		
6809	630	E9366	$35		
6810	115	FD1761	$15		
6820	100	FD1771	$15		
68B21	220	FD1791	$22		
6821	100	FD1793	$23		
6840	375	FD1795	$28		
6843	00	FD1797	$28		
6845	650	HD26501	75		
6847	650	HMG167-6	795		
6850	110	IM6402	380		
6852	250	INS8060N	1050		
6854	599	INS8154N	$9		
6875	500	MC1488	55		
68000	£78	MC1489	55		
74C922 New msk	420	MC14411	675		
8080A	250	MC14412	725		
8085A	350	MC3446	250		
8088	£18	MC3447P	315		
81LS95	80	MC3486	175		
81LS96	80	MC3487	175		
81LS97	80	MK3886-2M	57		
81LS98	85	MM5280D	695		
8118-10	225	MM5303	635		
8123	125	MM5307	1275		
8155	350	MM5387A	475		
8156	350	MM58174	700		
8202	£25	RO-3-2513L	650		
8205	225	RO-3-2513U	600		
8212	110	SFF96364E	800		
8214	425	SP0256AL2	£18		
		TMS2716-3	725		
		TMS6011	365		
		TMS4164-15	475		
		TMS4416-2	475		
		TMS4532-3	350		
		TMS9929	£20		
		TMS5100	£10		
		TMS6011	365		
		TMS4164-15	475		
		TMS9927	£15		
		TMS9928	£20		
		TMS9929	£16		
		ULN2003	75		
		UPD7002	425		
		Z80CPU 2.5	299		
		Z80ACPU4M	300		

74S Series

74S00	24	74S174	250
74S02	24	74S175	320
74S04	30	74S188	140
74S05	60	74S189	140
74S08	60	74S194	320
74S10	40	74S195	400
74S11	50	74S197	400
74S20	40	74S201	350
74S22	50	74S225	500
74S30	40	74S240	300
74S32	70	74S241	300
74S37	60	74S244	290
74S74	75	74S251	250
74S85	295	74S257	250
74S86	70	74S258	250
74S112	90	74S260	70
74S113	90	74S262	850
74S114	90	74S287	225
74S124	300	74S288	150
74S132	110	74S289	290
74S133	60	74S299	540
74S138	115	74S301	000
74S139	115	74S365	000
74S140	60	74S373	400
74S151	180	74S374	365
74S153	182	74S470	325
74S157	250	74S471	620
74S158	195	74S472	1150
74S163	300	74S474	400
		74S475	800
		74S571	620
		74S573	950

75 Series

75107/8	95
75110	90
75150	125
75154	125
75182/3	99
75188/9	55
75322	140
75450	86
75451/2	52
75454	70
75491/2	65

TTL 74

7400	11	7437	25	74100	80	74160	60
7401	11	7438	22	74104	50	74161	48
7402	11	7440	15	74105	55	74162	40
7403	12	7441	55	74107	20	74163	40
7404	13	7442	32	74109	25	74164	40
74L04	85	7443	90	74110	35	74165	48
7405	15	7444	90	74111	55	74166	48
7406	20	7445	55	74112	170	74167	150
7407	20	7446	60	74116	50	74170	125
7408	14	7447	35	74118	55	74172	250
7409	14	7448	40	74119	60	74173	60
7410	14	7450	16	74120	60	74174	54
7411	16	7451	16	74121	25	74175	19
7412	18	7453	16	74122	35	74176	40
7413	18	7454	16	74123	35	74177	45
7414	20	7460	16	74125	35	74178	80
7416	20	7470	30	74126	35	74179	80
7417	20	7472	24	74128	35	74180	40
7420	15	7473	24	74132	28	74181	115
7421	20	7474	20	74136	28	74182	60
7422	20	7475	25	74141	55	74184	90
7423	20	7476	25	74142	175	74185	95
7425	18	7480	40	74143	210	74186	470
7426	18	7481	120	74144	210	74188	250
7427	18	7482	65	74145	50	74190	48
7428	25	7483	38	74147	75	74191	46
7430	14	7484	70	74148	60	74192	46
7432	20	7485	60	74150	50	74193	45
7433	22	7486	20	74151	40	74194	40
		7489	170	74153	40	74195	40
		7490	20	74154	55	74196	46
		7491	35	74155	40	74197	40
		7492	25	74156	40	74198	80
		7493	25	74157	30	74199	84
		7494	35	74159	80	74221	54
		7495	35			74246	120
		7496	35			74247	120
		7497	90			74248	120

74249	120
74251	65
74259	150
74265	55
74273	150
74276	120
74278	100
74279	50
74283	50
74284	155
74285	155
74290	105
74293	80
74297	236
74298	100
74351	195
74365	30
74366	30
74367	30
74368	30
74390	75
74393	90
74490	95

74C

74C244	195
C245	195
C373	240
C374	245
C922	420
C923	500
C925	400

74LS

LS00	11	LS107	40	LS191	36
LS01	11	LS109	23	LS192	36
LS02	11	LS112	22	LS193	37
LS03	12	LS113	16	LS194	33
LS04	12	LS114	22	LS195	33
LS05	12	LS122	36	LS196	45
LS08	12	LS123	38	LS197	45
LS09	12	LS124	90	LS221	55
LS10	12	LS125	24	LS240	55
LS11	12	LS126	25	LS241	55
LS12	12	LS132	35	LS242	55
LS13	15	LS133	30	LS243	55
LS14	26	LS136	24	LS244	50
LS15	12	LS138	25	LS245	70
LS20	12	LS139	28	LS247	50
LS21	12	LS145	70	LS248	55
LS22	12	LS147	100	LS249	55
LS26	12	LS148	70	LS251	32
LS27	12	LS151	40	LS253	32
LS28	14	LS153	40	LS257	30
LS30	12	LS154	80	LS258	35
LS32	13	LS155	30	LS259	55
LS33	14	LS156	36	LS260	22
LS37	14	LS157	27	LS261	100
LS38	15	LS158	30	LS266	18
LS40	13	LS160	32	LS273	54
LS42	28	LS161	37	LS275	125
LS47	35	LS162	37	LS279	30
LS48	45	LS163	37	LS280	90
LS49	50	LS164	43	LS283	40
LS51	14	LS165	50	LS290	53
LS54	14	LS166	52	LS293	40
LS55	14	LS168	85	LS295	75
LS63	120	LS170	70	LS298	80
LS73	18	LS173	55	LS299	150
LS74	18	LS174	50	LS320	200
LS75	20	LS175	40	LS323	160
LS76	18	LS181	90	LS324	168
LS78	18	LS183	180	LS325	295
LS83	36	LS190	36	LS326	240
LS85	42			LS327	240
LS86	16			LS347	95
LS90	24			LS348	90
LS91	60			LS352	62
LS92	32			LS353	62
LS93	23			LS362	750
LS95	40			LS363	140
LS96	95			LS364	140

LS365	28
LS366	32
LS367	28
LS368	35
LS373	60
LS374	55
LS375	50
LS377	85
LS378	80
LS379	110
LS384	395
LS385	250
LS390	46
LS393	42
LS395	95
LS399	150
LS445	100
LS471	620
LS490	200
LS540	100
LS541	80
LS640	180
LS641	180
LS645	180
LS668	125
LS669	120
LS670	100
LS673	550

CMOS

4000	10	4014	46	4440	999
4001	10	4015	40	4450	350
4002	12	4016	20	4451	350
4006	50	4017	32	4490	350
4007	14	4018	45	4500	675
4008	32	4019	25	4501	28
4009	24	4020	42	4502	60
4010	24	4021	40	4503	35
4011	10	4022	40	4504	75
4012	16	4023	13	4505	185
4013	20	4024	32	4506	35
		4025	13	4507	35
		4026	80	4508	130
		4027	20	4510	46
		4028	39	4511	46
		4029	45	4512	42
		4030	15	4513	199
		4031	125	4514	125
		4032	80	4515	125
		4033	125	4516	65
		4034	140	4517	275
		4035	45	4518	40
		4036	275	4519	30
		4037	115	4520	70
		4038	110	4521	130
		4039	290	4522	125
		4040	40	4526	60
		4041	40	4527	50
		4042	40	4528	50
		4043	40	4529	150
		4044	40	4530	90
		4045	105	4531	130
		4046	46	4532	50
		4047	40	4534	455
		4048	40	4536	275
		4049	25	4538	70
		4050	25	4539	90
		4051	45	4541	140
		4052	60	4543	70
		4053	50	4544	150
		4054	85	4548	40
		4055	85	4549	375
		4056	85	4553	245
		4059	435	4555	35
		4060	45	4556	35
		4061	1195	4557	320
		4062	995	4558	120
		4063	85	4559	395
		4066	24	4560	160
		4067	245	4561	104
		4068	14	4562	495
		4069	13	4566	165
		4070	13	4568	250
		4071	13	4569	175
		4072	13	4572	36
		4073	15	4580	460
		4075	13	4581	250
		4076	50	4582	99
		4077	13	4583	99
		4078	15	4584	48
		4081	13	4585	99
		4082	13	4597	330
		4085	50	4599	290
		4086	60	40097	45
		4089	125	40098	42
		4093	20	40100	215
		4094	70	40101	130
		4095	95	40102	140
		4096	70	40103	175
		4097	190	40104	95
		4098	75	40105	115
		4099	75	40106	75
		4160	95	40107	60
		4161	99	40108	450
		4162	99	40109	100
		4163	99	40110	300
		4174	99	40114	240
		4175	105	40163	50
		4194	105	40174	45
		4408	790	40175	50
		4409	790	40192	95
		4410	725	40193	95
		4411	690	40194	90
		4412	790	40195	80
		4415	480	40244	195
		4419	280	40245	195
		4422	770	40373	240
		4433	770	40374	245
		4435	850	45106	595

SPEAKERS
8Ω, 0.3W, 2", 2.25", 2.5", 3" 80p
0.3W, 2.5" 40Ω; 64Ω or 80Ω 80p

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
IN914	4
IN916	5
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IN5401	15
IN5404	16
IN5406	17
IN5408	19
IS44	9
IS921	9
6A/100V	40
6A/400V	50
6A/800V	65

Noise Diode
Z5J 195

SCR's Thyristors

0.8A-100V	32
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

DIAC
ST2 25

BRIDGE RECTIFIERS (plastic case)

1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18	50

ZENERS
Range 2V7 to 39V 400mW 8p each
Range 3V3 to 33V 1.3W 15p each

VARICAPS

MVAM2	165
BA102	30
BB105B	40
BB106	40

Noise Diode
Z5J 195

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

SOLDERCON PINS
100 75p
500 370p

OPTO ELECTRONICS
LEDS including Clips

TIL209 Red 3mm	10
TIL211 Green 3mm	14
TIL212 Yellow	14
TIL220 .2" Red	12
0.2" Yel, Grn, Amber	14
Rectangular LEDs with two part clip R, G & Y	29
Rectangl. Stackable LEDS	18
Triangular LEDs R&G	18
0.2" Flashing LED Red	56
0.2" Bi colour LEDs Red/Green	65
Green/Yellow	80
0.2" Tri colour LEDs Red/Green/Yellow	85
0.2" Red High Bright	56
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	54
TIL38	45
TIL81	82
TIL100	90

7 Segment Displays

TIL321 .5" C.An	115
TIL322 .5" C.th	115
DL704 .3" C.Cth	99
DL707 .3" C.Anod	99
FND357 or 500	120
3" Green C.A	140
1.3" Red or Green >	150
Bargraph 10 seg. Red	225
Bargraph NSM3914	500

FERRIC CHLORIDE
Crystals 1lb
195p + 50p p&p

DALO ETCH RESIST
Pen plus spare tip 90p

0.5" LIQUID CRYSTAL DISPLAYS

3½ digit	495
4 digit	530
6 digit	625
BPX25	195
BPW21	295
BPX65	270
IL74	45
ILD74	99
ILQ74	185
TIL111	75
OCP71	120
ORP12	78
ORP61	85
2N5777	45
4N33	135

OPTO SWITCH
Reflective TIL139 170
Slotted similar to RS 186

ALUM.BOXES

4×2½×2"	85
4×2½×2½"	103
4×4×2½"	120
5×4×2	105
5×2½×1½"	90
5×2½×2½"	130
5×4×1½"	99
5×4×2½"	120
6×4×2"	120
6×4×3"	150
7×5×3"	180
8×6×3"	210
10×4½×3"	240
10×7×3"	275
12×5×3"	260
12×8×3"	295

COPPER CLAD BOARDS

	Fibre Glass Single-sided	Double-sided	SRBP 9.5"×8.5"
6"×6"	90p	110p	95p
6"×12"	150p	195p	

VEROBOARDS 0.1"

	Clad	Plain
2½"×3¾"	85p	—
2½"×5"	100p	—
3¾"×3¾"	100p	—
3¾"×5"	115p	87p
3¾"×17"	390p	298p
4¾"×18"	495p	275
Pkt. of 100 pins	55p	

Spot Face Cutter 150p
Pin Insertion Tool 185p

'VQ' Board	180
'DIP' Board	374
Vero Strip	144
S100 Board	£14

PROTO-DECs

Veroblock	405
S-Dec	350
Eurobreadboard	520
Bimboard 1	695
Superstrip SS2	£13

VERO WIRING PEN and Spool 350p
Spare Wire (Spool) 75p; Combs 6p ea.
Wire Wrapping Stakes 100 250p

VOLTAGE REGULATORS
1A T0220 Plastic Casing

	+ve		−ve	
5V	7805	40p	7905	45p
12V	7812	40p	7912	45p
15V	7815	40p	7915	45p
18V	7818	40p	7918	45p
24V	7824	40p		

100mA T092 Plastic Casing >

5V	78L05	30p	79L05	60p
6V	78L62	30p		
8V	78L82	30p		
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H	170	LM305H	140
LM304H	160	LM309K	135
1 0 4 0 3 7 8 H 0 5		LM317K	320
5V/5A	550	LM317P	99
78H12 12V/5A	580	LM323K	500
78HG+5 to +24V 5A	599	LM337T	175
79HG −2.25V to −24V 5A	685	LM723	35
		TBA625B	75

SWITCHES

SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
½A DP on/on/on	40

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

TOGGLE 2A 250V

SPST	33
DPDT	44
4 pole on off	54

SUB-MIN TOGGLE 2 amp

SP changeover	60
SPST on off	54
SPDT c/off	85
SPDT Biased	105
DPDT 6 tags	75
DPDT C/OFF	88
DPDT on/on/on	185
DPDT Biased	145
3 pole c/over	205

ROCKER: 5A, 250V, SPST 28p
ROCKER: 10A 250V SPDT 38p
ROCKER: With neon lights red when on. 10A 250V, DPST 85p
ROCKER: (White) 10A/250V DPDT 72p
ROTARY: Make your own Multiway Switch. Shafting Assembly 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 64p
DIL SWITCHES: (SPST) 4 way 65p; 6 way 80p; 8 way 87p; 10 way 135p; (SPDT) 4 way 190p.
THUMBWHEEL Mini front mounting
Decade Switch Module 220p
B.C.D. Switch Module 275p
Mounting Cheeks (pair) 75p
PROXIMITY Switch with magnet 125p

DIL SOCKETS

	Low profile	Wire wrap
8 pin	8p	25p
14 pin	10p	35p
16 pin	10p	42p
18 pin	16p	52p
20 pin	20p	60p
22 pin	22p	65p
24 pin	25p	70p
28 pin	28p	80p
40 pin	30p	99p

ZIF DIL SOCKET

16 way	475p
24 way	575p
28 way	850p
40 way	975p

DIL PLUGS (Headers)

Pins	Solder	IDC
14	38p	95p
16	42p	100p
24	88p	138p
40	195p	218p

RIBBON CABLE (price per foot)

Ways	Grey	Color
10	15p	28p
16	25p	40p
20	30p	50p
20	40p	65p
34	60p	85p
40	70p	90p
64	100p	135p

'D' CONNECTORS:

Pins	9 way	15 way	25 way	37 way
MALE				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	355
Strait	170p	160p	220p	310p
FEMALE				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p

COVERS
IDC 25 way Plg. 385p, Skt 450p

SIL Sockets 0.1"
20 way 65p
32 way 95p

EDGE CONNECTORS

	0.1"	0.156"
2×10 way		135p
2×15 way		140p
2×18 way	180p	145p
2×22 way	199p	200p
2×23 way	170p	190p
2×25 way	225p	220p
2×28 way	210p	
2×30 way	245p	
2×36 way	295p	
2×40 way	315p	
2×43 way	395p	
2×75 way	550p	

ULTIMUM

WATFORD'S most versatile MICRO EXPANSION SYSTEM. Interfaces with: APPLE, ATOM, DRAGON, PET, RESEARCH MACHINE, SPECTRUM, SUPERBOARD, VIDEO GENIE, ZX81, etc. As published in P.E. starting from Nov., 1982.

Send SAE for details.

IDC CONNECTORS (Speed block type)

2 rows	PCB Male with latch Strt. Pins	PCB Male with latch Angle Pins	Female Header Socket	Female Card-Edge Connector
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	195p
20 way	145p	166p	125p	240p
26 way	175p	200p	150p	320p
34 way	205p	234p	169p	340p
40 way	220p	250p	190p	420p
50 way	235p	270p	200p	470p

EURO CONNECTORS

	FEMALE SOCKETS Strt.	FEMALE SOCKETS Angle	MALE PLUGS Strt.	MALE PLUGS Angle
DIN 41617 31 way	170p	—	—	175p
DIN 41612 2×32 way	275p	320p	220p	285p
DIN 41612 2-3×32 way	295p	340p	240p	300p
DIN 41612 3×32 way	360p	385p	260p	395p

TRANSFORMERS (mains Prim. 220-240V)
3-0-3V, 6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA; 15-0-15V 75mA 98p
6VA: 2x6V-.5A; 2x9V-.4A; 2x12V-0.3A; 2x15V-.25A 220p
12VA: 2x4V5-1.3A; 2x6V-1.2A; 2x12V-.5A; 2x15V-.4A 295p (35p 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 330p (60p p&p)
50VA: 2×6V-4A; 2×9V-2.5A; 2×12V-2A; 2×15V-1.5A; 2×20V-1.2A; 2×25V-2A; 2×30V-0.8A 465p (60p p&p)
100VA: 2×12V-4A; 2×15V-3A; 2×20V-2.5A; 2×30V-1.5A; 2×40V-1.25A; 2×50V-1A 920p (60p p&p)

JUMPER LEADS Ribbon Cable Assembly
DIL Plug (Headers)
Single Ended Lead, 24" long

Length	14pin	16pin	24 pin	40 pin
24"	145p	165p	240p	325p
Double Ended Leads				
6"	185p	205p	300p	465p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

IDC FEMALE RECEPTACLE Jumper Leads 24"

	20pin	26pin	34pin	40pin
1 end	160p	200p	260p	300p
2 ends	290p	370p	480p	525p

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CRYSTALS

32.768KHz	100
100KHz	235
200KHz	268
455KHz	370
1MHz	275
1.008M	275
1.28MHz	392
1.5MHz	420
1.6MHz	395
1.8MHz	395
1.8432M	200
2.0MHz	225
2.4576M	200
2.5MHz	225
2.56250M	220
3.2768M	150
3.57954M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.194304M	200
4.433619M	100
4.608MHz	200
4.80MHz	200
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	200
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.867237M	175
9.00MHz	200
9.375MHz	350
10.0MHz	175
10.5MHz	250
10.7MHz	150
10.24MHz	200
12.0MHz	175
12.528MHz	300
14.31818M	170
14.7456M	175
14.765MHz	250
15.0MHz	200
16.0MHz	200
18.0MHz	180
18.432M	150
19.968MHz	150
20.0MHz	200
24.0MHz	170
24.930MHz	325
29.695MHz	150
26.670MHz	325
27.125MHz	295
27.145M	190
27.648MHz	300
38.66667M	175
48.0MHz	175
55.5MHz	400
100MHz	350
116.0MHz	300
145.8MHz	225

AMPHENOL PLUGS

	IDC	Solder
24 way IEE	475p	450p
36 way Centronix	525p	485p

ASTEC UHF MODULATORS
6MHz 325p
8MHz Wideband 450p

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- TEAC FD50F Single 5¼" D/S 80 track Drive cased with PSU **400K** (BBC comp.) £475
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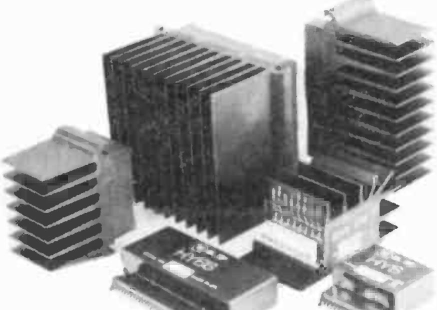
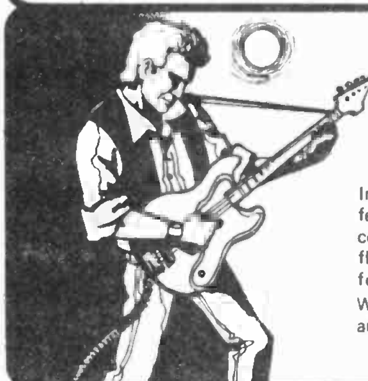


ILP Modular Amplifiers

the third generation

Due to continous improvements in components and design ILP now launch the largest and most advanced generation of modules ever.



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In keeping with ILP's tradition of entirely self-contained modules featuring, integral heatsinks, no external components and only 5 connections required, the range has been optimized for efficiency, flexibility, reliability, easy usage, outstanding performance, value for money.

With over 10 years experience in audio amplifier technology ILP are recognised as world leaders.

BIPOLAR MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
HY30	15	4-8	0.015%	<0.006%	± 18	76 × 68 × 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 × 68 × 40	240	£9.55
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 × 78 × 40	420	£18.69
HY124	60	4	0.01%	<0.006%	± 26	120 × 78 × 40	410	£20.75
HY128	60	8	0.01%	<0.006%	± 35	120 × 78 × 40	410	£20.75
HY244	120	4	0.01%	<0.006%	± 35	120 × 78 × 50	520	£25.47
HY248	120	8	0.01%	<0.006%	± 50	120 × 78 × 50	520	£25.47
HY364	180	4	0.01%	<0.006%	± 45	120 × 78 × 100	1030	£38.41
HY368	180	8	0.01%	<0.006%	± 60	120 × 78 × 100	1030	£38.41

Protection: Full load line. Slew Rate 15v/μs. Risetime: 5μs. S/N ratio 100db.
Frequency response (−3dB) 15Hz – 50KHz. Input sensitivity 500mV rms.
Input Impedance 100K Ω. Damping factor 100Hz >400.

PRE-AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price inc. VAT
HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble	10mA	£7.60
HY66	Stereo pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

Most pre-amp modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre amp modules if required for £5.47 (inc. VAT). Pre-amp and mixing modules in 18 different variations. Please send for details.

Mounting Boards

For ease of construction we recommend the **B6** for modules HY6–HY13 £1.05 (inc. VAT) and the **B66** for modules HY66—HY78 £1.29 (inc. VAT).

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 × 78 × 40	[illegible]	[illegible]
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 × 78 × 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 × 78 × 100	1025	£45.54

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate 20v/μs. Rise time 3μs. S/N ratio: 100db
Frequency response (−3dB) 15Hz – 100KHz. Input sensitivity 500mV rms
Input impedance: 100K Ω. Damping factor 100Hz > 400.

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C15

Mono Power Booster Amplifier to increase the output of your existing car radio or cassette player to a nominal 15 watts rms.

Very easy to use.

Robust construction. **£9.14 (inc. VAT)**

Mounts anywhere in car.

Automatic switch on.

Output power maximum 22w peak into 4Ω.
Frequency response (−3dB) 15Hz to 30KHz, T.H.D. 0.1% at 10w 1KHz
S/N ratio (DIN AUDIO) 80dB, Load Impedance 3Ω.
Input Sensitivity and impedance (selectable) 700mV rms into 15K Ω 3V rms into 8 Ω.
Size 95 × 48 × 50mm. Weight 256 gms.

C1515

Stereo version of C15. **£17.19 (inc. VAT)**

Size 95 × 40 × 80. Weight 410 gms.

POWER SUPPLY UNITS (Incorporating our own toroidal transformers)

Model Number	For Use With	Price inc. VAT
PSU 21X	1 or 2 HY30	£11.93
PSU 41X	1 or 2 HY60, 1 × HY6060, 1 × HY124	£13.83
PSU 42X	1 × HY128	£15.90
PSU 43X	1 × MOS128	£16.70
PSU 51X	2 × HY128, 1 × HY244	£17.07

Model Number	For Use With	Price inc. VAT
PSU 52X	2 × HY124	£17.07
PSU 53X	2 × MOS128	£17.86
PSU 54X	1 × HY248	£17.86
PSU 55X	1 × MOS248	£19.52
PSU 71X	2 × HY244	£21.75

Model Number	For Use With	Price inc. VAT
PSU 72X	2 × HY248	£22.54
PSU 73X	1 × HY364	£22.54
PSU 74X	1 × HY368	£24.20
PSU 75X	2 × MOS248, 1 × MOS368	£24.20

Please note: X in part no. indicates primary voltage. Please insert "0" in place of X for 110V, "1" in place of X for 220V, and "2" in place of X for 240V.

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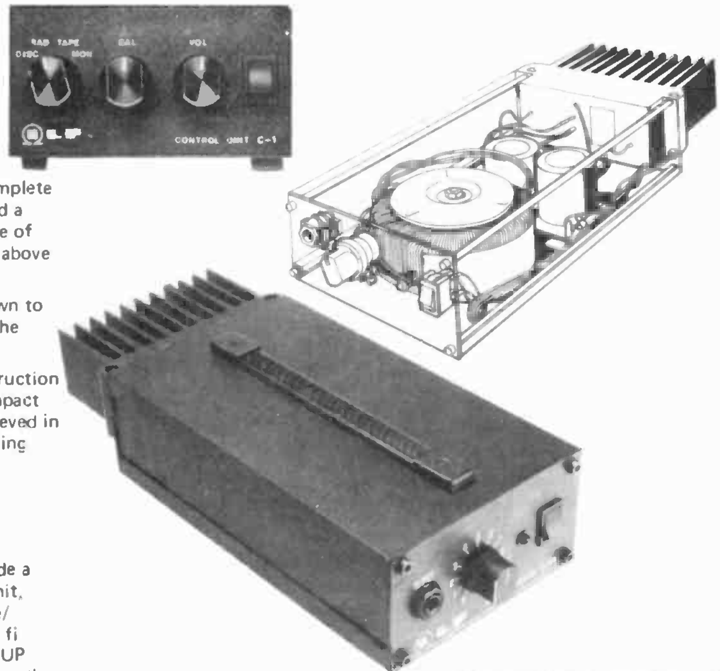

Unicase

Over the years ILP has been aware of the need for a complete packaging system for it's products, it has now developed a unique system which meets all the requirements for ease of assembly, adaptability, ruggedness, modern styling and above all price.

Each Unicase kit contains all the hardware required down to the last nut and bolt to build a complete unit without the need for any special tools.

Because of ILP's modular approach, "open plan" construction is used and final assembly of the unit parts forms a compact aesthetic unit. By this method construction can be achieved in under two hours with little experience of electronic wiring and mechanical assembly.

Hi Fi Separates

UC1 PRE AMP UNIT: Incorporates the HY78 to provide a "no frills", low distortion, (<0.01%), stereo control unit, providing inputs for magnetic cartridge, tuner, and tape/monitor facilities. This unit provides the heart of the hi fi system and can be used in conjunction with any of the UP Unicase series of power amps. For ultimate hum rejection the UC1 draws its power from the power amp unit.

POWER AMPS: The UP series feature a clean line front panel incorporating on/off switch and concealed indicator. They are designed to compliment the style of the UC1 pre-amp. Performance for each unit which includes the appropriate power supply, is as specified on the facing page.

Power Slaves

Our power slaves, which have numerous uses i.e. instrument, discotheque, sound reinforcement, feature in addition to the hi fi series, front panel input jack, level control, and a carrying handle. Providing the smallest, lowest cost, slave on the market in this format.

UNICASES

HIFI Separates					Price inc. VAT
UC1	Preamp				£29.95
UP1X	30 + 30W/4–8Ω	Bipolar	Stereo	HiFi	£54.95
UP2X	60W/4Ω	Bipolar	Mono	HiFi	£54.95
UP3X	60W/8Ω	Bipolar	Mono	HiFi	£54.95
UP4X	120W/4Ω	Bipolar	Mono	HiFi	£74.95
UP5X	120W/8Ω	Bipolar	Mono	HiFi	£74.95
UP6X	60W/4–8Ω	MOS	Mono	HiFi	£64.95
UP7X	120W/4–8Ω	MOS	Mono	HiFi	£84.95
Power Slaves					
US1X	60W/4Ω	Bipolar	Power	Slave	£59.95
US2X	120W/4Ω	Bipolar	Power	Slave	£79.95
US3X	60W/4–8Ω	MOS	Power	Slave	£69.96
US4X	120W/4–8Ω	MOS	Power	Slave	£89.95

Please note X in part number denotes mains voltage. Please insert '0' in place of X for 110V, '1' in place of X for 220V (Europe), and '2' in place of X for 240V (U.K.) All units except UC1 incorporate our own toroidal transformers.

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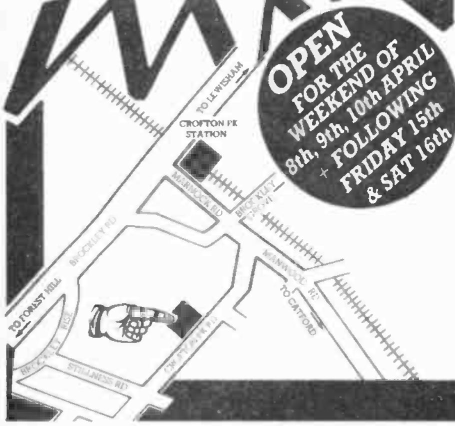

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COMPONENT KIT £266

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by ROLAND

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Design – Allan Bradford Published in P.E.

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(As Published in conjunction with "Practical Electronics")

COMPLETE KIT **£235**

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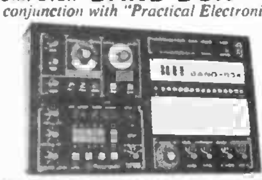

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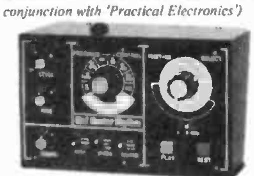
The BAND-BOX provides an Electronic Backing Trio consisting of Drums, Bass, and a Chord Instrument (one of 16 Waveform/Envelope combinations), with the capacity to store over 3,000 User Programmable Chord Changes on more than 120 different Chords. Using advanced Microprocessor technology. Playback of 50-100 Scores can be executed in any Key and at chosen Tempo. Complete Music Pad is electronically Indexed and stored on secondary battery back-up. Facility exists for composition of Intro, Repeat Chorus, and Coda sections including Multiple Score Sequences. Sockets are provided for Volume Pedal and Footswitch plus separate and mixed instrument Outputs. Total size 19" x 11" x 4½" incorporating Master Rhythm.

THE Programmable DRUM MACHINE

(As Published in conjunction with 'Practical Electronics')

EIGHT TRACK PROGRAMMING /TWENTY-FOUR PATTERNS/ TWELVE INSTRUMENTS SEQUENCE OPERATION. COMPLETE KIT £79.00 MANFD. £119.00



The Clef Master Rhythm is capable of storing 24 selectable rhythmic drum patterns, invented, modified, and entered by the Operator on to Eight Instrumentation tracks. A three position Instrumentation control expands the number of instruments available to twelve, grouped into sounds typical of playing with Drumsticks, Brushes, or Latin American Bongos and Claves.

Sequence operation allows two rhythm sections to be coupled with the second (B) section appearing at four, eight or sixteen Bar repetition. All drums can be adjusted for level and resonance on internal controls to suit individual taste, thus producing good musical sounds in a battery driven unit 8¼" x 5" x 2½".

HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w. of lighting

TDR300K	Remote Control Dimmer	£14.30
MK6	Transmitter for above	£ 4.20
TD300K	Touchdimmer	£ 7.00
TDE/K	Extension kit for 2-way switching for TD300K	£ 2.00
LD300K	Rotary Controlled Dimmer	£ 3.50

HOME CONTROL CENTRE

This New Remote Control Kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains wiring which are received by receiver modules connected to the same mains supply and used to switch on the appliance addressed. Receivers are addressed by means of a 16-way keyboard, followed by an on or off command. Since pushing buttons can become rather boring, the transmitter also includes a computer interface so you can programme your favourite micro to switch lights, heating, electric blanket, make your coffee in the morning, etc., without rewiring your house. JUST THINK OF THE POSSIBILITIES. The KIT includes all PCBs and components for one transmitter and two receivers, plus a drilled box for the transmitter.

Order as XK112. **£42.00**

Additional Recievers XK111 £10.00

ELECTRONIC LOCK KIT XK101

This KIT contains a purpose designed lock IC, 10-way keyboard, PCBs and all components to construct a Digital Lock, requiring a 4-key sequence to open and providing over 5000 different combinations. The open sequence may be easily changed by means of a pre-wired plug. Size: 7 x 6 x 3 cms. Supply: 5V to 15 V d.c. at 40uA. Ouput: 750mA max. Hundreds of uses for doors and garages, car anti-theft device, electronic equipment, etc. Will drive most relays direct. Full instructions supplied.

ONLY £10.50

Electric lock mechanism for use with latch locks and above kit **£13.50**

Have you got our FREE ORANGE CATALOGUE yet?
NOW! Send S.A.E. 6" x 9" TODAY!!
It's packed with details of all our KITS plus large range of SEMICONDUCTORS including CMOS, LS TTL, linear, microprocessors and memories; full range of LEDs, capacitors, resistors, hardware, relays, switches etc. We also stock VERO and Antex products as well as books from Texas Instruments, Babani and Elektor.
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and give us your Access or Barclaycard No. or write enclosing cheque or postal order. Official orders accepted from schools, etc.

MINI KITS

MK1 TEMPERATURE CONTROLLER/THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max.) and triac to switch heater. 1KW £4.00

MK2 Solid State Relay
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac £2.50

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10 element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply.

MK4 PROPORTIONAL TEMPERATURE CONTROLLER £4.50
Based on the SL441 zero voltage switch, this kit may be wired to form a "burst fire" power controller, enabling the temperature of an enclosure to be maintained to within 0.5°C. Max. load 3KW £5.55

MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 mins. to 35 hrs. Longer or shorter periods may be realised by minor component changes. Max. load 1KW. £5.00

3-NOTE DOOR CHIME

Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 × 71 × 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK102 **£5.00**

XK113 MW RADIO KIT

Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5.5 × 2.7 × 2cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. **£5.00**

COMPONENT PACKS

PACK 1	650 Resistors 47 ohm to 10 Mohm — 10 per value £4.00
PACK 2	40 × 16V Electrolytic Capacitors 10μF to 1000μF — 5 per value £3.25
PACK 3	60 Polyester Capacitors 0.01 to 1μF/250V — 5 per value £5.55
PACK 4	45 Sub-miniature Presets 100 ohm to 1 Mohm 5 per value £2.90
PACK 5	30 Low Profile IC Sockets 8, 14 and 16 — pin 10 of each £2.40
PACK 6	25 Red LEDs (5mm dia.) £1.25

DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a $3\frac{1}{2}$ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (−50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week.

Price £15.50

DISCO LIGHTING KITS

DL 1000K
This value for money kit features a bi-directional sequence speed of sequence and frequency of direction change being variable by means of potentiometers and incorporates a master dimming control **£14.60**

DLZ100K
A lower cost version of the above featuring undirectional channel sequence with speed variable by means of a pre set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. **Only £8.00**

Optional opto input DLA1 Allowing audio ("beat") light response. **60p**

DL3000K
This 3 channel sound to light kit features zero voltage switching, automatic level control and built in mic. No connections to speaker or amp required. No knobs to adjust simply connect to mains supply and lamps. (1Kw channel) **Only £11.95**

NOW available in stock

THE JUPITER ACE
MICROCOMPUTER

uses FORTH which executes about 10 times faster and requires less program memory than a comparable program using basic. Features 8K ROM, 3K RAM, built in speaker, 40 key keyboard and a 32 × 24 line-flicker free display on TV. Comes supplied complete with leads, mains adaptor, a comprehensive easy-to-follow manual on Forth programming + FREE cassette containing 5 sample programs.

ONLY £75.00
(+ £2.00 carriage + VAT)

WHY NOT COME IN AND SEE IT FOR YOURSELF!

"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor output. Designed primarily for controlling motorised garage doors and two auxiliary outputs for drive/garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.
The Kit comprises a mains powered receiver, a four button transmitter, complete with pre-drilled box, requiring a 9V battery and one opto-isolated solid state switch kit for interfacing the receiver to mains appliances. As with all our kits, full instructions are supplied.

ONLY £23.75

LCD 3½ DIGIT MULTIMETER

16 ranges including DC voltage (200 mv-1000v) and AC voltage, DC current (200 mA-10A) and resistance (0-2 M) + NPN & PNP transistor gain and diode check. Input impedance 10M. Size 155 × 88 × 31mm. Requires PP3 9V battery. Test leads included. **£29.00**

REMOTE CONTROL KITS

MK6 SIMPLE INFRA RED TRANSMITTER
Pulsed infra red source complete with hand-held plastic box. Requires a 9V battery. £4.20

MK7 INFRA RED RECEIVER
Single channel, range approx. 20ft. Mains powered with a triac output to switch loads up to 500W at 240V ac. £9.00 (RC500K —Special Price for MK6 and MK7 together £12.50

MK8 CODED INFRA RED TRANSMITTER
Based on the SL490, the kit includes all components to make a coded transmitter and only requires a 9V (PP3) battery and keyboard. 8 x 2 x 1.3cms £5.90

MK10 16-WAY KEYBOARD
For use with MK8 and MK18 to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) kit. £5.40

MK11 10-Channel + 3 Analogue o/p IR Receiver
Based on ML922 decoder IC. Functions include on/standby output, toggle, control of volume, tone and lamp brightness. Includes its own mains supply. £12.00

MK12 16-CHANNEL IR RECEIVER
For use with 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. Latched or momentary outputs – please specify when ordering. Includes its own mains supply. £11.95

MK13 11-WAY KEYBOARD For use with MK8, MK18 and MK11 kits. £4.35

MK16 Mains Powered IR Transmitter
Mains powered for continuous operation – single channel, for applications such as burglar alarms, automatic door openers, etc. Range approx. 6 ft. £2.50

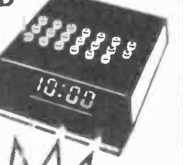
MK17 12V d.c. IR RECEIVER
For use with MK6 or MK16. Relay output with DP 3 Amp change-over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 6-13V d.c. £9.50

MK18 HIGH POWER IR TRANSMITTER
Similar to MK8 but with range of approx. 60ft. £6.20

Ancillary Kits : MK2 Solid State Relay
Opto-isolated with zero voltage switching. No. triac supplied. £2.60

MK15 DUAL LATCHED SOLID STATE RELAY
Comprises 2 x solid state relays and latch for use with momentary version of the MK12. 2 output triacs required (not supplied). £4.50

THE MULTI-PURPOSE TIMER HAS ARRIVED



Now you can run your central heating, lighting, hi-fi system and lots more with just one programmable timer. At your selection it is designed to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central heating (including different switching times for weekends), just connect it to your system programme and set it and forget it—the clock will do the rest.

FEATURES INCLUDE:-
- 0.5" LED 12 hour display.
- Day of week, am/pm and output status indicators.
- 4 zero voltage switched mains outputs.
- 50/60Hz mains operation.
- Battery backup saves stored programmes and continues time keeping during power failures. (Battery not supplied).
- Display blanking during power failure to conserve battery power.
- 18 programme time sets.
- Powerful "Everyday" function enabling output to switch every day but use only one time set.
- Useful "sleep" function–turns on output for one hour.
- Direct switch control enabling output to be turned on immediately or after a specified time interval.
- 20 function keypad for programme entry.
- Programme verification at the touch of a button.

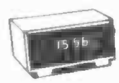
NOW ONLY £39 WITH SO MANY EXTRA FEATURES. OPTIONAL BLACK PLASTIC CASE. READY DRILLED £2.50

(Kit includes all components, PCB, assembly and programming instructions). ORDER AS CT5000

24 HOUR CLOCK/APPLIANCE TIMER KIT

Switches any appliance up to 1KW on and off at present times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triacs, PCBs and full instructions.

CT1000K Basic Kit	£14.90
CT1000K with white box (56/131 x 71mm)	£17.40
(Ready Built)	£22.50



For a detailed booklet on remote control — send us 30p and S.A.E. (6" × 9") today.

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Sinclair ZX Spectr

16K or 48K RAM... full-size moving-key keyboard... colour and sound... high-resolution graphics...

From only £125!

First, there was the world-beating Sinclair ZX80. The first personal computer for under £100.

Then, the ZX81. With up to 16K RAM available, and the ZX Printer. Giving more power and more flexibility. Together, they've sold over 500,000 so far, to make Sinclair world leaders in personal computing. And the ZX81 remains the ideal low-cost introduction to computing.

Now there's the ZX Spectrum! With up to 48K of RAM. A full-size moving-key keyboard. Vivid colour and sound. High-resolution graphics. And a low price that's unrivalled.

Professional power– personal computer price!

The ZX Spectrum incorporates all the proven features of the ZX81. But its new 16K BASIC ROM dramatically increases your computing power.

You have access to a range of 8 colours for foreground, background and border, together with a sound generator and high-resolution graphics.

You have the facility to support separate data files.

You have a choice of storage capacities (governed by the amount of RAM). 16K of RAM (which you can uprate later to 48K of RAM) or a massive 48K of RAM.

Yet the price of the Spectrum 16K is an amazing £125! Even the popular 48K version costs only £175!

You may decide to begin with the 16K version. If so, you can still return it later for an upgrade. The cost? Around £60.

Ready to use today, easy to expand tomorrow

Your ZX Spectrum comes with a mains adaptor and all the necessary leads to connect to most cassette recorders and TVs (colour or black and white).

Employing Sinclair BASIC (now used in over 500,000 computers worldwide) the ZX Spectrum comes complete with two manuals which together represent a detailed course in BASIC programming. Whether you're a beginner or a competent programmer, you'll find them both of immense help. Depending on your computer experience, you'll quickly be moving into the colourful world of ZX Spectrum professional-level computing.

There's no need to stop there. The ZX Printer – available now – is fully compatible with the ZX Spectrum. And later this year there will be Microdrives for massive amounts of extra on-line storage, plus an RS232 / network interface board.

Key features of the Sinclair ZX Spectrum

- Full colour – 8 colours each for foreground, background and border, plus flashing and brightness-intensity control.
- Sound – BEEP command with variable pitch and duration.
- Massive RAM – 16K or 48K.
- Full-size moving-key keyboard – all keys at normal typewriter pitch, with repeat facility on each key.
- High-resolution – 256 dots horizontally x 192 vertically, each individually addressable for true high-resolution graphics.
- ASCII character set – with upper- and lower-case characters.
- Teletext-compatible – user software can generate 40 characters per line or other settings.
- High speed LOAD & SAVE – 16K in 100 seconds via cassette, with VERIFY & MERGE for programs and separate data files.
- Sinclair 16K extended BASIC – incorporating unique 'one-touch' keyword entry, syntax check, and report codes.

um

The ZX Printer – available now

Designed exclusively for use with the Sinclair ZX range of computers, the printer offers ZX Spectrum owners the full ASCII character set – including lower-case characters and high-resolution graphics.

A special feature is COPY which prints out exactly what is on the whole TV screen without the need for further instructions. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch.

The ZX Printer connects to the rear of your ZX Spectrum. A roll of paper (65ft long and 4in wide) is supplied, along with full instructions. Further supplies of paper are available in packs of five rolls.

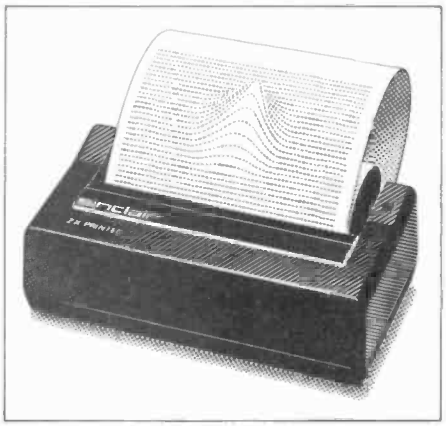
The ZX Microdrive – coming soon

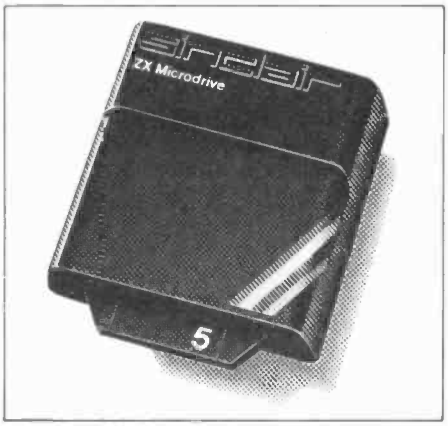
The new Microdrives, designed especially for the ZX Spectrum, are set to change the face of personal computing by providing mass on-line storage.

Each Microdrive can hold up to 100K bytes using a single interchangeable storage medium.

The transfer rate is 16K bytes per second, with an average access time of 3.5 seconds. And you'll be able to connect up to 8 Microdrives to your Spectrum via the ZX Expansion Module.

A remarkable breakthrough at a remarkable price. The Microdrives will be available in the early part of 1983 for around £50.





ZX Spectrum software on cassettes – available now

The Spectrum software library is growing every day. Subjects include games, education, and business/household management. Flight Simulation...Chess...Planetoids...History...Inventions...VU-CALC...VU-3D...Club Record Controller...there is something for everyone. And they all make full use of the Spectrum's colour, sound, and graphics capabilities. You'll receive a detailed catalogue with your Spectrum.

ZX Expansion Module

This module incorporates the three functions of Microdrive controller, local area network, and RS232 interface. Connect it to your Spectrum and you can control up to eight Microdrives, communicate with other computers, and drive a wide range of printers.

The potential is enormous, and the module will be available in the early part of 1983 for around £30.

sinclair

Sinclair Research Ltd, Stanhope Road, Camberley, Surrey GU15 3PS. Tel: Camberley (0276) 685311.

How to order your ZX Spectrum

BY PHONE – Access, Barclaycard or Trustcard holders can call 01-200 0200 for personal attention 24 hours a day, every day. BY FREEPOST – use the no-stamp needed coupon below. You can pay by cheque, postal order, Access, Barclaycard or Trustcard.

EITHER WAY – please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt – and we have no doubt that you will be.

To: Sinclair Research, FREEPOST, Camberley, Surrey, GU15 3BR. **Order**

Qty	Item	Code	Item Price £	Total £
	Sinclair ZX Spectrum – 16K RAM version	100	125.00	
	Sinclair ZX Spectrum – 48K RAM version	101	175.00	
	Sinclair ZX Printer	27	59.95	
	Printer paper (pack of 5 rolls)	16	11.95	
	Postage and packing: orders under £100	28	2.95	
	orders over £100	29	4.95	
			Total £	

Please tick if you require a VAT receipt ☐

*I enclose a cheque/postal order payable to Sinclair Research Ltd for £

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Signature

PLEASE PRINT

Name: Mr/Mrs/Miss

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SUPER KITS!

SETS INCL. PCBS, ELECTRONIC PARTS, INSTRUCTIONS. MOST ALSO INCL. KNOBS, SKTS, WIRE, SOLDER, BOX. BATTERIES NOT INCL. BUT MOST WILL RUN FROM 9V TO 15V DC SUPPLIES. ALSO SEE BELOW.

AUTOWAH: Guitar-triggered wah-wah	SET 58	£14.01
BASS BOOST: Increases volume of lower octaves	SET 138-B	£8.87
CALL SIGN: Programmable 8-note musical call sign	SET 121-Ls	£14.23
CHORUS GENERATOR: Makes a solo voice or instrument sound like more	SET162	£31.59
COMPARATOR: LED level indicator for 2 channels	SET 129-LS	£16.70
COMPRESSOR: Limits & levels maximum signal strength	SET 133-LS	£12.37
FREQUENCY DOUBLER: Raises guitar frequency by I octave	SET 98	£11.75
FREQUENCY-GENERATOR: Multiple waveform test osc, variable .5Hz to 470KHz	SET 128	£18.44
FUNKY-WOBULO: Novelty voice modulator for funny effects	SET 149	£11.79
FLANGER: Fascinating delayed-feed-back effects plus phasing	SET 153	£22.49
FUZZ: Smooth distortion whilst keeping natural attack & decay	SET 91	£11.68
GUITAR EFFECTS: Multiple variation of level & filter modulation	SET 42	£15.92
GUITAR OVERDRIVE: Fuzz plus variable filter quality	SET 56	£21.17
GUITAR SUSTAIN: Extends effective note duration	SET 75	£11.77
HARMONOLA: 3-Octave organ with variable voicing attack, sustain vibrato	SET 124-T	£162.15
4-Octave version	SET 124-F	£184.71
HUM CUT: Tunable filter for reducing low frequency noise	SET 141	£11.43
JABBERVOX: Voice disguiser with clever use of reverb & tremolo	SET 150	£23.46
MAD-ROJ Variable sirens, incl. police, galaxy machine-guns etc	SET 146	£9.99
METRONOME: With audible & visual beat & down-beat marking	SET 143	£13.52
MICROPHONE PRE-AMP: with switchable bass & treble response	SET 144	£8.92
MINISONIC (PE) MK2: 3-octave very versatile music synthesiser	SET 38	£181.56
MIXERS: Several – details in catalogue (see below)		
NOISE LIMITER: reduces tape & system hiss	SET 145	£9.99
PHASER: with automatic & manual rate & depth controls	SET 164	£21.20
POWER SUPPLIES (300mA): 9v	SET 130-N	£13.50
or preset 12 to 15v	SET 130-T	£13.85
REVERB: Analogue unit with variable delay & depth controls	SET 122-LS	£20.39
RHYTHM GENERATOR: 15 switchable rhythms controlling 10 instruments	SET 103F	£61.71
RING MODULATOR: for intermodulating 2 separate sine frequencies	SET 87	£13.62
ROGER 2-GONG: 2 gongs sounded at end of transmision	SET 126-LS	£12.31
ROGER BLEEP: Single bleep sounded at end of transmission	SET 127-LS	£10.07
SCRAMBLER: Codes & decodes transmissions authorised channels	SET 117-LS	£21.81
SEQUENCERS: 128-note keyboard controlled (keyboard incl.)	SET 76	£120.45
16-note (up to 64-bit pattern) panel controlled	SET 86	£64.63
SPEECH PROCESSOR: for clearer transmission & better level control	SET 110-LS	£11.77
STORM EFFECTS: Automatic & manual wind, rain & surf generator	SET 154	£16.72
SYNTHESISER INTERFACE: allows instrument to trigger synth functions	SET 81	£9.49
TREMOLO: Deep tremolo with depth & rate controls	SET 136	£10.71
TREBLE BOOST: Increases volume of upper octaves	SET 138-T	£8.46
TONE CONTROL: bass & treble cut, gain & range (6 controls)	SET 139	£13.62
VIBRATO: variable rate & depth plus additional phasing	SET 137	£23.99
VODALEK: Robot type voice modulator with depth & rate controls	SET-155-LS	£12.40
VOICE FILTER: Tunable for selected freq bandwidth & gain	SET 142	£9.69
VOICE-OP-FADER: for reduction of music level during talk-over	SET 30	£9.85
VOICE-OP-SWITCH: with variable sensitivity & delay, 1A 2PCO relay	SET 123-LS	£13.80
WAH-WAH: with auto-trigger, manual & oscillator control	SET 140	£17.31
WHEEBY-JEEBY: 2 intercoupled oscillators produce variable sirens	SET 151	£13.78
WIND & RAIN: manual control of these two effects	SET 28	£11.39
WOBBLE-WAH: Oscillator controlled wah-wah for fascinating effects	SET 161	£13.40

KIMBER ALLEN KEYBOARDS (surely the best?):	3-Oct £32.43, 4-Oct £40.68, 5-Oct £48.52
KEYBOARD CONTACTS GJ (SPCO):	3-Oct £20.29, 4-Oct £26.50, 5-Oct £32.71
KEYBOARD CONTACTS GB (DPST):	3-Oct £23.27, 4-Oct £30.45, 5-Oct £37.62

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Please use full address. Payment CWO, CHQ, PO, ACCESS, BARCLAY, or pre-arranged collection. Prices incl. UK P&P & 15% VAT. E&OE. Despatch usually 7 days on most items. Details of parts in above kits are stated in our comprehensive catalogue. Send S.A.E. (9×4 or bigger) for Catalogue (if you live overseas please send £1.00 or equiv). MORE KITS ARE IN CATALOGUE.

TRANSFORMERS EX-stock

12V OR 24V or 12-0-12V

Ref.	12V	24V	Price	P&P
213	1.0	0.5	£3.19	£1.20
71	2	1	£4.25	£1.20
18	4	2	£4.91	£1.60
85	5	2.5	£6.78	£1.50
70	6	3	£7.69	£1.40
108	8	4	£8.98	£1.64
72	10	5	£9.82	£1.80
116	12	6	£10.89	£1.90
17	16	8	£12.97	£2.12
115	20	10	£17.46	£2.44
187	30	15	£21.69	£2.64
226	60	30	£44.15	O.A.

Auto's Step Up/Down
105, 115, 190, 200, 210, 230, 240, for step up or down.

Ref.	(Watts)	Price	P&P
113*	15	£2.39	£1.20
64	80	£4.85	£1.40
4	150	£6.48	£1.60
67	500	£13.30	£2.24
84	1000	£22.70	£2.80
93	1500	£28.17	O.A.
94	2000	£42.14	O.A.
73	3000	£71.64	O.A.
80	4000	£93.01	O.A.
57	5000	£108.30	O.A.

*0, 115, 220, 240.

30V (2×15V tapped secs)
3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V or 15V-0-15V.

Ref.	30V	15V	Price	P&P
112	0.5	1	£3.19	£1.20
79	1	2	£4.32	£1.40
3	2	4	£6.99	£1.60
20	3	6	£8.10	£1.85
21	4	8	£9.67	£1.90
51	5	10	£11.95	£2.00
117	6	12	£13.52	£2.02
88	8	16	£18.10	£2.26
89	10	20	£20.88	£2.24
90	12	24	£23.20	O.A.
91	15	30	£26.60	£3.00
92	20	40	£35.64	£4.83

50V (2×25 tapped secs)
Pri 120/240V 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V or 25-0-025V.

Ref.	25V	50V	Price	P&P
102	0.5	1	£4.13	£1.40
103	1	2	£5.03	£1.40
104	2	4	£8.69	£1.84
105	3	6	£10.36	£1.90
106	4	8	£14.10	£2.12
107	6	12	£18.01	£2.34
118	8	16	£24.52	£2.70
119	1-	20	£30.23	O.A.
109	12	24	£36.18	O.A.

60V (2 tapped 30V secs)

Amp 60v	30v	Price	P&P
1	2	£7.15	£1.50
2	4	£9.20	£1.90
3	6	£13.31	£2.02
4	8	£15.15	£2.26
5	10	£19.16	£2.24
6	12	£21.86	£2.64
8	16	£30.72	O.A.

OVERSEAS ENQUIRIES WELCOME

CASED AUTOS 115V USA Socket o/lets
Socket outlet 240V cable.

VA	Ref.	Price	P&P
20	56W	£7.21	£1.25
74	64W	£9.35	£1.50
150	4W	£12.10	£1.84
250	69W	£14.73	£1.60
500	67W	£22.14	£2.24
1000	84W	£33.74	£2.80
2000	95W	£60.47	O.A.

MAINS ISOLATORS
SECS. 0-CT-120V twice.

Ref.	VA	Price	P&P
*07	20	£5.30	£1.50
149	60	£8.63	£1.60
150	100	£10.06	£1.84
151	200	£13.69	£2.12
152	250	£16.31	£2.64
154	500	£25.02	£2.90
155	750	£35.91	O.A.
156	1000	£45.89	O.A.
157	1500	£60.02	O.A.
158	2000	£72.43	O.A.
159	3000	£101.12	O.A.
6K	6000	£207.92	O.A.

400/440 to 240V CT ISOLATORS

VA	Price	+ p&p
60	£8.11	£1.50
250	£16.07	£2.60
350	£19.88	£3.10
500	£24.77	£3.40
1000	£50.53	O.A.
2000	£74.79	O.A.
3000	£104.86	O.A.
6000	£207.92	O.A.

+ 15% VAT

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New Range:-
2000 Handheld DMM 3½ LCD. 1000V 2A AC/DC 20mm Res. Diode test; cont buzzer fused **£71.40+p&p+VAT 15%.**
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43mm×43mm		82mm×78mm	
0.50uA	£6.70	0.50uA	£7.37
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0.1mA	£6.70	0.1mA	£7.37
0.30V	£6.70	0.30v	£7.37

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100V	2amp	£0.52	400V	6amp	£1.44
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TELEPHONE: 01-488 3316/7/8
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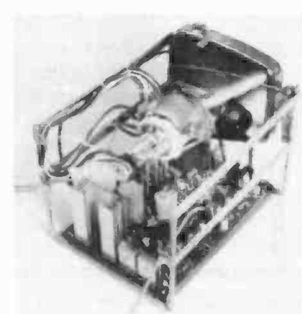

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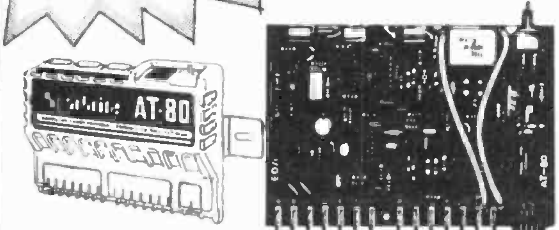

AT-80
Electronic Car Security System

- Arms doors, boot, bonnet and has security loop to protect fog/spot lamps, radio/tape, CB equipment
- Programmable personal code entry system
- Armed and disarmed from outside vehicle using a special magnetic key fob against a windscreen sensor pad adhered to the inside of the screen ● Fits all 12V neg earth vehicles
- Over 250 components to assemble

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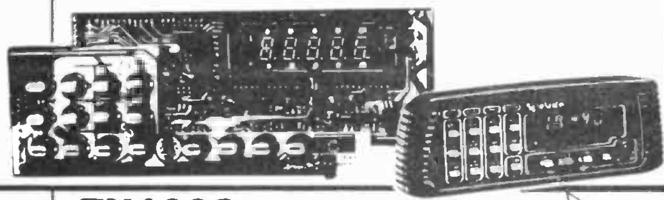
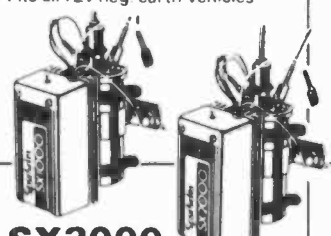
● A most sophisticated accessory ● Utilises a single chip mask programmed microprocessor incorporating a unique programme designed by EDA Sparkrite Ltd ● Affords 12 functions centred on Fuel, Speed, Distance and Time ● Visual and Audible alarms warning of Excess Speed, Frost/Ice, Lights-left-on ● Facility to operate LOG and TRIP functions independently or synchronously ● Large 10mm high 400ft-L fluorescent display with auto intensity ● Unique speed and fuel transducers giving a programmed accuracy of + or − 1% ● Large LOG & TRIP memories, 2,000 miles, 180 gallons, 100 hours ● Full Imperial and Metric calibrations ● Over 300 components to assemble. A real challenge for the electronics enthusiast!



SX1000
Electronic Ignition

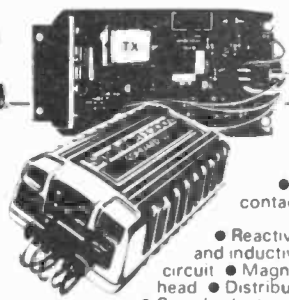
- Inductive Discharge
- Extended coil energy storage circuit
- Contact breaker driven
- Three position changeover switch
- Over 65 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

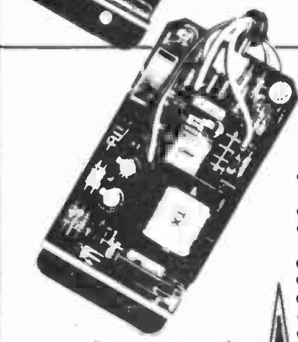


TX1002
Electronic Ignition

NEW

● Contactless or contact triggered ● Extended coil energy storage circuit ● Inductive Discharge ● Three position changeover switch ● Distributor triggerhead adaptors included ● Die cast weatherproof case ● Clip-to-coil or remote mounting facility ● Fits majority of 4 & 6 cyl. 12V. neg. earth vehicles ● Over 145 components to assemble.





SX2000
Electronic Ignition

- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge
- Contact breaker driven
- Three position changeover switch
- Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles

TX2002
Electronic Ignition

● The ultimate system ● Switchable contactless ● Three position switch with Auxiliary back-up inductive circuit ● Reactive Discharge Combined capacitive and inductive ● Extended coil energy storage circuit ● Magnetic contactless distributor trigger-head ● Distributor triggerhead adaptors included ● Can also be triggered by existing contact breakers ● Die cast waterproof case with clip-to-coil fitting ● Fits majority of 4 and 6 cylinder 12v neg. earth vehicles ● Over 150 components to assemble

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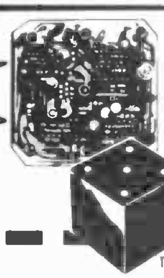

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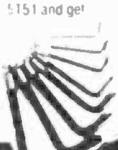

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SX19	100	Mixed Ceramics 68pf-0.5mf	£1
SX20	100	Assorted Polyester/Polystyrene Capacitors	£1
SX21	60	Mixed C280 type capacitors metal foil	£1
SX22	100	Electrolytics, all sorts	£1
SX23	50	Quality Electrolytics	£1

*Quantities approximate, count by weight

BRAND NEW LCD DISPLAY MULTITESTER.

RE 188m
LCD 10 MEGOHM INPUT IMPEDANCE
*3½ digit *16 ranges plus hFE test facility for PNP and NPN transistors *Auto zero, auto polarity *Single-handed, pushbutton operation *Over range indication *12.5mm (½-inch) large LCD readout *Diode check *Fuse circuit protection *Test leads, battery and instructions included

Max indication	1999 or –1999
Polarity indication	Negative only. Positive readings appear without + sign
Input impedance	10 Megohms
Zero adjust	Automatic
Sampling time	250 milliseconds
Temperature range	– 5°C to 50°C
Power Supply	1 x PP3 or equivalent 9V battery
Consumption	20mW
Size	155 x 88 x 31mm

RANGES
DC Voltage 0-200mV, 0-2-20-200-1000V. Acc. 0.8%
AC Voltage 0-200-1000V. Acc. 1.2%
DC Current 0-200uA, 0-2-20-200mA, 0-10 A. Acc. 1.2%
Resistance 0-2-20-200K ohms, 0-2 Megohms. Acc. 1%
BI-PAK VERY LOWEST POSS PRICE **£35.00** each

LEATHER CASE FOR RE 188m £2.50 EACH

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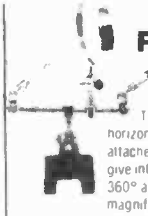
SX46	30 Assorted Zener Diodes 250mw-2 watt mixed voltages, all coded. New	£1
SX47	4 Black Instrument Knobs–winged with pointer ¼" Standard screw. Fit size 29 x 20mm	50p
SX49	20 Assorted Slider Knobs Black/Chrome, etc.	£1
SX80	12 Neons and Filament Lamps. Low voltage and mains – various types and colours – some panel mounting	£1

SIREN ALARM MODULE

American Police type screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car, burglar alarm, freezer breakdown and other security purposes. 5 watt, 12v max.

£3.85
Order No. BP124.

The Third and Fourth Hand...



.... you always need but have never got – until now. This helpful unit with Rod mounted horizontally on Heavy Base. Crocodile clips attached to rod ends. Six ball & socket joints give infinite variation and positions through 360° also available attached to Rod a 2½ diam magnifier giving 2.5 x magnification. Helping hand unit available with or without magnifier. Our Price with magnifier as illustrated ORDER NO. T402 **£5.50**
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SX52 6 Black Heatsink will fit 10-3 and 10-220. Ready drilled. Half price value £1
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FB3	4	13 x 3"	156	£2.00

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Order No.	Pieces	Size	Sq. Ins.	Price
FB4	2	14 x 4"	110	£2.00

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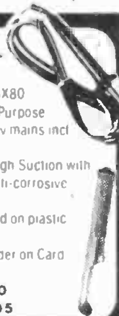
NPN like 2N3055 – but not full spec
100 watts 50V min.
10 for £1.50 – Very Good Value
100s of uses – no duds
Order No. SX90

BI-PAK SOLDER – DESOLDER KIT



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1 High Quality 40 watt General Purpose Lightweight Soldering Iron 240v mains incl 3/16" (4.7mm) bit
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Complete PCB Kit comprises
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ONLY £5.50

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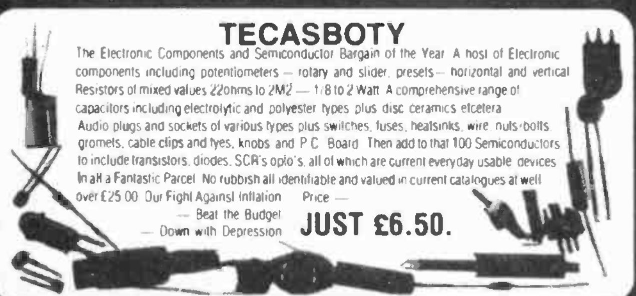

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2N3055 The best known Power Transistors in the World – 2N3055 NPN 115w. Our BI-PAK Special Offer Price:

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SPECIAL PRICE £0.70 each
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4 AMP — 400v — T0202 — TAG 136G

1 OFF	10 OFF	50 OFF	100 OFF
40p	£3.75	£17.50	£30.00

8 AMP 400v — T0220 — TAG 425

60p	£5.75	£27.50	£50.00

SLIDER POTENTIOMETERS — ALL AT 50p PER PAK

Plastic 40mm Travel Mono

SX63 5 x 470 ohms Lin	SX67 5 x 47k Lin
SX64 5 x 1k Lin	SX68 5 x 47k Log
SX65 5 x 22k Lin	SX69 5 x 100 Lin
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SX40 250 Silicon Diodes—Switching like IN4148 DO-35 All good—uncoded. Worth double our price 45v 75mA £1.25

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OPTO 7-Segment Displays

Brand New 1st Quality
LITRONIX DL 707R 14-pin

Red 0.3" Common Anode Display 0-9 with right hand decimal point TTL compatible 5v DC Supply. Data supplied.

IN PACKS OF
- 5 pieces £3 (60p each)
- 10 pieces £5 (50p each)
- 50 pieces £20 (40p each)
- 100 pieces £35 (35p each)
- 1,000 pieces £300 (30p each)

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Miniature round nose side cutters — insulated handles 4½inch length. Order No Y043.

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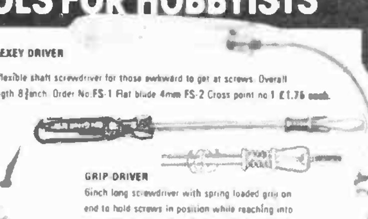
All with insulated handles



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Set of 5 BA spanner shafts plus universal handle in roll-up wallet. Sizes 0BA 2-4-6-8BA Order no: T192
£2.75 set

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7¾in blade order no NS1 £0.65p each
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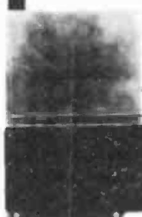
Guarantee

Satisfaction or your money back has always been BI-PAK's GUARANTEE and it still is. All these Sale items are in stock in quantity and we will despatch the same day as your order is received.

EXPERIMENTOR BOXES – ALUMINIUM – PLASTIC



ALUMINIUM BOXES

Made with Bright Aluminium folded construction with deep lid and screws

SIZE" L	W	H	Order No.	Price
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4	2¼	1½	161	83p
4	2½	2	163	83p
3	2	1	164	87p
8	6	3	166	£1.68
6	4	2	167	£1.12

Plastic Boxes

Coloured Black. Close fitting Flanged Lid, fixing screws into brass bushes

SIZE" L	W	H	Order No	Price
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4¾	2½	1½	143	£1.30
6	3¼	2	144	£1.50

Plastic as above but with aluminium top panel

4	2¾	1	146	£1.40

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5½	4¼	2¼ slope to 1½	148	£2.14

All measurements for boxes are shown in inches. L = Length W = Width H = Height

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The more you buy the cheaper they come!

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VOLTAGE REGULATORS T0220

Positive +	Negative +
7805 – 50p	7905 – 55p
7812 – 50p	7912 – 55p
7815 – 50p	7915 – 55p
7824 – 50p	7924 – 55p

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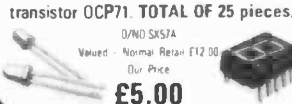
A selection of Large & Small size LED's in Red Green, Yellow and Clear, plus shaped devices of different types. 7 Segment displays, photo transistors, emitters and detectors. Types like MEL11, FPT100 etc. Plus Cadmium Cell ORP12 and germ. photo transistor OCP71. TOTAL OF 25 pieces.



O/NO SX57A
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£5.00

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Charges –	Power –
PP3 (9V)	220-240V AC
U12 (1.5V penlite)	Dims –
U11 (1.5V C)	210 x 100 x 50mm
U2 (1.5V D)	£6.95

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Power supply fits directly into 13 amp socket. Fused for safety. Polarity reversing socket. Voltage switch. Lead with multi plug. Input – 240V AC 50HZ Output – 3 4.5 6 7.5 9 & 12V DC. Rating – 300 ma MW88

1 Amp SILICON RECTIFIERS

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Red plastic case with adjustable fixing bracket. Emits high pitched wailing note of varying pitch – 100 cycles per minute. Dims – 90mm (dia) 60mm (depth) Power – 12v DC

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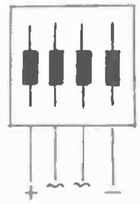
SILICON BRIDGE RECTIFIERS



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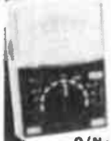
MULTITESTERS



1,000 opv Including test leads & Battery
AC volts - 0-15-150-500-1,000.
DC volts:- 0-15-150-500-1,000.
DC currents:- 0-1ma-150ma
Resistance:- 0-2.5 K ohms 100 K ohms
Dims - 90 x 61 x 30mm.
O/No.1322. OUR PRICE £6.50 ONLY

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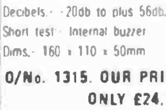
DC current:- 0-50ua 0-5ma-50ma 0-12amps.
Resistance:- 0-6K ohms-70K ohms-6meg ohms-60meg ohms
Decibels:- -20db to plus 56db.
Short test:- Internal buzzer
Dims.:- 160 x 110 x 50mm



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ONLY
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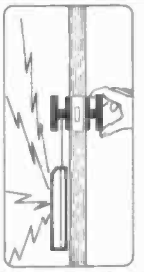

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½W 10Ω-10MΩ 5% E24	3p
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As above with DP switch	80p
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E12 Series 1pf-10nF	7p

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SIEMENS POLY-C 5% 7.5mm 250V CAPACITORS E12

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Complete range of other voltages & spacings in stock. Please phone.

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.22/35V	14p
.33/35V	14p
.47/35V	14p
.68/35V	14p
1.0/35V	14p
2.2/16V	14p
22/35V	22p
33/35V	22p
4.7/16V	22p
4.7/35V	24p
6.8/25V	25p
6.8/35V	25p
10/16V	25p
10/35V	34p
15/10V	22p
15/16V	30p
15/25V	32p
22/6.3V	26p
22/16V	32p
33/10V	36p
47/6.3V	43p
100/3V	37p

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1000pf 500V	7p

MINI FILM MULLARD TRIMMERS

1.4-5.5pf (800MHz)	23p
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5 5-65pf (200MHz)	36p

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50Ω, 100Ω, 200Ω, 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 95p each

Veroboard 0.1" Copper Clad

2.5×3.75	80p
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3.75×5	1.03
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VQ Board	1.80
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Fully enclosed Pither Presets E 3 Series
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QUALITY ELECTROLYTICS BY MATSUSHITA OR SIEMENS AXIALS

ufd	V	
.47	63	8p
.47	100	9p
.47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	18p
47	63	26p
47	100	28p
68	25	18p
68	63	25p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
330	16	19p
330	25	22p
330	63	38p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
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Beautiful Mini Radial Low Voltage Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p

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1. Thin lines
2. Thick lines
3. Thin bends
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75Ω VHF	
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No 3 (Med)	65p
No 6 (Micro)	65p
Bits X25	
No 50 (Small)	65p
No 51 (Med)	65p
No 52 (Lge)	65p

DIL SOCKETS

Pins	Lo prof	W.Wp
8	8p	25p
14	9p	35p
16	10p	40p
18	16p	50p
20	20p	—
22	22p	—
24	24p	70p
28	28p	79p
40	30p	99p

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1st Class Epoxy Glass for better results than spraying. Expose to UV

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100×220	1.90
203×114	1.85
233×220	3.99
Double sided	
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100×220	2.15
203×114	2.21
233×220	4.55
Developer for above (do not use Sodium Hydroxide) 500ml	2.50

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1N821	70p
1N823	82p
1N914	4p
1N916	6p
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	4p
1N4150	18p
1N4448	22p
1N4517	22p
1N5172	30p
1N5176	94p
1N5400	12p
1N5401	13p
1N5402	14p
1N5403	15p
1N5404	16p
1N5405	17p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1N5625	60p
1N5626	62p
1N5627	68p
1S44	10p
1S131	40p
1S134	56p
1S421	1.00
1S421R	1.00
1S940	10p
1S941	11p
1S961	22p
AA118	28p
AA129	57p
AA144	25p
AAY30	44p
AAY33	46p
AA217	27p
BA100	22p
BA102	25p
BA115	25p
BA133	40p
BA136	30p
BA142	20p
BA144	15p
BA155	15p
BA156	30p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAV49	15p
BAX13	10p
BAX16	11p
BAT38	20p
BAY44	15p
BAY93	10p
BB103B	70p
BB103G	70p
BB104B	80p
BB104G	80p
BB105	52p
BB105A	57p
BB105B	58p
BB109G	65p
BY126	20p
BY127	22p
BY134	52p
BY182	1.26
BY188A	65p
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	56p
MZ2361	1.80
OA10	70p
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p
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2.4-47V	8p
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2.5 Watt E24 Series 7.5-75V	1.10
20W Pos Stud (BZY93 series) E24 values 7V5-75V	2.00

BRIDGE RECTIFIERS
(PIV shown in brackets)

1½ amp type	
W01 (100)	20p
W02 (200)	26p
W04 (400)	28p
W08 (800)	40p
6 amp type Square with hole	
PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	86p
PW06 (600)	90p
25 amp type Metal clad with hole	
K01 (100	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40

DIACS

BR100	40p
ST2	25p

THYRISTORS
Sensitive Gate Small Signal

2N5060	30p
2N5061	32p
2N5062	36p
2N5063	37p
2N5064	40p
BR101	75p
BRY39	80p
BRY55-100	60p
BRY55-300	67p
BRY56	50p
TIC44	36p
TIC47	50p

4.8 & 12 Amps Texas TO220
Suffix: A = 100V, B = 200V, C = 300V, D = 400V, M = 600V

4A	
TIC106A	46p
TIC 106B	47p
TIC106C	49p
TIC106D	59p
TIC106M	69p
8A	
TIC116A	68p
TIC116B	68p
TIC116C	71p
TIC116D	73p
TIC116M	80p
12A	
TIC126A	72p
TIC126B	72p
TIC126C	73p
TIC126D	77p
TIC126M	96p

TRIACS Texas 400V
TO220 Case

TIC206D (4A)	66p
TIC225D (6A)	74p
TIC226D (8A)	88p
TIC236D (12A)	1.16
TIC246D (16A)	1.22
TIC246D (16A)	1.22
TIC253D (20A)	1.90
TIC263D (25A)	2.11

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2N5777	78p
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2N5779	1.00
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TIL81	1.00
TIL99	1.25
TIL116	1.10
TIL138	2.40
TIL139	2.40
TIL209	15p
TIL211	19p
TIL212	19p

New LEDs Now in stock
R = red, G = green, Y = yellow

	1+	50+
Large diffused		
RSD	9p	7p
RSD	15p	12p
YSD	15p	12p
Large clear		
RSC	12p	10p
GSC	17p	13p
YSC	17p	13p
Super bright Large (100 times brighter)		
RSU	36p	28p
GSU	42p	34p
YSU	42p	34p
Tri-colour flat		
RGY8	83p	75p

TRANSISTORS

2N404	1.50	2N3010	75p	2N4440	12.58
2N914	20p	2N3011	25p	2N4870	80p
2N916	39p	2N3019	50p	2N4871	55p
2N917	65p	2N3053	27p	2N4888	92p
2N918	33p	2N3054	56p	2N4898	1.29
2N929	36p	2N3055SCSF	80p	2N4901	1.69
2N929A	45p	2N3055RCA	80p	2N4902	3.52
2N930	20p	2N3055H	1.20	2N4903	3.24
2N930A	30p	2N3108	42p	2N4904	2.75
2N1131	24p	2N3109	48p	2N4906	3.25
2N1132	25p	2N3232	1.50	2N4906	3.42
2N1302	45p	2N3250	36p	2N4907	3.20
2N1303	65p	2N3251	36p	2N4908	3.70
2N1304	60p	2N3300	60p	2N4909	2.90
2N1306	65p	2N3301	68p	2N4910	1.95
2N1308	65p	2N3303	80p	2N4913	2.59
2N1890	50p	2N3390	38p	2N4914	2.69
2N1893	30p	2N3391	30p	2N4915	2.95
2N2102	30p	2N3391A	34p	2N4916	48p
2N2217	39p	2N3392	27p	2N4917	47p
2N2218	33p	2N2393	24p	2N4918	95p
2N2218A	25p	2N3394	20p	2N4919	1.28
2N2219	27p	2N3395	25p	2N4920	1.34
2N2219A	28p	2N3396	26p	2N4921	55p
2N2220	22p	2N3397	27p	2N4922	69p
2N2221	22p	2N3439	98p	2N4923	99p
2N2221A	23p	2N3440	80p	2N4924	92p
2N2222	24p	2N3441	1.25	2N4926	95p
2N2222A	25p	2N3442	1.35	2N4927	95p
2N2223	2.60	2N3444	1.70	2N4928	1.59
2N2223A	4.15	2N3445	4.80	2N5086	35p
2N2303	39p	2N3446	6.09	2N5087	38p
2N2368	25p	2N3447	5.72	2N5088	37p
2N2369	19p	2N3448	6.56	2N5089	37p
2N2369A	18p	2N3468	1.00	2N5126	48p
2N2405	88p	2N3517	1.06	2N5127	38p
2N2410	1.15	2N3553	2.30	2N5128	38p
23N2411	3.60	2N3570	2.54	2N5129	30p
2N2412	80p	2N3571	2.19	2N5130	37p
2N2477	95p	2N3572	2.06	2N5131	22p
2N2483	25p	2N3584	2.76	2N5133	22p
2N2484	26p	2N3585	2.99	2N5135	38p
2N2890	2.10	2N3605	36p	2N5136	38p
2N2891	2.28	2N3606	28p	2N5137	23p
2N2892	3.00	2N3607	28p	2N5138	18p
2N2904A	27p	2N3632	9.88	2N5139	48p
2N2905	28p	2N3638	25p	2N5140	25p
2N2905A	29p	2N3638A	37p	2N5141	25p
2N2906	25p	2N3639	36p	2N5143	25p
2N2906A	30p	2N3641	39p	2N5172	15p
2N2907	25p	2N3642	25p	2N5175	58p
2N2907A	26p	2N3643	15p	2N5179	39p
2N2920	3.47	2N3644	28p	2N5180	43p
2N2923	25p	2N3645	33p	2N5183	1.00
2N2924	15p	2N3646	28p	2N5184	1.10
2N2925	15p	2N3702	10p	2N5188	1.15
2N2926	10p	2N3703	10p	2N5189	1.00
		2N3704	10p	2N5190	68p
		2N3705	10p	2N5191	70p
		2N3706	10p	2N5193	90p
		2N3707	10p	2N5194	79p
		2N3708	10p	2N5245	37p
		2N3709	10p	2N5246	40p
		2N3710	10p	2N5247	45p
		2N3711	10p	2N5248	46p
		2N3712	2.00	2N5249	48p
		2N3713	1.38	2N5266	2.88
		2N3714	2.98	2N5293	98p
		2N3715	3.31	2N5294	1.28
		2N3771	1.75	2N5295	1.37
		2N3772	1.83	2N5296	1.28
		2N3773	2.06	2N5298	1.37
		2N3779	1.70	2N5302	3.20
		2N3789	3.27	2N5303	3.80
		2N3790	2.73	2N5305	25p
		2N3791	2.47	2N5306	37p
		2N3792	2.68	2N5307	40p
		2N3794	25p	2N5308	25p
		2N3819	21p	2N5401	35p
		2N3820	38p	2N5415	1.10
		2N3821	1.84	2N5416	1.54
		2N3822	90p	2N5447	16p
		2N3823	45p	2N5448	19p
		2N3824	1.70	2N5449	21p
		2N3866	80p	2N5450	23p
		2N3877A	35p	2N5451	25p
		2N3900	25p	2N5457	29p
		2N3901	30p	2N5458	29p
		2N3902	6.65	2N5459	29p
		2N3903	15p	2N5460	72p
		2N3904	15p	2N5461	60p
		2N3905	15p	2N5462	80p
		2N3906	15p	2N5484	40p
		2N3945	85p	2N5485	29p
		2N3962	30p	2N5490	1.37
		2N3964	1.42	2N5493	1.56
		2N4030	66p	2N5494	1.37
		2N4031	55p	2N5496	1.59
		2N4032	65p	2N5551	37p
		2N4036	58p	2N5648	45p
		2N4037	43p	2N5664	35p
		2N4058	10p	2N5785	90p
		2N4059	17p	2N5813	23p
		2N4240	3.00	2N6027	20p
		2N4248	15p	2N6030	6.60
		2N4249	17p	2N6082	11.09
		2N4250	17p	2N6099	1.20
		2N4284	32p	2N6191	1.30
		2N4285	35p	2N6109	1.15
		2N4287	45p	2N6111	1.00
		2N4788	22p	2N6121	54p
		2N4289	15p	2N6122	56p
		2N4290	45p	2N6123	59p
		2N4291	45p	2N6124	55p
		2N4292	45p	2N6125	59p
		2N4294	45p	2N6126	71p
		2N4297	2.50	2N6129	79p
		2N4302	39p	2N6130	93p
		2N4303	40p	2N6131	98p
		2N4304	43p	2N6132	83p
		2N4314	60p	2N6133	1.14
		2N4247	68p	2N6134	1.36
		2N4347	2.28	2N6250	1.45
		2N4351	1.16	2N6254	1.55
		2N4400	15p	2SC1306	56p
		2N4401	27p	2SC1444	2.50
		2N4402	30p	2SC2078	7.70
		2N4403	30p	3N128	1.12
		2N4409	36p	3N136	3.50
		2N4410	42p	3N139	3.30
		2N4427	79p	3N140	2.37

40 Cricklewood Broadway, London NW2 3ET. Tel: 01-452 0161. Telex: 914977

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CRICKLEWOOD – STOCKING PARTS OTHER STORES CANNOT REACH!

3N143	2.85
3N157	3.00
3N153	2.47
3N154	2.56
3N200	6.93
3N201	2.98
40250	95p
40251	2.77
40254	2.75
40264	2.63
40280	2.00
40290	2.00
40309	1.80
40311	97p
40312	1.64
40313	1.83
40315	1.94
40316	95p
40360	60p
40361	67p
40362	67p
40363	2.22
40364	2.90
40372	4.80
40373	2.60
40374	2.84
40406	1.39
40407	75p
40408	1.59
40410	1.80
40411	2.85
40412	90p
40594	99p
40595	99p
40600	2.58
40601	2.36
40602	1.68
40603	1.09
40604	1.85
40606	2.44
40637	2.00
40643	1.90
40673	63p
40822	1.80
40871	89p
40872	89p
AC125	35p
AC126	25p
AC127	25p
AC128	25p
AC132	39p
AC151	51p
AC152	45p
AC153	55p
AC153K	64p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
ACY17	70p
AD136	7.90
AD145	1.65
AD149	79p
AD150	1.31
AD161	39p
AD162	39p
AF106	75p
AF109	75p
AF114	65p
AF117	70p
AF118	89p
AF124	72p
AF125	72p
AF126	72p
AF130	53p
AF170	88p
AF172	88p
AF178	88p
AF200	65p
AF201	75p
AF239	1.24
AF240	1.00
AF279B	75p
AF279G	75p
AL102	3.48
AU110	2.20
AU113	2.30
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
BC109C	12p
BC113	30p
BC140	29p
BC141	37p
BC142	29p
BC143	34p
BC147	10p
BC147A	10p
BC147B	10p
BC147C	20p
BC148	10p
BC148A	12p
BC148B	13p
BC148C	13p
BC149	10p
BC149B	12p
BC149C	13p
BC152	35p
BC153	23p
BC154	27p
BC157	11p
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BC159C	18p
BC160	42p
BC161	48p
BC167	10p
BC167A	10p

BC167B	13p
BC168	10p
BC168B	10p
BC168C	10p
BC169	10p
BC169B	10p
BC169C	10p
BC170	15p
BC170A	17p
BC170B	17p
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BC350	20p
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BC384	30p
BC384L	30p
BC407	30p
BC408	24p
BC409	30p
BC413	25p
BC414	25p
BC415	30p
BC416	30p
BC418	30p
BC440	32p
BC441	33p
BC460	32p

BC461	33p
BC478	29p
BC479	30p
BC516	40p
BC517	40p
BC547	13p
BC547A	14p
BC547B	14p
BC548	12p
BC548A	13p
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BC548C	15p
BC549	13p
BC549B	14p
BC549C	15p
BC550	30p
BC550C	33p
BC557	15p
BC557A	16p
BC557B	16p
BC558	14p
BC558A	15p
BC558B	16p
BC558C	16p
BC559	15p
BC559B	16p
BC559C	17p
BC560	32p
BC560C	34p
BCY30	1.15
BCY30A	1.30
BCY31	1.15
BCY31A	1.30
BCY32	1.15
BCY32A	1.30
BCY33	90p
BCY33A	1.00
BCY34	90p
BCY34A	90p
BCY54	1.91
BCY58	32p
BCY59	33p
BCY66	1.80
BCY67	2.00
BCY70	16p
BCY71	16p
BCY72	19p
BCY77	34p
BCY78	22p
BCY79	22p
BCY87	6.60
BCY88	4.30
BCY89	4.10
BCZ10	4.60
BCZ11	4.60
BD115	58p
BD116	2.50
BD121	2.25
BD124	1.50
BD131	44p
BD132	44p
BD135	40p
BD136	40p
BD137	42p
BD138	39p
BD139	39p
BD140	39p
BD142	2.40
BD153	1.25
BD155	1.20
BD157	54p
BD158	55p
BD160	3.80
BD181	1.75
BD182	2.50
BD183	2.70
BD187	1.09
BD201	1.30
BD202	1.39
BD204	1.44
BD220	1.00
BD221	95p
BD223	1.00
BD224	95p
BD232	1.11
BD233	70p
BD234	72p
BD237	58p
BD238	58p
BD239A	57p
BD239C	64p
BD240	59p
BD240C	73p
BD241A	60p
BD241C	67p
BD242A	65p
BD242C	70p
BD243A	72p
BD243C	85p
BD244A	82p
BD244C	1.00
BD245A	1.14
BD245C	1.30
BD246A	1.20
BD246C	1.50
BD249A	2.00
BD249C	2.31
BD250A	2.11
BD250C	2.46
BD433	79p
BD434	55p
BD435	81p
BD436	81p
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	93p
BD442	92p
BD529	1.20
BD530	1.30
BD535	75p
BD536	75p
BD537	80p
BD538	80p
BD539	80p
BD539C	1.10
BD540	85p
BD540C	1.20
BD675	72p
BD676	77p
BD677	78p

BD678	83p
BD711	1.32
BD712	1.32
BDX14	1.20
BDX18	1.59
BDX32	3.47
BDY10	2.00
BDY11	2.50
BDY17	2.00
BDY23	3.40
BDY25	3.75
BDY38	1.74
BDY54	1.70
BDY55	1.75
BDY56	1.80
BDY57	5.25
BDY58	6.15
BDY60	1.60
BDY61	2.30
BDY62	2.34
BDY92	3.75
BF115	35p
BF119	1.00
BF121	75p
BF123	70p
BF127	80p
BF153	38p
BF154	25p
BF157	80p
BF158	25p
BF159	58p
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BF163	50p
BF166	57p
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BF181	36p
BF182	36p
BF183	38p
BF184	36p
BF185	37p
BF194	12p
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BF196	12p
BF197	12p
BF198	15p
BF199	15p
BF200	1.49
BF224J	32p
BF225J	35p
BF240	38p
BF241	38p
BF244A	35p
BF244B	35p
BF245A	30p
BF245B	51p
BF246	52p
BF246A	39p
BF246B	53p
BF247A	54p
BF247B	55p
BF254	39p
BF255	42p
BF256A	25p
BF256B	56p
BF256C	62p
BF257	30p
BF258	32p
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BF270	65p
BF271	40p
BF273	40p
BF274	40p
BF324	38p
BF336	36p
BF337	28p
BF338	48p
BF355	60p
BF362	85p
BF363	85p
BF457	46p
BF458	56p
BF459	82p
BF469	86p
BF470	86p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFR90	2.11
BFS28	2.95
BFS61	1.00
BFS98	1.10
BFT19	1.65
BFT19B	1.88
BFT66	2.48
BFW10	1.48
BFW10	1.48
BFW11	1.48
BFW43	2.47
BFW59	1.08
BFW87	1.53
BFW90	1.53
BFX12	1.00
BFX13	91p
BFX19	50p
BFX20	80p
BFX29	26p
BFX30	27p
BFX34	1.00
BFX37	70p
BFX43	70p
BFX68	1.00
BFX84	27p
BFX85	28p
BFX86	28p
BFX87	25p
BFX88	25p
BFX89	F.75
BFY18	48p
BFY19	1.10

BFY37	1.20
BFY39	50p
BFY41	1.18
BFY50	23p
BFY51	23p
BFY52	23p
BFY53	31p
BFY56	31p
BFY56A	68p
BFY75	75p
BFY76	50p
BFY77	80p
BFY78	80p
BFY90	79p
BSX81	1.87
BSW41	95p
BSW67	1.00
BSW70	1.00
BSX19	24p
BSX20	20p
BSX21	40p
BSX26	34p
BSX27	78p
BSX28	56p
BSX29	34p
BSX39	80p
BSX60	75p
BSX61	80p
BSX76	50p
BSX77	55p
BSY24	77p
BSY25	1.00
BSY26	35p
BSY29	70p
BSY39	47p
BSY54	40p
BSY65	55p
BSY95A	25p
BU104	2.22
BU105	1.70
BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	4.35
BU409	1.25
BU500	2.95
BUY20	11.00
BUY21	10.90
BUY23	13.60
BUY24	12.10
BUY25	15.00
BUX20	17.00
BUY18S	3.95
E430	5.60
J300	48p
J310	53p
MA8001	45p
MA8002	62p
MA8003	39p
MD7000	2.60
ME0401	25p
ME0402	30p
ME0404	25p
ME0411	35p
ME0412	35p
ME0413	35p
ME0414	48p
ME0461	45p
ME0462	45p
ME1001	45p
ME1002	45p
ME1075	45p
ME1100	45p
ME1120	48p
ME3002	25p
ME4001	45p
ME4002	45p
ME4003	45p
ME4101	25p
ME4102	25p
ME4013	25p
ME4104	25p
ME6001	25p
ME6002	25p
ME6003	25p
ME6101	25p
ME6102	28p
MJ481	1.69
MJ491	1.72
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
MJ2501	2.25
MJ2955	1.00
MJ3000	2.19
MJ3001	2.25
MJ3701	2.55
MJ4502	3.99
MJE340	53p
MJE370	97p
MJE371	89p
MJE520	92p
MJE521	94p
MJE2955	99p
MJE3055	69p
MJE3739	4.58
MPB111	1.00
MPB112	1.39
MPB121	1.35
MPB122	1.40
MPB123	1.16
MPB512	1.59
MPF102	39p
MPF103	29p
MPF104	29p
MPF105	29p
MPF112	59p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p

MPSA14	45p
MPSA16	30p
MPSA18	65p
MPSA20	48p
MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	42p
MPSL51	48p
MPSU01	94p
MPSU04	1.22
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	96p
MPSU55	58p
MPSU56	59p
MPSU57	1.20
MRF421	poa
MRF450A	poa
MRF453	poa
MRF454	poa
MRF475	7.56
MRF477	poa
MRF479	poa
MRF604	poa
OC20	2.30
OC22	2.00
OC23	2.00
OC25	2.50
OC28	1.70
OC29	2.35
OC35	2.36
OC41	80p
OC43	70p
OC44	82p
OC70	50p
OC71	50p
OC72	50p
OC82	50p
OC82D	70p
OC83	75p
P346A	58p
R2008B	2.14
R2010B	1.88
SC107	27p
SC108	27p
SC109	27p
TIP29A	32p
TIP29C	38p
TIP30A	35p
TIP30C	38p
TIP31A	38p
TIP31C	39p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	65p
TIP49	1.20
TIP50	1.40
TIP53	1.57
TIP54	1.59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	1.20
TIP127	1.27
TIP130	1.50
TIP132	1.60
TIP135	1.60
TIP137	1.60
TIP140	1.04
TIP142	1.04
TIP145	1.19
TIP147	1.19
TIP2955	77p
TIP3055	70p
TIS37	62p
TIS43	40p
VN10KM	60p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	10p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX500	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p

LINEAR ICs

AY1-5050	95p
AY3-8910	5.39
AY3-8912	5.59
AY5-2376	5.89
CA3000	4.80
CA3001	4.95
CA3002	4.60
CA3005	3.15
CA3007	4.82
CA3010	1.30
CA3012	1.75
CA3013	4.12
CA3014	2.35
CA3015	2.62
CA3018	75p
CA3018A	2.00
CA3020	2.00
CA3020A	3.90
CA3021	3.20
CA3022	3.12
CA3026	1.52
CA3028A	1.21
CA3028B	2.53
CA3029	1.44
CA3030A	2.97
CA3033	5.44
CA3034	5.18
CA3035	2.75
CA3039	1.50
CA3041	3.47
CA3042	3.47
CA3043	3.92
CA3046	69p
CA3047	4.60
CA3048	2.98
CA3049	3.21
CA3050	4.11
CA3051	3.80
CA3052	2.82
CA3053	1.00
CA3054	1.66
CA3059	2.80
CA3060	4.09
CA3062	13.84
CA3065E	4.62
CA3068	4.23
CA3070	3.20
CA3071	3.30
CA3075	2.25
CA3076	3.42
CA3078T	2.25
CA3080	1.89
CA3080A	3.95
CA3080E	70p
CA3081	1.90
CA3085	1.35
CA3086	56p
CA3088E	2.35
CA3089E	1.95
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	39p
CA3140T	85p
HA1366W	2.40
HA1388	2.54
ICL7106	7.40
ICL7107	9.50
ICL8038	2.99
ICM7555	80p
LC7120	3.20
LC7130	3.20
LF351	47p
LF353	82p
LF355	83p
LF356	92p
LF357	1.00
LF13201	2.98
LF13331	3.30
LF13741H	68p
LF13641N	58p
LM10CH	4.25
LM11CH	4.50
LM114	6.75
LM137K	11.52
LM301AH	1.00
LM301AN	25p
LM305AH	2.90
LM305N	88p
LM307H	1.05
LM307N	55p
LM308AH	3.16
LM308AN	2.14
LM308H	95p
LM308N	88p
LM309K	2.80
LM310H	1.95
LM310N	1.89
LM311H	1.04
LM311N	70p
LM317K	2.80
LM317MP	1.04
LM318H	2.40
LM318N	1.49
LM319H	2.46
LM319N	2.10
LM320 – See 79XX Series Volt Regulators	
LM324N	29p
LM337K	4.75
LM337MP	1.65
LM337T	1.99
LM339AN	1.60
LM339N	47p
LM340 – See 78XX Series Volt Regulators	
LM345K	8.60
LM348N	62p
LM349N	1.15
LM350K	4.00
LM359N	1.44
LM360N	3.88
LM376N	65p
LM377N	1.69
LM378N	3.40
LM379S	4.79
LM380N14	75p
LM380N8	1.50
LM381AN	2.28
LM381N	1.40
LM382N	1.12
LM383T	3.40

LM384N	1.40
LM386N1	85p
LM386N4	1.20
LM388N	2.43
LM391N60	1.70
LM391N80	1.83
LM392N	75p
LM393N	94p
LM394H	3.80
LM396K	13.52
LM709N8	64p
LM709CH	1.00
LM710CH	89p
LM710CN	52p
LM711CH	1.38
LM711CN	70p
LM723CH	1.21
LM723CN	40p
LM725CH	3.40
LM725CN	3.19
LM733CN	77p
LM741CH	94p
LM741CN	15p
LM741CN14	80p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM1303N	1.20
LM1304N	2.50
LM1305N	3.15
LM1307N	2.75
LM1310N	1.45
LM1330N	2.25
LM1458	44p
LM1496	1.08
LM1800	3.24
LM1801	2.99
LM1812	8.00
LM1818	2.99
LM1820	2.15
LM1828	4.79
LM1830	2.44
LM1845	4.12
LM1848	2.89
LM1850	2.75
LM1871	4.39
LM1872	4.39
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907N8	2.60
LM2917N	1.89
LM2917N8	1.89
LM3524	6.77
LM3301	1.00
LM3302	74p
LM3401	85p
LM3403	75p
LM3405	1.45
LM3900	48p
LM3905	1.25
LM3909	79p
LM3911	1.20
LM3914	1.79
LM3915	1.99
LM3916	2.19
LM4250CH	2.63
LM4250N	2.39
LM13600	1.09
MB3712	1.99
MB3756	3.80
MB8719	7.95
MC1352	1.75
MC1456	1.80
MC3340	1.46
MOST MC Prefix = LM Prefix	
NE531N	1.36
NE543N	2.50
NE544N	1.50
NE555	16p
NE556	46p
NE558	1.89
NE560	3.25
NE565	1.18
NE566	1.49
NE567	1.37
NE570	3.75
NE571	3.75
NE5534	1.49
OM335	7.20
PLL02A	4.85
PLL03A	12.75
RC4194	
RC4195	
RC4136	59p
S566B	2.59
SAD1024	11.99
SAS560	2.59
SAS570	2.59
SAS580	2.59
SAS590	2.59
SFF96364	7.99
SL610C	4.00
SL470	3.47
SL490	3.47
SL611C	4.00
SL612C	4.00
SL620C	6.00
SL621C	6.00
SL623C	10.00
SL630C	6.00
SL640C	6.00
SL641C	6.00
SN76001N	2.80
SN76008	3.80
SN76477	4.49
SN76488	4.49
SN76550	80p
SN76666	2.90
SO41P	1.60
SO42P	1.60
TA7210	1.49
TA7204	1.95
TA7205	89p
TA7222	1.45
TA7310	1.49
TAA263	1.50
TAA300	3.95
TAA320	2.05
TAA350	3.60
TAA521	1.50
TAA522	2.47
TAA550	73p
TAA560	2.35
TAA570	2.35
TAA621AX1	2.75
TAA661A	1.50

TAA661B	1.70
TAA700	2.00
TAA930	2.50
TAA930B	2.63
TAA970	2.45
TAA991D	2.45
TAD100	2.00
TBA120AS	75p
TBA331	1.50
TBA341	2.05
TBA395	1.65
TBA396	1.50
TBA450	1.95
TBA460	1.53
TBA500	2.87
TBA500Q	3.11
TBA510	2.96
TBA510Q	3.06
TBA520	2.57
TBA520Q	2.75
TBA530	2.56
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TBA581	3.11
TBA641	3.00
TBA651	1.90
TBA673	4.15
TBA700	2.38
TBA700Q	2.47
TBA720AQ	2.60
TBA750	2.25
TBA750Q	2.46
TBA790A	2.11
TBA800	78p
TBA810	95p
TBA820	75p
TBA820M	75p
TBA920	1.95
TBA920Q	1.97
TBA950	2.25
TBA990	2.65
TBA990Q	2.74
TCA105	3.00
TCA160C	2.87
TCA220	3.44
TCA270	2.44
TCA440	2.20
TCA450	2.68
TCA640	4.15
TCA650	4.15
TCA660B	4.15
TCA730	4.80
TCA740	4.80
TCA750	4.85
TCA760	2.75
TCA800	3.50
TCA800Q	3.60
TCA830S	1.90
TCA910	2.19
TCA940	1.69
TDA1002	3.39
TDA1003	3.94
TDA1004	2.87
TDA1005	3.94
TDA1010A	2.25
TDA1022	4.95
TDA1024	1.19
TDA1034	3.20
TDA2020	2.99
TDA2030	2.85
TDA2522	4.20
TDA2530	3.30
TDA2540	4.10
TDA2541	4.10
TDA2560	4.10
TDA2571	4.40
TDA2581	3.75
TDA2590	5.20
TDA2591	4.73
TDA2600	6.15
TDA2610	3.90
TDA2611A	2.50
TDA2640	3.64
TDA3000	2.76
TL061	40p
TL062	80p
TL064	99p
TL071	36p
TL072	50p
TL074	1.30
TL081	50p
TL082	75p
TL083	85p
TL084	89p
TL170	49p
TL43C	69p
UAA170	1.69
UAA180	1.69
ULN2003	85p
UPC575C2	2.65
UPC1156	2.76
UPC1181	8.75
UPC1182	2.99
UPC1185	6.45
XR2206	2.92
XR2207	3.75
XR4232	1.83
ZN414	79p
ZN418	2.25
ZN1034	1.99
ZN1040	6.69
ZTK22	85p
ZTK33	85p

TTL

7400	10p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	16p
7407	16p
7408	14p
7409	14p
7410	14p
7411	16p
7412	16p
7413	16p
7414	17p
7416	17p
7417	17p
7420	15p
7421	20p
7422	20p
7423	20p
7425	18p
7426	18p
7427	18p
7428	18p
7430	14p
7432	17p
7433	21p
7437	19p
7438	19p
7440	15p
7441	65p
7442	27p
7443	65p
7444	65p
7445	46p
7446	50p
7447	35p
7448	40p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	30p
7472	25p
7473	23p
7474	18p
7475	22p
7476	24p
7480	40p
7481	1.19
7482	63p
7483	38p
7484	63p
7485	60p
7486	18p
7489	1.70
7490	20p
7491	35p
7492	25p
7493	34p
7494	34p
7495	34p
7496	34p
7497	85p
74100	80p
74104	50p
74105	55p
74107	20p
74109	25p
74110	29p
74116	50p
74118	53p
74119	57p
74120	59p
74121	25p
74122	30p
74123	34p
74125	30p
74126	30p
74128	25p
74132	29p
74136	27p
74141	55p
74142	1.75
74143	1.95
74144	1.95
74145	38p
74147	80p
74148	55p
74150	49p
74151	35p
74153	35p
74154	35p
74155	45p
74156	35p
74157	40p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	40p
74165	44p
74166	48p
74170	1.17
74172	2.50
74173	48p
74174	54p
74175	49p
74176	39p
74177	45p
74178	68p
74180	40p
74181	1.15
74182	55p
74184	90p
74185	90p
74188	4.69
74190	2.50
74191	45p
74192	45p
74193	45p
74194	40p
74195	40p
74196	40p
74197	40p
74198	77p
74199	77p
74221	53p

74LS TTL

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	18p
74LS14	22p
74LS15	12p
74LS20	12p
74LS21	12p
74LS22	12p
74LS27	12p
74LS28	14p
74LS30	12p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	14p
74LS40	12p
74LS42	28p
74LS47	35p
74LS51	14p
74LS54	14p
74LS56	14p
74LS73	18p
74LS74	18p
74LS75	18p
74LS76	18p
74LS78	18p
74LS80	1.20
74LS83	33p
74LS85	39p
74LS86	16p
74LS90	22p
74LS92	25p
74LS93	24p
74LS95	36p
74LS96	50p
74LS107	20p
74LS109	23p
74LS112	20p
74LS113	22p
74LS114	22p
74LS122	25p
74LS123	34p
74LS124	89p
74LS125	24p
74LS126	25p
74LS132	33p
74LS136	24p
74LS138	24p
74LS139	27p
74LS145	70p
74LS147	99p
74LS148	69p
74LS151	39p
74LS153	39p
74LS154	79p
74LS155	29p
74LS156	36p
74LS157	27p
74LS158	28p
74LS160	32p
74LS161	35p
74LS162	35p
74LS163	35p
74LS164	40p
74LS165	50p
74LS168	84p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	39p
74LS175	39p
74LS181	88p
74LS183	1.20
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	37p
74LS194	32p
74LS195	32p
74LS196	45p
74LS197	48p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	55p
74LS245	70p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	32p
74LS257	29p
74LS258	33p
74LS259	55p
74LS261	99p
74LS266	18p
74LS273	53p
74LS275	1.25
74LS279	30p
74LS280	95p
74LS283	40p
74LS289	4.70
74LS290	45p
74LS293	40p
74LS295	75p
74LS298	79p
74LS299	1.55
74LS323	1.55
74LS324	1.45
74LS325	2.96
74LS326	2.36
74LS327	2.30
74LS347	95p
74LS348	88p
74LS352	59p
74LS353	59p
74LS362	7.25
74LS365	27p
74LS366	27p
74LS367	27p
74LS368	27p
74LS373	54p
74LS378	80p
74LS386	1.14
74LS390	46p
74LS393	42p
74LS395	87p
74LS395	1.90
74LS398	2.70
74LS399	1.50
74LS445	1.30
74LS490	1.95
74LS540	88p
74LS541	88p
74LS640	99p
74LS641	99p
74LS643	99p
74LS644	99p
74LS668	1.18
74LS669	99p
74LS670	99p
74LS673	5.50
74LS674	9.99

74C CMOS/TTL

74C00	27p
74C04	29p
74C10	28p
74C14	89p
74C20	28p
74C30	35p
74C42	96p
74C48	1.40
74C73	64p
74C76	57p
74C83	1.74
74C85	1.34
74C86	1.10
74C89	5.95
74C90	1.05
74C93	1.44
74C95	1.00
74C107	60p
74C151	2.55
74C154	4.95
74C157	2.20
74C160	1.54
74C161	1.15
74C162	1.16
74C163	65p
74C164	1.15
74C165	2.00
74C173	90p
74C174	65p
74C175	75p
74C192	89p
74C193	68p
74C194	89p
74C195	70p
74C200	10.00
74C221	1.20
74C901	1.91
74C902	71p
74C903	2.30
74C904	1.84
74C905	10.88
74C907	1.91
74C908	1.87
74C911	9.59
74C912	8.00
74C914	2.88
74C915	1.99
74C918	2.50
74C920D	8.50
74C922	4.50
74C923	5.00
74C925	6.00
74C926	6.58
74C928	5.00
74C929	5.20
74C930J	7.80
74C932	3.12

COMPUTER ICs

CPUs

1802	6.50
2650A	11.98
6502	3.24
6800	2.74
6802	2.69
6809	6.50
8036	3.49
8060	10.50
8080A	2.60
8085A	3.49
8900	57.75
8980	21.00
SCMP1	17.60
Z80A	3.15

MEMORIES

2101	4.00
2102AL2	1.35
2111-1	3.00
2114 (200ns)	85p
2532	3.60
2708	2.25
2716 (5V)	2.11
4027	3.00
4044	4.50
4060	9.50
4116 (200ns)	75p
4118-3	3.25
4164	4.50
5204	7.80
6116	4.40
6514	3.30
6810	1.15
7489	1.75
74189	4.00
74LS288	1.50
74S188	1.50
74S287	3.05
74S288	2.25
5101	1.99

LOGIC ICs Including COMPUTER SUPPORT

ADC0804	3.95
ADC0816	14.90
ADC0817	10.06
AY5-2376	6.90
AY5-1013A	3.00
INS1671	20.00
INS1771	20.00
INS1791	20.00
MC1466L	6.50
MC1488	85p
MC1489	85p
MC4024	3.25
MC4044	3.25
MK50250	30.00
MK50398	8.95
MM5303	6.25
MM5307	12.75
MM5357	22.50
MM57106	14.00
MM57109	12.00
MM57160	9.00
MM57161	9.00
MM58174	11.80
RO2513LC	5.99
RO2513UC	7.50
SAA5000	3.00
SAA5010	7.10
SAA5012	7.10
SAA5020	5.50
SAA5030	9.00
SAA5040	15.00
SAA5041	15.00
SAA5050	8.50
SAA5052	8.80
TMS6011	3.65
ULN2003A	85p
8T26	1.36
8T28	1.36
8T95	1.36
8T97	1.36
81LS95	90p
81LS96	1.20
81LS97	90p
81LS98	1.20
6522	3.19
6532	8.85
6821	1.12
6845	10.00
6847	10.00
6850	1.35
6852	2.48
6875	4.85
8131	3.75
8154	8.42
8155	3.50
8212	1.10
8216	1.00
8223	1.90
8224	1.10
8226	2.80
8228	2.50
8238	6.75
8243	4.88
8250	8.65
8251	3.15
8253	7.95
8254	10.00
8255	2.48
8257	4.00
8258	4.00
8278	4.40
8304	4.50
8544	1.50
8601	1.20
8678CABN	19.50
8832	2.90
8833	2.25
9097	3.00
9099	3.00
9601	5.50
9602	2.50
Z80ACTC	2.65
Z80ADART	5.50
Z80ADMA	8.90

40 CMOS

4000	10p	4044	41p
4001	10p	4045	99p
4002	11p	4046	44p
4006	40p	4047	39p
4007	15p	4048	39p
4008	32p	4049	22p
4009	24p	4050	23p
4010	24p	4051	44p
4011	10p	4052	49p
4012	15p	4053	49p
4013	20p	4054	83p
4014	46p	4055	83p
4015	39p	4056	83p
4016	20p	4059	4.35
4017	32p	4060	42p
4018	44p	4063	79p
4019	26p	4066	22p
4020	44p	4067	2.22
4021	39p	4068	14p
4022	39p	4069	13p
4023	12p	4070	13p
4024	32p	4071	13p
4025	12p	4072	13p
4026	77p	4073	13p
4027	20p	4075	13p
4028	37p	4076	44p
4029	43p	4077	13p
4030	14p	4078	13p
4031	1.19	4081	12p
4032	80p	4082	12p
4033	1.20	4085	49p
4034	1.29	4086	53p
4035	50p	4089	1.20
4036	2.40	4093	20p
4037	1.30	4094	69p
4038	99p	4095	75p
4039	2.80	4096	70p
4040	40p	4097	2.88
4041	40p	4098	74p
4042	39p	4099	90p
4043	46p		

For higher numbers in 40 Series, substitute 74C for 40 prefix, e.g. 40106 = 74C106

45 CMOS

4502	59p
4503	29p
4507	33p
4508	1.19
4510	45p
4511	48p
4512	39p
4514	1.10
4515	1.10
4516	55p
4518	39p
4519	29p
4520	45p
4521	90p
4526	59p
4527	59p
4528	46p
4532	69p
4534	4.29
4536	2.59
4538	65p
4539	99p
4543	65p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.59
4584	39p
4585	79p

ZERO INSERTION DIL SOCKETS

24 pin	4.80
40 pin	5.20

NEW! T.V. SOUND TUNER BUILT AND TESTED

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is "Will anyone notice if we save money by chopping this out?" In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are common and all this is really quite sad, as the TV companies do their best to transmit the highest quality sound. Given this background a compact and independent TV tuner that connects direct to your HI-FI is a must for quality reproduction.

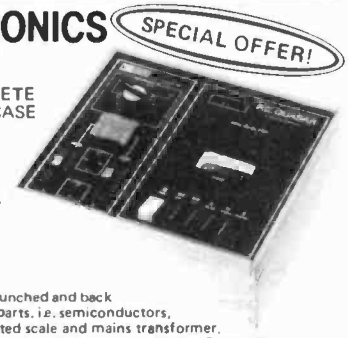
£22.95 + £2.00 p&p.

This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder. Dimensions: 11¾"x 8½"x 3¼"

E.T.I. kit version of above without chassis, case and hardware. £12.95 plus £1.50 p&p.

PRACTICAL ELECTRONICS STEREO CASSETTE RECORDER KIT COMPLETE WITH CASE

SPECIAL OFFER!



ONLY **£31.00** plus £2.75 p&p.

• NOISE REDUCTION SYSTEM. • AUTO STOP. • TAPE COUNTER. • SWITCHABLE E.Q. • INDEPENDENT LEVEL CONTROLS. • TWIN V.U. METER. • WOW & FLUTTER 0.1%. • RECORD/PLAYBACK I.C. WITH ELECTRONIC SWITCHING. • FULLY VARIABLE RECORDING BIAS FOR ACCURATE MATCHING OF ALL TYPES.

Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts. i.e. semiconductors, resistors, capacitors, hardware, top cover, printed scale and mains transformer. You only supply solder & hook-up wire. Featured in April P.E. reprint 50p. Free with kit.

PERSONAL LS AMPLIFIER KIT

Amplifier for your personal stereo cassette player — as featured in January issue of Everyday Electronics. Turn your personal stereo into a mains powered home unit.

Parts:
Stereo power amp PCB with all components, £3.50 + 75p p&p. Power supply unit £1.95 + £1.50 p&p. Pair of eliptical speakers, **£1.50 the pair + £1 p&p.** Input & output sockets and plugs, £1.50. Recommended case (for the power supply and amp only), **£2.95 + 80p p&p.** P&P inclusive price of £1.75 for any two or more.

125W HIGH POWER AMP MODULES

The 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 back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

SPECIFICATIONS:
Max. output power (RMS): 125 W. Operating voltage (DC): 50 - 80 max. Loads: 4 - 16 ohm. Frequency response measured @ 100 watts: 25Hz - 20KHz. Sensitivity for 100w: 400mV @ 47K. Typical T.H.D. @ 50 watts, 4 ohms: 0.1%. Dimensions: 205x90 and 190x36mm.

ACCESSORIES: Suitable mains power supply kit with transformer: **£8.50 + £2.00 p&p.** Suitable LS coupling electrolytic. **£1 + 25p p&p.**

KIT	BUILT
£10.50 +£1.15 p&p	**£14.25** +£1.15 p&p.

BSR RECORD DECK

Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45rpm spindle adaptor ideally suited for home or disco.
£12.95 + £1.75 p&p. 13"x 11" app.

SPECIAL OFFER! Replacement Stereo cassette tape heads — £1.80 each. Mono: £1.50 each. Erase: £0.70 each. Add 50p p&p to order.

SPEAKER BARGAINS

2 WAY 10 WATT SPEAKER KIT
8" bass/mid range and 3¼" tweeter. Complete with screws, wire, crossover components and cabinet. All wood precut — no cutting required. Finish - chipboard covered wood simulate, size 14½"x 8¾"x 4". PAIR for ONLY
£12.50 plus £1.75 p&p.

All mail to:
21B HIGH STREET, ACTON, W3 6NG.
Note: Goods despatched to U.K. postal addresses only. All items subject to availability. Prices correct at 30/10/82 and subject to change without notice. Please allow 7 working days from receipt of order for despatch. RTVC Limited reserve the right to update their products without notice. All enquiries send S.A.E. Telephone or mail orders by ACCESS welcome.

ALL CALLERS TO: 323 EDGWARE ROAD, LONDON W2. **Telephone: 01-723 8432.**
(5 minutes walk from Edgware Road Tube Station)
Now open 6 days a week 9 – 6. Prices include VAT.

RTVC

Gateway to a Commission in the Technical Corps of the Army.

Since 1953 Welbeck, Britain's first Sixth Form College, has played a crucial role in providing Officers for the Technical Corps of the Army and now produces a large proportion of the Army's technical graduates.

It is not a military unit but a boarding school with very high academic standards offering 'A' level courses in science and technology, with some Arts subjects; great emphasis is placed on games, leadership training and preparation for Sandhurst through the Combined Cadet Force to which every boy must belong.

To an intelligent, energetic and fit young man with the ambition and genuine motivation to be an Army Officer Welbeck offers a first class prospect with an opportunity, at a later stage, for a degree course in engineering or related science at the Army's expense.

The maintenance contributions are reasonable. Entry is highly competitive and applicants should be expecting to obtain good passes at GCE 'O' level (or equivalent) in Mathematics, Physics, English and at least two other subjects preferably including Chemistry.

Normal entry is in the September or January following 'O' levels and the closing date for the next available entry in January 1984 is 1st May 1983. The age limits on entry are from 16 to 17½ years.

Further details about the College and the prospectus may be obtained from the Headmaster, Dept. G 17, Welbeck College, Worksop, Notts S80 3LN.

Army Officer

PE VOLUME 19 No. 4 APRIL 1983

NO FOOLING

ALL readers please note that this is our April issue. We have had some interesting correspondence in past years following publication of our April issue and one or two "not quite true" pieces. If you see what we mean? There are two such pieces in this issue. They are both obvious once you have read them properly, if not before! However, it appears that we may have to consider not publishing any further items of an April 1 nature, since it is becoming more and more difficult to discriminate between fact and fiction.

There are two true news stories in this months' *News & Market Place* that could be "not quite true". The ones we are referring to are 'Shades of 1984' and 'Walk Around 3D.' Both are true but, in their own way, both are significant steps forward and therefore one could be excused for doubting them. While some of our editorial team were busily at work writing nonsense (something they do particularly well!) it occurred to those slaving over the truth that since some items of the latter commodity are rather way-out, their work could be undermined by the first group! The moral is believe everything we say unless its code name is April 1, we tell you its rubbish or we have made a mistake! (Please don't ring up for Lliys Electronics phone number).

THE REAL THING

Having spoken about "news" it is worth looking at where things may go in the next year or so. Obviously the computer will eventually have a considerable impact on the hobby electronics area. By this we do not mean that computing will take over from soldering and testing—it may for some, but that is a change of hobby. What we are getting at is the computer automation of i.c. design, which will change what is generally available.

The cost of a custom i.c. is rapidly falling due mainly to automated design and the ability to manufacture combination circuits with analogue and digital circuitry on one chip. Charles E. Sporck, President of National Semiconductor Corp., recently said in a *Electronic Design International* article "Now thanks to design automation, we can provide a half dozen circuits with the investment it once took to produce just one. All this will give us the freedom to look at more dedicated circuit applications".

This could affect our hobby in two ways: First, it could mean more complex and sophisticated equipment could be easily constructed from one chip plus some controls, readouts, transducers etc.

Second, it could mean a demise in our hobby if such chips are not available on the open market. This is bound to happen to some extent—as it does now—but we do not believe we will have to give up and go away in the foreseeable future! Perhaps PE will have to arrange for supply of special chips to our designs in years to come, who knows?

Of course with things changing as fast as they are we could become Practical Bioelectronics at some stage in the not too distant future. Last month we announced in *News & Market Place* that Mississippi University were close to the birth of a molecular diode using a molecule that can exist in two states. This obviously means that implant electronics, not far from that described in this months' *Semiconductor Update,* is nearing reality. As we said, we may not be able to publish any more April 1 pieces!

Mike Kenward

P.S. Don't forget from next month PE will be even better value with more editorial pages in every issue — see page 6/6 of Micro-file for details of contents.

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Dorset BH15 1JG
Phone: *Editorial* Poole 671191
We regret that lengthy technical enquiries cannot be answered over the telephone

Queries and letters concerning advertisements *to:*
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King's Reach, Stamford Street, SE1 9LS
Telex: 915748 MAGDIV-G

Letters and 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 PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or addressed envelope and international reply coupons, 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 most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at £1 each including Inland/Overseas p&p. Please state month and year of issue required.

Binders

Binders for PE are available from the same address as back numbers at £4·60 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 £13·00 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.

Shades of 1984

The video age works *both* ways. Be warned! The Pacman and Invader watching society is in turn being watched. Not just by those television cameras which oversee the busy commuterways, but by less obvious ones. Tomorrow's world will bring the *thinking* camera into commonplace existence. Today's world has seen to it.

The Home Office's Research and Development Branch has, after five years work, succeeded in bringing to fruition a remote vehicle *number plate reading* camera. This TV camera is undergoing operational trials, now, in London. The Home office requests that its whereabouts is not revealed.

Because the tireless policeman does not exist, it is impossible to note the registration number of every passing vehicle to see if it has been stolen; but now, this portentious camera system surely heralds the demise of organised car theft. Terrorists too, may find themselves inexplicably netted. From its secret vantage point, the number plate reader checks out each passing number via a landline to the Police National Computer.

In fact, the camera itself is conventional, save sensitivity in the infra-red region for night viewing. Its focus setting is guaranteed by using a sensor buried in the road, which triggers the "snap shot". Presumably it's because rear number plates tend to stay cleaner than front ones that the camera views receding traffic. The clever bit is that the signal from the camera is somehow electronically processed to extract the registration number, and sound the alarm if something is amiss. It is our guess that some sort of block scan takes place to seek out recognisable alphanumeric characters, and then convert them to their ASCII (or other) codes for transmission.

According to Crime Prevention News, overall accuracy on the experimental system is about 50 per cent in all conditions, rising to 70 per cent with new cars. Quick visual, and other checks are said to keep false alarms to a minimum. Computer errors in the electricity bill are irritating enough, so let's hope so.

Despite a projected production cost of £60,000 a number of police forces are keenly interested in the trials.

MICROCONTROLLER VIDEO

SAT Electronics have developed a video RAM card for use with the PE Microcontroller which is the first of a series of expansion boards.

The video card is a full memory mapped display interface for use with a VDU or TV. The memory of the interface is accessed in exactly the same way as the existing RAM within the Microcontroller and as such, can be used as extra memory if required, on full battery back-up.

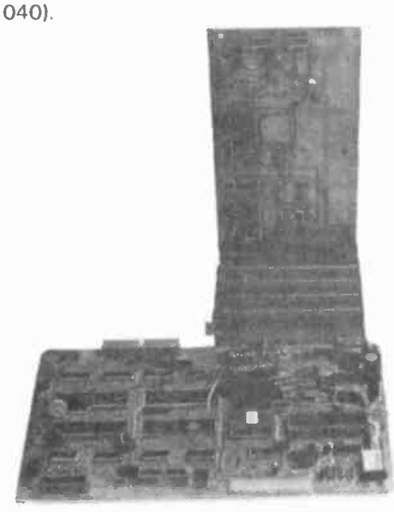
The size of the memory is 2K and it is arranged as a 32x16 on screen matrix. There are 128 characters available and these are ideally suited to control or text handling operations because of the inclusion of a graphics set. In addition, these characters are available in a flashing mode.

The card itself has a 43 way edge connector and can either be plugged directly onto the expansion socket or fitted via a Mother card assembly.

Complete documentation is provided together with the card, expansion socket and all the necessary wires and components.

The price of the video RAM card is £49·68 including VAT and p&p.

In addition to the video RAM card other cards which will be available soon include a Mother board assembly, multi-channel AtoD and DtoA convertors, real time, day, date card, counter timer, full ASC11 keyboard controller, RAM cards (various sizes) and a sound generator card. For further details contact SAT Electronics 235 Cross Street, Sale, Cheshire (061 905 1040).



INNOVATION WORKSHOP

Ever had an idea for an electronic device, but lacked the funds to try it out? Ever wondered how many other seeds of ingenuity remain ungerminated elsewhere? Residents of the North East need not allow their potential contributions to science remain on ice. Newcastle's Microelectronics Applications Research Institute (MARI) is prepared to help them thaw out their frozen dreams at its Microelectronics Innovation Workshop. Based at MARI's own premises, the workshop is a bid to attract local inventors and entrepreneurs with new applications for microelectronics, and, hopefully, to spark off fresh companies. The scheme is funded by Tyne and Wear County Council and the DoE under the Urban Programme.

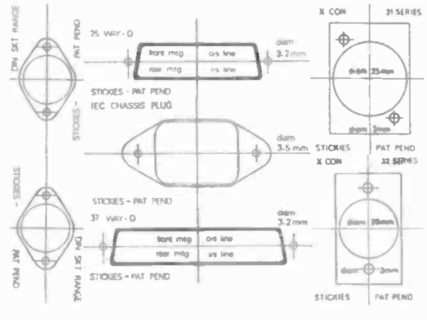
Individuals using the workshop receive supervision and assistance during the early stages of their development work. They are able to experiment and test their ideas using equipment and facilities which would otherwise be beyond their means; and they may also attract customers and backers.

The workshop was opened in December last year, and many projects are already growing within it which include an assembly system for technical dentistry, and a reading aid for the blind.

The Innovation Workshop appears to be a very good idea, and it would not be a bad thing if they were to spring up elsewhere.

MARKING BLUES

For those of us who have trouble marking out front panels and cutting out same without damage, there is now an easier and far less hazardous alternative. Namely—'Sticky Templates'. These self-adhesive clear film templates are simply stuck onto the panel in the required position. Each one has horizontal and vertical centre lines which makes lining up multi-connector arrays easy. When the area is worked the film also protects the panel. From Futronics Technology (UK) Ltd., 15 North Avenue, London, W13 8AP (01-991 0070).



MARKET PLACE

The Amazing Mr. CUBOT

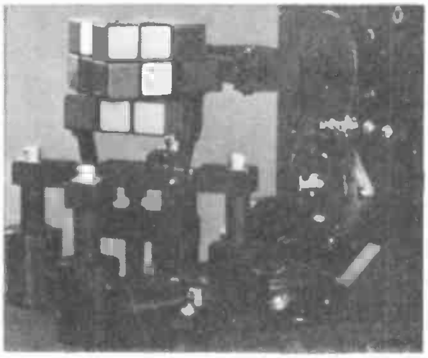
Some say that Rubik's Cube is now passé, but not Cubot. Cubot is a portable robot weighing about 70 pounds, that can solve Rubik's Cube and, like a ventriloquist's dummy, retire to a standard size suitcase. Cubot may not be humanoid, but it can nevertheless clasp a randomised Cube in its gripper, view it knowingly, and then proceed to unscramble it.

Enginners of the Battelle Memorial Institute designed and built Cubot as a fun, off hours effort. Battelle spokesman, Dr. Michael Lind said that this robot is intended to demonstrate the Institute's unique capabilities in the integration of differing technologies. Cubot combines electro-optics, microprocessing, and mechanics, and was created by a volunteer force of twenty scientists and engineers of the Pacific Northwest Laboratories, Engineering Physics department.

Cubot has an eye that is sensitive to the Cube's six colours, and which is used to recognise patterns as it surveys the Cube's six faces. Information is absorbed by the robot's first microcomputer. Here, an algorithm generates the series of instructions for a second microcomputer which controls the minipulator. With a clunk and a whirr Cubot can unscramble the Cube in less than four minutes. Not as fast as some human beings, true, but Cubot's designers are confident that they can hone their prodigy's performance down to two minutes.

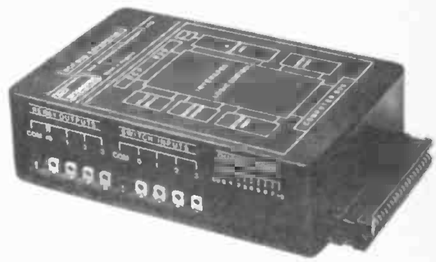
Rubik's Cube has a staggering number of combinations ($4{\cdot}3 \times 10^{19}$). To put its ability to beguile firmly into perspective, it has been calculated that if a person had started generating legitimate combinations at a rate of one a second, upon the creation of the universe, by today only one per cent of all possible combinations would be completed.

Cubot is not the first robot to solve this intricate puzzle, but as far as is known, it is the first robot to physically unscramble the cube without human intervention.



ZX SPECTRUM ADD-ONS

Two new 'add on' accessories for the ZX Spectrum are the DCP Interspec and the DCP Speech pack. These products are direct descendants of the successful ZX81 peripherals produced by DCP Microdevelopments (David C. Palmer). Interspec provides many electrical interfaces including an 8 channel A to D converter for joysticks or temperature sensing, 4 relay outputs for high current control, 4 switch inputs buffered for direct connection to contacts and an 8 bit I/O port for the users own digital design applications. Featured on the rear of the unit is the DCP BUS; an expansion system using a 15 way connector directly controlling up to 4 more accessories, this is expandable to 255 more devices with the addition of a few discrete components. Second is the Speech Pack: this is the Spectrum version of its ZX81 namesake, it features a built in speaker, expandable vocabulary, volume control and ZX connector for other accessories. This pack is controlled by simple OUT commands followed by the number of the selected word. Interspec costs £39·95 and the Speech Pack £49·95 inc VAT and p&p. Available from, DCP Microdevelopments Ltd, 2 Station Close, Lingwood, Norwich NR13 4AX. (0603) 712482).



Silicon News Corner

Bulletins covering new semiconductor devices arrive at PE almost daily, and it is possible only to describe them briefly. Details of how to obtain further information are included, however.

Motorola: A T0220 packaged 15A thyristor, one of a series designed for high speed invertors and switching. The MCR2150/A has a maximum turn-off time guaranteed at 4µs!

A TMOS SCR, the MCR1000 offers the input impedance of a power MOSFET with the latching action of a thyristor. It is rated at 600V, 15A, with turn on and off times of 200ns and 6µs respectively. Ask for engineering bulletin EB103 from Motorola Semiconductor products Dvn., York House, Empire Way, Wembley, Middlesex.

National Semiconductor: The DP8409–2 multimode DRAM Controller/Driver is a one-chip approach to dynamic memory design. It is capable of driving up to 88 DRAMs!

National's new Nitride Plus passivation technique goes into their LP165/LP365 series simultaneously programmable quad comparator. This highly flexible device dissipates only 10µW/comparator, and its outputs are compatible with DTL, TTL, CMOS and MOS. National Semiconductor, 301 Harpur Centre, Horne Lane, Bedford.

Burr-Brown: Low noise, instrumentation grade op. amps, OPA27 and OPA37 with gains of 1·8kV/mV (125dB), and c.m.r. ratio of 126dB. Power consumption is 3mA. They differ only in frequency compensation. Burr-Brown, Cassiobury House, Station Rd., Watford, Herts.

RCA: A 741 pin compatible op. amp, the CA3420 series combines PMOS and bipolar technology to tolerate supplies down to 2V, and common mode input voltages down to 0·45V below negative rail. RCA, Lincoln Way, Windmill Rd., Sunbury-on-Thames, Middlesex.

Altek: A 2K byte CMOS RAM of ultra low power data retention. The M5M5118P will standby at 10µA with the supply reduced from 5V to 3V. Access time is less than 200ns.

A new d.i.l. active delay line, the Lexor 84300 series is TTL compatible. Delay is from 25 to 500ns, with tapped outputs, and fan-out is 10 TTL loads per tap. Altek Microcomputers, 22 Market Place, Wokingham, Berks.

Intersil: A low power A/D converter featuring 3½ digits, auto-zero, auto-polarity, differential input, single differential reference, and direct drive to l.c.d. or l.e.d. The big step forward in the ICL 7136 is overrange recovery, faster conversion speed (3 per sec.), yet with only 100µA power consumption (2000 hr. battery life). Input noise can be reduced below predecessors by use of a larger auto-zero capacitor without side effects. This is a pin-for-pin upgrade from the ICL 7216 *without* circuit changes. Intersil Datel (UK) Ltd., Belgrave House, Basing View, Basingstoke, Hants.

...NEWS &

SHARP'S PC-1251

The PC-1251 from Sharp Electronics is a wallet size computer featuring extended BASIC, 24K bytes of ROM and 4·2K bytes of RAM including 3·7K bytes of user area.

Frequently used commands, statements or mathematical functions can be user defined using any of the 18 reservable keys.

Battery backup protects the contents of the memory in the RAM when the power is off. With this feature, you can turn off the unit in the middle of a program, or load several programs and, without the need for rewriting or reloading, have full use of them later.

The display is a 24-digit 5×7 dot matrix the brightness of which can be varied. Other features include auto power-off to prevent battery drain and a 10 digit calculation feature.

Also available for use with the PC-1251 is the CE-125 which is an integrated printer and microcassette recorder. The PC-1251 has been designed to fit into the CE-125.

The 24-digit thermal printer can type at approximately 0·8 lines/second.

A wide range of software is also available for use with the PC-1251 including the already proven software of the PC-1211.

The complete system including the printer/cassette module has overall dimensions of 205×149×23mm and weighs just 1·2lbs. The price of the PC-1251 is £79·95 and the CE-125 is priced at £99·95 (prices include VAT and p&p). With each unit Microl will be giving away a free £10·00 software voucher.

Microl, Dept PE, 38 Burleigh St. Cambridge (0223 312453).

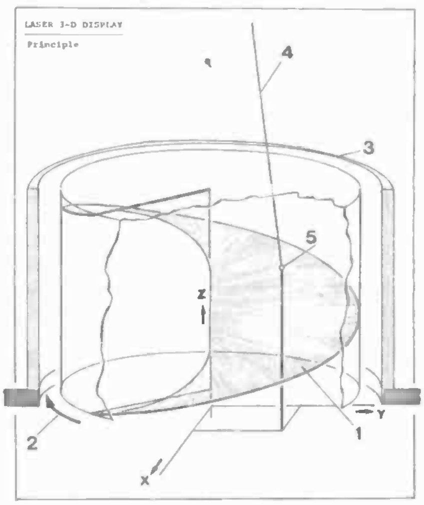
Walk Around 3-D

The prospect of a three-dimensional chess game shimmering at the centre of a computerised 3-D display has more appeal than imminence. Yet developments are taking place, and these utilise contraptions ranging from contorting mirrors to whirling corkscrews. Surprisingly, holography is not a front runner in the race for the '3DU'. Whilst the technical problems associated with the production of three-dimensional graphics may not be as simple as X Y Z, a recent development has made possible a true volumetric image within a glass cylinder.

The system uses an upright helix revolving at 30 times a second, acting as a target for a computer controlled, low power helium neon laser. By modulating and deflecting the beam under microelectronic control, it is possible to generate flecks and lines of light on the rotor. Rapid rotation of the helix target makes it virtually invisible, thus creating the illusion of light lines in space. The shape of the rotor is such that sooner or later, any point within the display volume will have a solid surface passing through it, upon which the laser beam may be struck. The computer takes care of the crucial timing.

The experimental system, developed by an IBM scientist and a team at Heidelburg University in West Germany, is only capable of delineating framework outlines. Because of its 360 deg. viewing angle, a feature which in itself has illuded engineers until now, it is not practical to suppress out of view contours. This is because the observer's viewpoint is not always known, and means that solids can be represented, but not viewed as opaque. A full colour, real time, interactive display is claimed to be feasible, which can be as compact as five centimetres, or as large as five metres in diameter.

Among the suggested applications is an air traffic control display set above a map of the area.



Briefly...

Two new miniature loudspeakers now available from Mullard, are claimed to be the thinnest ever offered. Both are only 5mm in depth, the smallest (type ADO1980) has a 34mm (diameter) cone whilst the slightly larger (type ADO1985) has a 38mm cone.

Even though only button-sized, the loudspeakers can handle 0·3W r.m.s. and have a 400 to 3000Hz frequency range. Each is offered with impedances of 8Ω, 15Ω or 25Ω.

Construction is rugged, both mechanically and environmentally. The frame is a tough plastic pressing. The cone is also plastic. A high permeability samarium cobalt magnet enables high efficiency to be achieved within an ultra-slim format.

• • • •

Digital television signals to the recently approved CCIR Standard have for the first time been successfully transmitted by optical fibre link between two television studio centres. The experimental transmission, which took place in December 1982, used equipment developed and built by BBC Research Department at Kingswood Warren.

The optical fibre cable contains eight graded-index multimode fibres, and was installed by British Telecom in the existing ducts between the BBC studios at Lime Grove and Television Centre, a path length of about 800 metres. The signals were carried on a single fibre, the basic bit rate of 216 Mbit/s being increased to 270 MBit/s by channel coding. A direct modulated 820 nm laser transmitter was used, the power launched into the fibre being 600μW.

As the television signal was carried in separate component form, pictures of original RGB quality were obtained at the receiving terminal. This avoidance of intermediate PAL coding will allow remote down-stream processing, e.g. colour separation overlay and special effects, to be done with a precision which has hitherto only been achieved at the source itself.

• • • •

Mitsubishi Electric Corporation Plan to manufacture VTRs in it's UK Factory for sales in the European market.

The initial production of 5,000 units per month will be made at the Haddington Works of Mitsubishi UK which currently produces colour TVs.

The company envisages a full scale production of 10,000 units per month with parts for the VTRs being supplied from Japan at first but it is hoped that as many parts as possible will be supplied from the EC market.

MARKET PLACE

ORIC 1

Late in January Oric Products International officially launched the Oric 1 microcomputer from their HQ at Coworth House, Ascot. This mansion set in landscaped woodland seems an unlikely nest from which to fledge such a futuristic bird. Oric 1 presently available with a 16K or 48K memory is their answer to Sinclairs apparent monopoly of the home and small business users market, and at £99·95 and £169 respectively they are very competitive. Although Oric 1 has been available for some months now on a mail order basis the company plan to phase out this method in favour of the high street retailer. Indeed orders already received have outstripped their predicted sales figures five times over, first year sales are now expected to reach a quarter of a million units. An important feature of this 57 key machine is its ergonomic similarity to the typewriter keyboard, offering such luxuries as tactile feedback and auto repeat keys. The two inch loudspeaker has an impressive range covering six octaves, and can be programmed to synthesise various musical instruments. Other technical details include—28×40 character high resolution graphics and Teletext/Viewdata compatability. With an extended BASIC this machine uses the 6502A microprocessor chip, and comes with a comprehensive manual and a FORTH cassette.

AND FINALLY...

Until recently, a family of biproducts of the petrochemical industry, called Tetraprils were quite useless. Now, thanks to the research work of Botch Laboratories of Drudgely, the lowest density member of this family of synthetic proteins has a future in the electronics and electrical industry. Scientists at Botch have discovered that extruded fibres of *Tetrapril 1* display a phenomenon called electrostriction. The electrostrictive effect is the physical distortion of a material whilst conducting electricity, and is usually only a fraction of a per cent variation in overall volume. Yet, while looking and feeling much the same as a piece of common elastic band, a Tetrapril fibre will contract by up to 250 per cent when conducting small currents.

Conversion from electrical power dissipation to mechanical force is 85 per cent efficient, so that a lightweight electromechanical actuator can be constructed which develops amazing leverage from one watt of power consumption. It is only necessary to anchor a fibre to the mechanism chassis at one end, attach its other end to a lever, and pass current through it, and you have an actuator. The fibre can either work against a spring, or in antiphase against another fibre. To prove the point, Botch has built a radio controlled aircraft using Tetrapril fibres throughout, as its servo's.

How did Botch discover such a peculiar characteristic in a material which for years has been thought of, literally as rubbish? Research Director, Tom Foolery said that the name of the biproduct itself provides the clue!!!

Countdown . . .

Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below. Note: some exhibitions may be trade only. If you are organising any electrical/electronics, radio or scientific event, big or small, we shall be glad to include it here. Address details to Mike Abbott.

Brighton Electronics March. T
BEX Leeds Mar. 16–17. Dragonara Hotel. K
INSPEX Mar. 21–25. National Exhibition Cntr. Birmingham International. Z1
Sensors & Systems Mar. 22–24. The Forum, Wythenshawe. T
Compec Wales Mar. 22–24. Cardiff University. Z1
ETM (Electronic Test/Measurement) Mar. 22–24. The Forum, Wythenshawe, Manchester. T
Laboratory Manchester Mar. 23–24. New Century Hall, Corporation St. E
American Holography Mar.–June inc. Light Fantastic Gallery. Covent Garden, London. A8
London Computer Fair April 14–16. Central Hall, Westminster. B5
All Electronics Show April 19–21. Barbican Cntr., London. E
Fibre Optics April 19–21. Porter Tun Rooms, The Brewery (!), Chiswell St., London EC1. E
International Materials Handling April 19–26. Earls Court. I
International Packaging Exhibition April 25–29. NEC B/ham. I
HEVAC (Heating, Ventilation & Air Cond.) Apr. 26–28. Barbican. I
Scottish Personal Computer World Show April 16–18. MacRobert Pavilion, Ingliston, Edinburgh M
Midland Computer Fair April 28–30. Bingley Hall, B/ham. Z1
Biotech May 4–6. Wembley. O
Micro City May 10–12, Bristol Exhibition Complex. F3
The Business Computer Show May 10–12. Wembley. O
Cable (Conf. & Ex.) May 10–12. Wembley Conf. Centr., London. O
Defence Components Expo May 10–12. Metropole, Brighton. I
Welsh Amateur Radio, TV & Electronics Rally May 22. Barry Memorial Hall, S. Glam. C
Computers In The City (conf. & ex.) May 24–26. Barbican. O
Business Telecom May 24–26. Barbican. O
International Word Processing May 24–27. Wembley Conf. Cntr. Z
East Suffolk Wireless Revival May 29. Ipswich Civil Service Sportsground. V1
Russian Holography June–Sept. Inc. Light Fantastic Gallery. A8
Semlab June. Olympia. I
IBM Productivity (conf. & small ex.) June 14–16. Tara Hotel, London. O
The Computer Fair June 16–19. Earls Court Z1
Compec North June 21–23. Belle Vue, Manchester. Z1
Transducer/Tempcon June 28–30. Wembley Conf. Cntr. T
Leeds Electronics Show July 5–7. University. E

A8	Holographic Exhibitions ✆ 01-826 6423
B5	Robin Bradbeer, North London Poly
C	Reg. Rowles ✆ Cardiff 565656
E	Evan Steadman ✆ 0799 22612
F3	Tomorrow's World Exhibitions, Bristol
I	Industrial Trade Fairs ✆ 021 705 6707
K	Douglas Temple Studios ✆ 0202 20533
M	Montbuild Exhibitions ✆ 01-486 1951
O	Online ✆ 09274 28211
T	Trident ✆ 0822 4671
Z	BETA Exhibitions ✆ 01-405 6233
Z1	IPC Exhibitions ✆ 01-643 8040

BATTERY TESTER

Chris LARE

IN recent years the dry battery has become much less used due to the ready availability of mains derived supplies, and, more recently the increased price competitiveness of Nickel Cadmium rechargeable cells. Even so much portable equipment still relies on batteries which bring with them the need for replacement at regular intervals, and more importantly the problem of when to do this. In theory it is very easy to test a battery by measuring its output voltage but this can be very misleading since a battery can often give an almost new voltage reading if no current is drawn from it as happens with a standard voltmeter. Some form of dummy load is obviously required and by the time that this and the meter have been organised it is often simpler to ignore the problem until the batteries go totally flat, probably leaking as they do so.

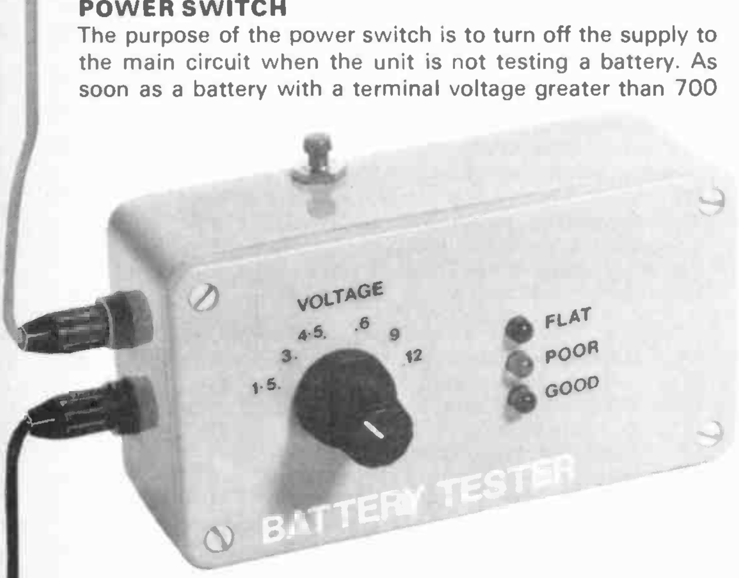
This article describes a fairly simple and cheap battery tester which loads the battery to 15 milliamps and indicates the output voltage state on three light emitting diodes. The circuit was designed for use with standard 1·5 volts/cell batteries and accordingly will test for the following voltages: 1·5, 3, 4·5, 6, 9 and 12. There is no reason why other voltages cannot be chosen, and the unit may be converted to test NiCads by simply altering a few resistors. The tester has no on/off switch and switches itself on when a voltage greater than 700 millivolts is applied to the test terminals. The current drain when not in use is well below a microamp and so will not discharge the PP3 battery specified any faster than the normal storage charge loss. Obviously this implies that an absolutely flat battery will not switch the tester on and this may be taken as a very positive indication of the state of the battery under test.

The circuit can be split into three very distinct sections which are the power switch, the dummy load and the voltage detector/display. Each section will be considered separately. Fig. 1 shows the complete circuit diagram.

POWER SWITCH

The purpose of the power switch is to turn off the supply to the main circuit when the unit is not testing a battery. As soon as a battery with a terminal voltage greater than 700 millivolts is applied to the probe TR1 switches on and thus TR2 also switches hard on allowing the battery current to flow into the rest of the circuit. C1 and C2 provides the main supply decoupling. When TR1 turns off R2 and R3 pull the emitter and base of TR2 very close together so that TR2 is firmly held in a non conducting case with very minute current flow into the main circuit. The measured consumption was considerably less than a microamp. Diode D1 was included to help prevent possible damage if the test battery is connected back to front because although the base-emitter junction of the transistor TR1 will work in this way damage might occur if a 6 volt or larger battery is wrongly connected.

A self test button was included which simply connects the internal battery supply to the test probe input. The voltage selector should be set to 9 volts for any useful conclusions to be drawn from this.



DUMMY LOAD

This type of test equipment usually uses a bank of high wattage resistors to act as the dummy load with the resistor values chosen such that the desired current is drawn for each applied voltage. The main disadvantages of this method are that the resistors are quite bulky and furthermore, should the source voltage fall the current drawn will also fall. In order to avoid these problems a constant current sinking circuit was employed, which will draw 15 milliamps from the source irrespective of the source voltage and so no load switching is required.

A purpose designed integrated circuit, the LM334Z, was used to drive the dummy load sink circuit. In its natural form the LM334Z can only pass a maximum of 10 milliamps and so an external pass transistor (TR3) was used to increase the current handling to the desired 15 milliamps. The LM334Z works by sensing the voltage across R5 which it attempts to maintain at 67·7 millivolts (at 25°C). As the voltage rises across R5 the LM334Z passes less current and thus the base current into TR3 falls, reducing the overall current flow and hence the voltage across R5. In the same way as the voltage across R5 falls so the current flow through TR3 is increased. Since this configuration is essentially a very high gain feedback system C4 and R4 were included to prevent oscillation starting by slightly damping the feedback control. If a full 12 volt battery is tested, TR3 will dissipate 180 milliwatts and so a small heatsink is recommended.

The LM334Z is heat sensitive and as the temperature increases so does any given current flow in exact proportion. The exact figure for this rise is 0·33% per °C and implies that if the temperature rises by 10% the load circuit will draw about 0·5 milliamps more but this is of no real consequence in this application.

THE VOLTAGE DETECTOR/DISPLAY

It was decided that a three state output of 'good', 'poor' and 'flat' would be sufficient. Three l.e.d.s were used, two driven directly from the outputs of a voltage comparator, the other from a couple of transistors to make it light when neither of

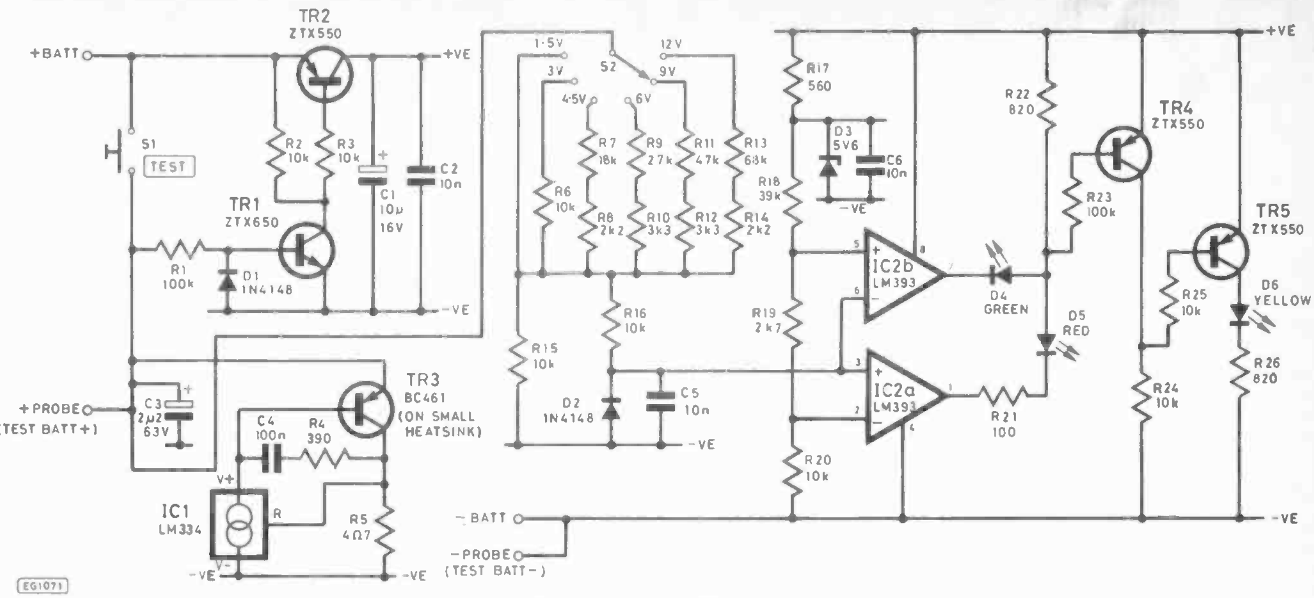


Fig. 1. Circuit of Tester

the other two are on. The basic circuit uses a dual low power open collector comparator in the form of an LM393 which is a cut down version of the well known LM339.

In the design of a circuit such as this where various input voltages are to be compared against a known reference value the reference may be varied and compared with a fixed reference. The latter approach offers far less problems and was adopted here, where two fixed reference voltages of 1·37 and 1·1 volts were chosen to correspond to a 1·5 volt cell somewhat discharged and totally useless. These voltages were derived from a 5·6 volt Zener diode chosen as being the most stable value available. R17 allows some 6 milliamps to flow through the Zener, the voltage thus generated being decoupled by C6. R18, 19 and 20 form a simple divider chain to produce the required voltages which are fed directly to the two comparators. The probe voltage is passed to S2 which selects the required potential divider to drop the desired test voltage down to 1·5 volts. These dividers are not perfectly accurate but are quite good enough for this application. This method has the advantage that the tolerance allowed on each type of battery increases as the battery voltage increases which is ideal. Table 1 shows the intended threshold levels for each battery. Obviously the 1·5 volt test input is a simple direct connection. The voltage from the common point of the divider is fed to the comparators via R16, which together with D2 gives protection against wrongly connected batteries. C5 simply decreases the impedance seen by the comparators and helps prevent oscillation at the threshold points.

Consider the case where the battery is fully charged up to its rated voltage which is set on the selector switch. The voltage at pin 6 of the comparator will be 1·5 volts which is higher than the 1·37 reference and so the output of that comparator will be driven low which will turn on the green l.e.d. Similarly if the battery under test is nearly flat the voltage on pin 3 of the comparator will be lower than the reference on pin 2 and since the inputs to the comparators are swapped this condition will drive the comparator output low light the red l.e.d. The extra series resistor R21 simply evens up the brightness of the red l.e.d. in comparison with the other two. Both the green and red l.e.d. use the same current limit resistor R22.

When the battery is in the state termed 'poor' the voltage applied to the comparators will be between 1·1 and 1·37 volts and so neither the green or the red l.e.d. will light and so no voltage will be dropped across R22. This means that TR4 will turn off so that its collector voltage will fall by virtue of R24 with the effect that TR5 switches on lighting the yellow l.e.d. It can thus be seen that one of the l.e.d.s will be on the whole time the tester is switched on.

As stated before the prototype was powered from a PP3. When the unit is in use the current drain of 16 milliamps is larger than that recommended for the PP3 but the actual on time should be so small as to not make this a cause for concern.

CONSTRUCTION

The prototype was housed in a plastic box 120 x 40 x 65mm. The test probe connections were brought out to two 4mm terminals allowing standard meter prods to be used since the wide variety of available batteries renders the mechanical design of a universal test clip very difficult. The rotary switch was mounted directly onto the printed circuit board and was used to hold the board into the box. It is therefore suggested that the circuit board design shown is used rather than Veroboard (Fig. 5).

Assemble the circuit board first but do not fit the BC461 (TR3) at this stage. When fitting the switch cut off the normal connection loops on the terminals and offer the switch up to the p.c.b. Solder in only two of the pins and check that it is mounted level with the board before soldering the rest of the pins. Solder in the l.e.d.s so that they stand some 11mm away from the board. It is as well to test the board fully before final assembly.

Mark the lid of the box as shown (Fig. 2). The easiest way of marking the voltages on is to mark the centre of the switch and then lightly draw a 27mm diameter circle around

Table 1: Calculated threshold levels (Volts)

Battery Voltage	1·5	3·0	4·5	6·0	9·0	12
Flat Threshold	1·1	2·2	3·32	4·44	6·62	8·8
Poor Threshold	1·37	2·74	4·14	5·5	8·25	10·96

In actual practice these values will not be attained due to resistor tolerances. Obviously 1% resistors may be used but but this was not considered essential.

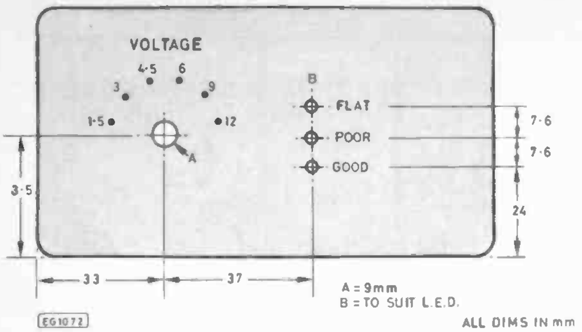


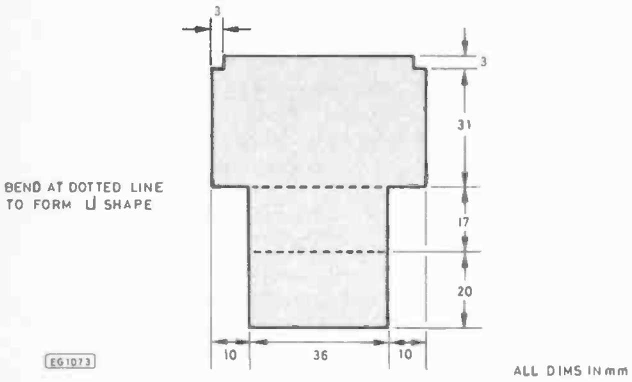
Fig. 2. Details of panel drilling and legending

this point in pencil. Draw arcs on the circle with a pair of compasses set to 6·5mm to correspond to each switch position and mark each intersection with the compass point. Rub out the pencil lines, drill and mark up the lid with Letraset.

Mark up a battery clip out of light gauge aluminium as detailed in Fig. 3, bending it on the dotted lines to form a U.

Adjust the stop position of the rotary switch to the sixth position and assemble the board onto the box lid. A large washer will probably be required to space the shaft slightly. Fit the sockets into the box, together with the test switch and wire to the board. Briefly test the unit again before fitting the lid onto the box.

Fig. 3. Battery clip



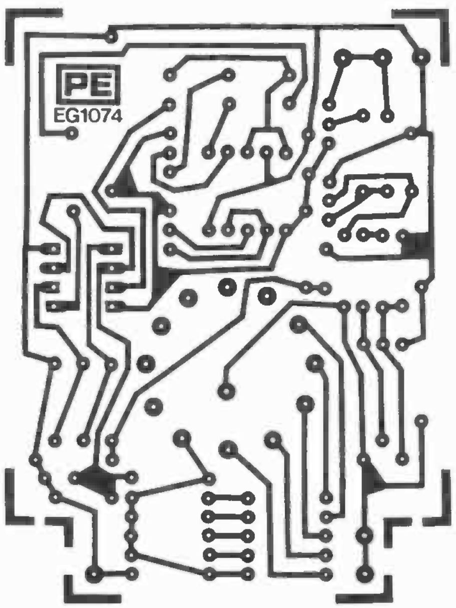


Fig. 4. Printed circuit layout

Components

Resistors	
R1, 23	100k
R2, 3, 6, 15, 16, 20, 24, 25	10k
R4	390
R5	4R7
R7	18k
R8, 14	2k2
R9	27k
R10, 12	3k3
R11	47k
R13	68k
R17	560
R18	39k
R19	2k7
R21	100
R22, 26	820
All ¼ watt 5%	
Capacitors	
C1	10μ 16 volt elect. (or 25 volt)
C2, 5, 6	0·01μ ceramic disc
C3	2μ2 63 volt elect.
C4	0·1μ Mullard C280
Semiconductor	
D1, 2	1N4148
D3	5·6 volt 400mW Zener
D4	Green l.e.d.
D5	Red l.e.d.
D6	Yellow l.e.d.
TR1	ZTX650
TR2, 4, 5	ZTX550
TR3	BC461
IC1	LM334Z
IC2	LM393

Miscellaneous

Plastic box 120 x 40 x 65, press to make switch, 12 pole single way switch (Lorlin type) p.c.b., small T05 heatsink clip, PP3 battery, battery clips, red and black 4mm sockets, terminal pins, connecting wire, aluminium for battery clip, suitable knob, test prods.

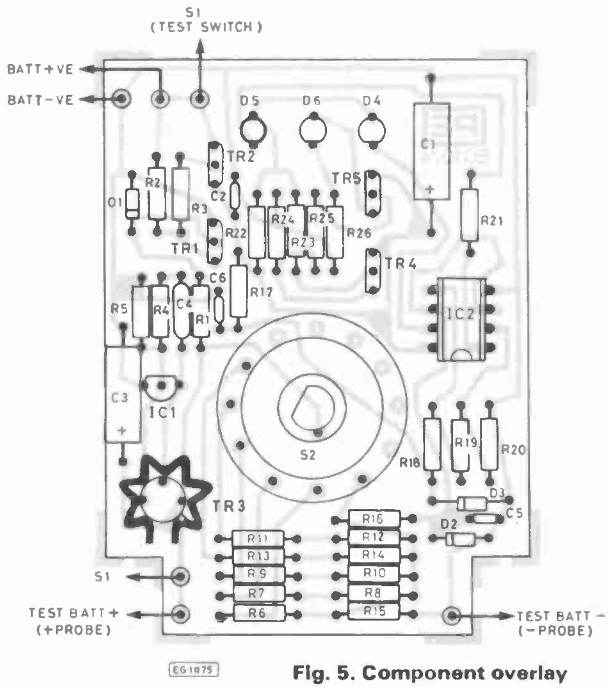
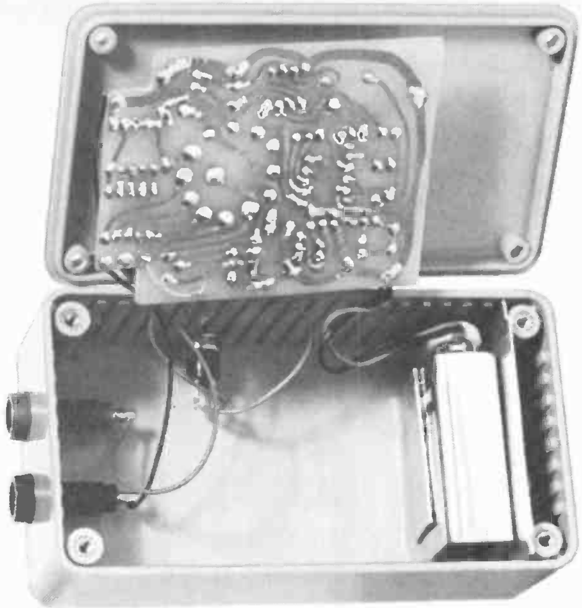


Fig. 5. Component overlay



Internal layout

TESTING

Apply a 9 volt supply to the board via a battery and measure the current consumption which should be close to zero. Remove the ammeter and press the self test switch. The circuit supply should rise quickly to 9 volts and one of the l.e.d.s should light. If it does not appear to work measure the current consumption which should be less than 20 milliamps with the test switch pressed; a greater current than this will indicate the presence of a short circuit. Wire a 220 ohm pot between battery positive and negative with the wiper connected to the probe input. The voltage selector switch should be set to 1·5 volts. Monitor the wiper voltage which should be initially zero. Slowly increase this voltage and check that the red l.e.d. comes on at 700 millivolts, changes to yellow at 1·1 volts and finally changes to the green l.e.d. at 1·37 volts and above. If this test does not work as intended the voltage reference chain is the most likely source of trouble. Set the switch to 3 volts and slowly increase the voltage again checking the changeover points are close to those in the table.

Now solder in the BC461, having first fitted on the heatsink. Connect an ammeter across the test switch and check that the current flow is around 15 milliamps indicating the correct operation of the dummy load. Finally set the voltage selector to 9 volts and press the test switch whereupon the green l.e.d. should light.

IN USE

It is important to remember that this unit is set up for 1·5 volt cells, and when used on other types of battery, particularly NiCads, erroneous results will be noticed. For NiCad batteries the tester may be modified by slightly altering the resistors in the divider chain, making the 'poor' range much narrower and reducing the base voltage used to 1·2 volts instead of 1·5 volts. Obviously other battery voltages can be tested by simply working out the resistor values in the potential divider e.g. a 15 volt battery would require dividing by 10 to 1·5 volts and so a 100 kilohm divider resistor should be used. ★

BAZAAR

ATARI games system, plus eleven cartridges, including: adventure, invaders, soccer, chess. Worth over £300, only £180. Mr. M. Ward, 9 St. Andrews Ave., Crewe, Cheshire CW2 6JJ.

VIC 20, cassette deck, 4K RAM Pack (VCR), Joystick plus many cassettes, manuals, £165. A. Minett, 195 Thornhill Rd., Surbiton, Surrey KT6 7TG. Tel: 01-397 2567.

WANTED Manual or circuits for Nagard OS321 dual beam scope; will pay for copying or originals. A. C. Walkland, 11 Ivy Rd., St. Denys, Southampton.

PROGRAMMING Introductory course wanted for free weekend. Details to R. Peace, 24 Mowbray Road, Northallerton.

HEATH kit GR78 receiver, £40. Heath kit scope 10–102, £50. Pye Cambridge R/T, £25. Carr. extra. Edwards, 2 Beach Rd., Burton Bradstock, Bridport, Dorset DT6 RRF. Tel: 0308 897625.

BBC Microcomputer Model 'B'. £100+ worth of software and two books. Cost new £525. Accept £325. Mr. M. Clark, Jardinet, Oakland Park, Falmouth, Cornwall.

TANDY Quick Printer 2, recently overhauled by Tandy, + 3 rolls of paper, £75, including postage. Ian Benton, The Pharmacy, Bardney, Lincoln LN3 5SS. Phone: Bardney (0526) 398208.

UK101 8K RAM, sound board, all cased with manual. Bargain price of £130, o.n.o. the lot. Mr. I. Rhule, 59 Stanbury Rd., Peckham, London SE15. Tel: 01-639 8433.

UK101 Enhanced 8K cased plus software. 1/2MHz. 300, 600, 4000, Baud. Tape handler, ROM. £150 o.n.o. D. Lund, 25 Hillcrest Ave., Longridge, Nr. Preston, Lancs. Tel: (077 478) 4517.

BINATONE 5-star 40 channel mobile 27MHz CB transceiver. 4 watts. New. Japan made. £50·00. K. Y. Chang, 041 332 7695, after 7 p.m. K. Y. Chang, 70 1-up Ashley St., Glasgow G3 6HW.

FOR Compukit—RAM/EPROM board + 4K RAM, £30; toolkit, £5; BASIC 5, £10; Motherboard, £5. Mr. N. Odell, 31 Humphrey Rd., Greenhill, Sheffield S8 7SE. Tel: (0742) 745027.

PRINTER and keyboard on pedestal (Terminet) 80 col U/L case 30 CPS RS232. Ex. condition, £100. Tel: (evenings) 0744 88 3918.

ZX Spectrum 16K, £75, new. L.C.D. Multimeter, £28; clearing out equipment and projects, s.a.e. No callers. D. Martin, 6 Downland Gardens, Tattenham Corner, Epsom, Surrey.

TELEQUIPMENT Oscilloscope type D43 B/Beam, has anyone any workshop or service information, circuit etc. for sale? John Mitchell, 8 Rutland St., Gorton, Manchester M18 8QH. Tel: 061-231 6522.

ADVANCE type H1 a.f. signal generator 15Hz–50kHz Sine/square perfect £35 o.n.o. Newnes Radio/TV service manuals 1949–1961 £20 o.n.o. E. G. Jones, 16 Riverway, Nailsea, Avon BS19 1HZ. Tel: 0272 853747.

ACORN Atom 12K RAM 12K ROM all leads p.s.u. and manual Included hardly used £140. Dave Houghton, 2 Western Villas, Church Road, Kennington, Ashford, Kent TN24 9QG. Tel: 0233 23077.

ACORN Atom 12K RAM, 12K ROM + > £50 worth software and p.s.u. £150 (can deliver anywhere). Tel: 061 681 2875.

ATARI games computer CX2600 with five cartridges including space invaders and Basic programming with keyboards £100. Mr. L. Allen, 14 Frampton Close, Bournville, Birmingham B30 1QT.

KEYBOARD with oscillator and dividers, filters and rhythm board for organ £15. Tel: 01-644 3474 evenings. Mr. J. Pettifer, 261 Gander Green Lane, Sutton, Surrey.

HAVE two AVO 8 want Rockwell Aim 65 or consider other 6502 based Micro working broken. Mr. N. Campbell. Tel: Marshalls Cross 820093 St. Helens.

MICROLINE 82 printer has anyone any information on this printer for sale or loan? Please phone. Mike Cole, 24 Murray Close, Andover, Hants SP10 2HL. Tel: 0264 3983.

ORGAN Grosvenor Spinet, two manuals, pedals, rhythm unit, playable, needs slight attention £150. Buyer collects. Tel: Ashford (Middlesex) 58878.

FOR SALE Transtec 1200 Video monitor, IR £140. Ideal for use with microcomputer. Mr. P. Carroll, Killagoola, Moycullen, Co. Galway, Eire. Tel: 091 85191.

WINDSOR model 30A oscilloscope circuit wanted. J. D. Weager, 'Glan-y-Mynydd' Pentrepiod, Abertillery, Gwent NP3 2DT. Tel: 0495 214843.

SOLARTRON dual beam oscilloscope type CD1400 15MHz spare plug-in modules full working order £70. G. R. Bird, 56, Albatross Gdns, S. Croydon, Surrey. Tel: 01-651 5104.

LEAK Garrard Wharfedale Hi-Fi Throughline tuner. Varislope 111 pre-amp. Power amplifier, Margoline player. Speakers. Data. Working. Offers. G. D. Patterson, 5 Oakwood Road, Henleaze, Bristol BS9 4NP. Tel: Bristol 624769.

C.P.U. board E.C.M. 6809 Links fitted i.c. holders some components SIL £13. Other components s.a.e. list. G. A. Noble, 50 Crofthill Road, Slough, Berks SL2 1HF.

VIC 20, 5K, cassette, literature, software and portable colour TV (Hitachi). All new £330 o.n.o. F. Gareeboo, Hulme Hall, Oxford Place, Victoria Park, Manchester M14 5RR.

KEYBOARD for electric organ, 49 notes with contacts £20. Maplin DMO2 £5. Both unused. Tel: 041 632 5408.

FD200 SME Fluid Damper, unopened £10. Pair monitor audio Lintz sound cable (7·5m), unopened £10. Tel: 07605 402.

Tandy®

NEW!

Micronta™ Clamp Meter

£29.95

- Overload Protected
- Pointer Lock Switch

This clamp-on AC ammeter is designed to measure AC current without disconnecting or breaking the line being checked, making it safer to use. The large range selector knob is conveniently positioned for one-hand operation. The meter incorporates a pointer lock switch holding the pointer in position (for reading later) when the meter cannot be seen while measuring. AC current: 0-6-15-60-150-300 amperes. Accuracy ± 3%. Size: 7⅜ x 2$^{13}/_{16}$ x 1$^{3}/_{16}$". With carry strap.

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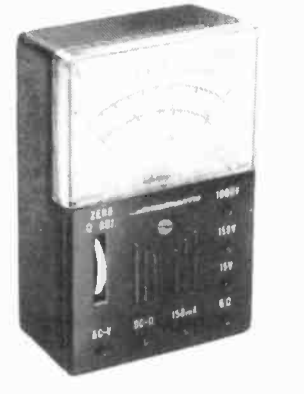
LCD Multitester

Features "beep" continuity check and autoranging function! Measures up to 1000 VDC, 500 VAC, 200 mA (both AC and DC), 2 megs resistance. Accurate to within ±1 digit. 6⅜". Requires two "AA" batteries. **22-192** **£64.95**

1K OHMS/V Tester



Keep one in your glove compartment. Has 2" meter, mirrored scale to prevent parallax, pin jacks for all ranges. AC and DC Volts: 0-15-150-1000 Current: 0-150 mA, DC. Resistance: Rx1000 (100,000 ohms, full scale). 3½ x 2$^{5}/_{16}$ x 1¼". Requires "AA" battery. **22-027** **£7.95**

Digital Logic Probe

Makes Go/No-Go tests on small signal and power types and permits matching of similar transistors. Indicates relative current gain, "opens", "shorts". Socket plus hook clip leads for in-circuit tests. Output jacks for external meter or scope. 2¾ x 4⅜ x 1$^{3}/_{16}$". Requires "AA" battery. **22-025** **£9.95**

Dynamic Transistor Checker

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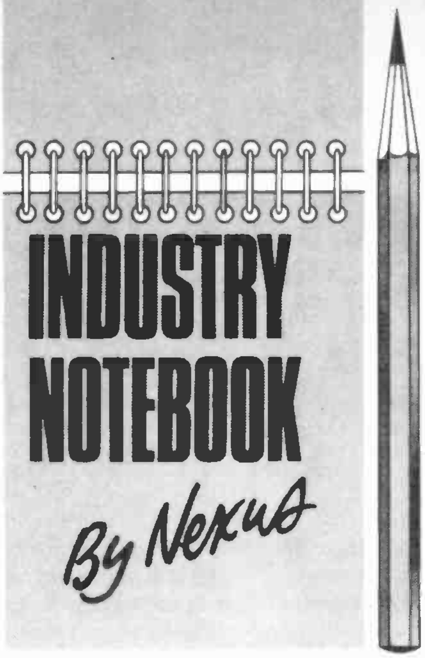


Inscrutable

China has nearly one quarter of the world's population and is the largest single market as yet untapped by Western technology. The inscrutable oriental of legend is becoming less so but only very gradually, almost reluctantly. The door to large scale international trade is only slowly opening but with it could come a much better appreciation of what China is about.

Apart from the enormous population, other statistics on China are monumental. Her total borderline if we include the coastline extends to 22,000 miles of which her border with the Soviet Union accounts for 4,300 miles. China's main preoccupation in recent years has been fear of Soviet intentions, reciprocated by the Soviets. Earlier friendly relations evaporated in 1966 when Chairman Mao instigated the Cultural Revolution to maintain the purity of the communist ideal which not only rejected the ideology of capitalism but also Soviet communism which, in Mao's view, had become 'revisionist'.

The distrust between the two communist giants resulted in another staggering statistic, the largest standing army in the world with 4·75 million under arms. The land force consists of 169 divisions in 35 armies. Eleven armoured divisions have 10,000 tanks. At sea there are 32 destroyers and frigates, 102 submarines and about 1,000 smaller naval craft. The air arm has 5,000 combat aircraft. And China's nuclear arsenal now includes 5,000 mile range ICBMs with 3-megaton warheads.

The trouble is that, formidable as the Chinese strength appears to be on paper, most of the equipment is as much as 20 years out of date having depended on Soviet technology initially and, later on, copies made in China. Similarly, industrial production suffered during the period of ideological re-education. The present leadership group appears intent on modernisation in the armed forces and in industry, even though it involves the capitalist countries.

The Chinese trade delegation visiting Britain and Europe in 1980 in search of modern arms were fascinated by developments like the Harrier aircraft but were horrified at the cost. But they could perhaps afford some of the sophisticated electronics to transform existing weapons platforms into efficient defence equipment.

The first fruits of turning to Britain (at least so far reported) are the re-fitting of two Luda class destroyers, themselves derived from the Soviet Kotlin class. They are being re-equipped with Sea Dart missiles, radar, fire control systems and new operations rooms under a £100 million contract. As China has nine of this class of destroyer there should be the possibility of follow-on orders.

Last January, Industry Minister Patrick Jenkin was in Peking attempting to sell British nuclear technology which could result in power station orders worth several hundred million. On a smaller scale Solartron's trade with China in measuring and analysis equipment topped £1 million last year.

There remains the riddle of Hong Kong and the New Territories which are due to be returned to China by treaty in 1997. The prospect of an earlier date caused consternation in Hong Kong last year but confidence was restored by rumours that while Hong Kong would certainly return to China it would have a special status. Indeed it should when tiny Hong Kong exports more goods than the whole of China and would therefore seem invaluable if only as a profitable interface with the outside world.

The Chinese trade door may be inching open but also in the queue outside are the other European nations, the United States and Japan, all competing. Lurking in the background is the possibility of the inscrutable Chinese mending fences with the Soviet Union in which case the West may have been wasting its time.

Looking West

As well as looking East, British maufacturers are also looking West, particularly to the United States. Plessey, following a £34 million purchase of Stromberg-Carlson last year, started the New Year with joint ventures with Scientific Atlanta on cable-TV and Rockwell International on military radio. These new associations give Plessey a foot-hold in the US market for telephone exchanges, a technology foot-hold in the UK for cable-TV and a US marketing foot-hold in the USA for selling the US Army the single channel radio access equipment used in the Ptarmigan radio system developed for the British army.

Racal is also taking on board US technology for future Pay-TV and Cellular Radio projects besides having flourishing wholly-owned subsidiaries in the United States. I note with some amusement that when 10 members of the Italian Parliament recently visited the United States on a trade mission to examine the best electronic manufacturing facilities, high on the list was Racal-Milgo, wholly British owned. This company, incidentally, rated top in price/performance ratio, top in technology and in the first three on service organisation and trade literature by the 1982 Brand Preference Survey. Overall it won the honour of being 'the one most preferred to do business with'.

Another Racal company in the US is Racal-Dana Instruments. They have just invested in a new 100,000 sq.ft headquarters in East Irvine Industrial Park, near Los Angeles.

Some companies are looking the other way. Philips, for example, is reported to be one of the firms tendering to set up a colour-TV factory in the Soviet Union. They are in competition with Japanese companies. It seems strange that the Russians are so patchy in performace. After all these years they still appear to be incapable of performing routine mass-production tasks like making motor cars without assistance from outside. And what happened to the Hungarian and Polish electronic industries? Surely they could provide the goods?

Inmos

The months and years slip away as do the millions in Inmos, the British semiconductor outfit. Taxpayer investment is already approaching £100 million if, indeed, the figure hasn't already been exceeded. And the 4,000 jobs promised will probably never be achieved. I have always been sceptical on politically motivated investment. If a product is worthwhile then private capital will automatically be attracted to it. I still wish Inmos well but I wish they could have done a lot better. The grant of a further £15 million may yet save the company but it now looks to be an awful long time before the total investment gets repaid.

Telecoms

In contrast we have the recently privatised Cable & Wireless. Lucky those who bought in at the offered price of 168p in October 1981. Those who held on have doubled their money with further growth in prospect. Booming profits have not only benefited shareholders. Swan Hunter Shipbuilders and their workforce on the Tyne have won an £18 million order for a new C & W cable ship. It will provide work for 800 men over a period of 18 months.

And how about British Telecom itself! Best ever profits leading to a freeze in prices for a further few months. Of course we can argue that the call charges were too high in the first place. Never mind! The prospect of competing in a real instead of captive market has done the trick. BT is really trying harder and will, I believe do better.

Fly Smiths

Next time you fly in a Boeing remember you are also flying Smiths Industries. Their electronic auto-throttle system is on all 727s and 737s together with a host of other flight deck instruments. The Smiths auto throttle (100 more sets have just been ordered) saves fuel on all regimes of flight from take-off to landing.

Part 1 SOUND SYNTHESIS BOARD

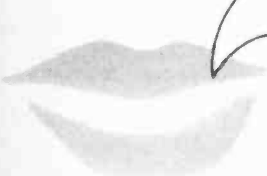
DIGIT TALKER

THE transmission of speech stimulated the start of the electronics industry. It has, however, taken over 100 years to develop a machine which will economically reproduce the complexity of the human voice.

Until recently, all sound reproduction has been based on electro-mechanical systems centred around plastic discs or magnetic tape. Such systems are generally bulky, delicate and expensive, and can only be used in a limited number of environments. There are, however, a large number of applications, especially in instrumentation, where an operator is not able to look at an instrument panel but needs to know immediately the results of his action, and in what way to correct them. Such applications are found in Motoronics, Avionics and Mechatronics. In effect, the requirement is for a *speak-out* unit, as opposed to a read-out unit, and it was to this end that the Warwick Design Group produced their Voice Synthesis Board.

Many ways of reproducing speech digitally have been suggested. The simplest of these is to convert the analogue speech signal to a linear digital form. As the maximum bandwidth of speech is around 4kHz, a minimum sample rate of 8kHz is needed. If a 12 bit analogue to digital converter is used this technique would take up memory at a rate of 96,000 bits per second.

A. Wiggin



A method for reducing this astonishing amount of memory is to sample the analogue signal at 8kHz but, instead of measuring the absolute value at each step, simply record whether or not the signal is increasing or decreasing. This can be done with just one bit, thus reducing the memory required to 8000 bits per second, without significantly reducing the quality of the speech output.

A more radical approach to the problem is to use a microprocessor to act in the same way as a human voice. This means that the action of each part of the vocal tract has to be analysed and turned into an algorithm which can be programmed into the microprocessor. Such an algorithm is shown in Fig. 1.1. It consists of the lungs which provide the basic energy, the vocal cords, the mouth and the nasal cavities. Sound generated by the vocal cords is modulated by the mouth, the movements of the jaws, the tongue and the lips. The whole combination can be considered as a time variant filter, whereby the nasal cavity acts as a fixed frequency resonator. Another useful feature of the human voice is that the muscles cannot react faster than 20 to 25 milliseconds. Hence speech can be split up into 20 millisecond envelopes. This characteristic can be used to great advantage when trying to condense the amount of memory.

Sounds are produced by the vocal system in three ways. Voiced sounds are generated by tensing the vocal cords which forces them to vibrate as air is expelled from the lungs. An example of a voiced sound is 'ee' in the word 'speech'. Secondly, fricative sounds are generated by air from the lungs rushing past a constriction such as the teeth or lips. The sound 's' at the beginning of the word 'speech' is a fricative. Finally, plosive sounds are generated by a total obstruction of the mouth cavity by either the tongue or the lips. Air pressure is built up and then suddenly released. The word 'pop' begins and ends with a plosive.

COMPUTER ALGORITHM

These elements of a human voice can be built into a computer by using this algorithm. Fig. 1.2 shows a system which comprises a random signal source and a periodic signal source. The former is used to generate the fricative and plosive sounds and the latter the voiced sounds. Either one of these can be selected to drive the time variant filter which simulates the action of the lips, the tongue and the jaw movements. The algorithm assumes that there is complete independence between the source and the filter and that only one of the sources is being used at any given time. In all, 13 parameters are needed to drive the algorithm, but due to the reaction time of the muscles, they only need to be updated 50 times a second. Hence, if a 10-bit analogue-to-

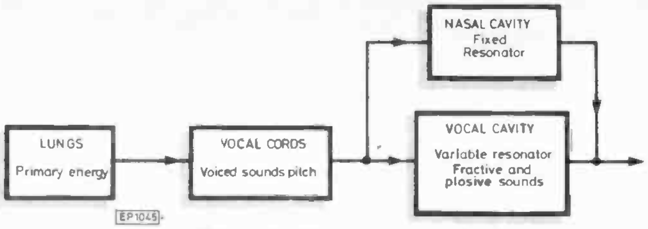


Fig. 1.1. Elements of the human vocal tract

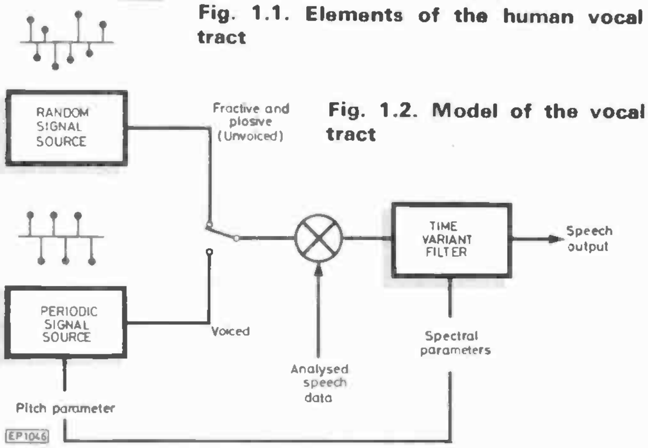


Fig. 1.2. Model of the vocal tract

digital converter is used, only 6000 bits are needed to synthesise one second of speech.

Further economies can be achieved by quantitising some of the algorithm parameters such as pitch and amplitude into a set number of values. The periods of silence which occur between syllables need not be recorded, only their duration. In many cases, syllables and phrases repeat and therefore they can be referred to by the computer time and time again. By using all these techniques it is possible to reduce the data needed for the successful synthesis of speech to as low as 1,100 bits per second.

Linear Predictive Coding (LPC), as it is known, is the most efficient means of synthesising the human voice using digital techniques. A maximum of 49 bits are needed to update the 13 parameters of the algorithm every 20 milliseconds. They can be split up as follows:

1) Energy (amplitude) — 4 bits
2) Repeat — 1 bit
3) Pitch (frequency) — 5 bits
4) The ten reflection coefficients
   - K1 and K2 — 5 bits
   - K3–K7 — 4 bits
   - K8–K10 — 3 bits

Fig. 1.3 shows how the word "HELP" is synthesised using the LPC algorithm.

	E	R	P	K1	K2	K3	K4	K5	K6	K7	K8	K9	K10	FRAME TYPE
	0000													SILENCE
	0100	0	00000	10011	01110	1001	0111							UV
	0111	1	00000											UV–REPEAT
	1101	0	10010	10000	10100	1000	0110	0111	1000	1010	100	101	010	V
	1101	1	10011											V–REPEAT
	1110	1	10011											V–REPEAT
	1101	0	10100	01101	01111	1010	1010	1001	0111	1000	100	101	101	V
HEL	1101	0	10100	01110	01011	1000	1100	1101	1000	0100	100	011	101	V
	1101	0	10011	10001	01010	0110	1001	1111	1011	0101	010	000	110	V
	1011	1	11010											V–REPEAT
	1010	0	10010	01101	00111	1000	1100	1111	0111	0010	001	010	110	V
	1001	1	10001											V–REPEAT
	1001	1	01110											V–REPEAT
	1000	1	01101											V–REPEAT
	0010	0	01110	00101	00101	1101	1001	1110	0101	0111	001	011	011	V
	0000													SILENCE
	0000													SILENCE
	0000													SILENCE
	0111	0	00000	10100	01011	1011	1000							UV
	0111	0	00000	10001	01011	1011	0110							UV
P	0101	1	00000											UV–REPEAT
	0011	0	00000	10011	00111	1010	0110							UV
	0010	0	00000	10010	00101	1011	0101							UV
	0000													SILENCE
	1111													STOP CODE

V–VOICED
UV–UNVOICED

Fig. 1.3. L.P.C. for the word "HELP"

INSTRUCTION NAME	CTL PINS 8 4 2 1	TOGGLES OF PDC
Reset	0 0 0 0	1
Load address	0 0 1 0	2
Read & branch	1 1 0 0	1
Test talk	1 1 1 0	3
Read bit	1 0 0 0	1
Speak	1 0 1 0	1
Output	0 1 0 0	3

EP1047

Fig. 1.4. Instruction set for the TMS5100

As there are a considerable number of applications for machines with a voice, several companies have developed microprocessor systems to run nothing but the LPC algorithm. Amongst these companies is Texas Instruments, which has developed a dedicated microprocessor, based on their TMS 1100 device. The TMS 5100 Voice Synthesis Processor generates human speech by digitally processing data stored in a non-volatile 128K bit ROM. It has its own Digital-to-Analogue converter and audio push-pull amplifier. The amount of external programming needed to drive the processor has been reduced to a minimum. The seven instructions shown in Fig. 1.4 are loaded into the device on 4 control lines and 1 clock line.

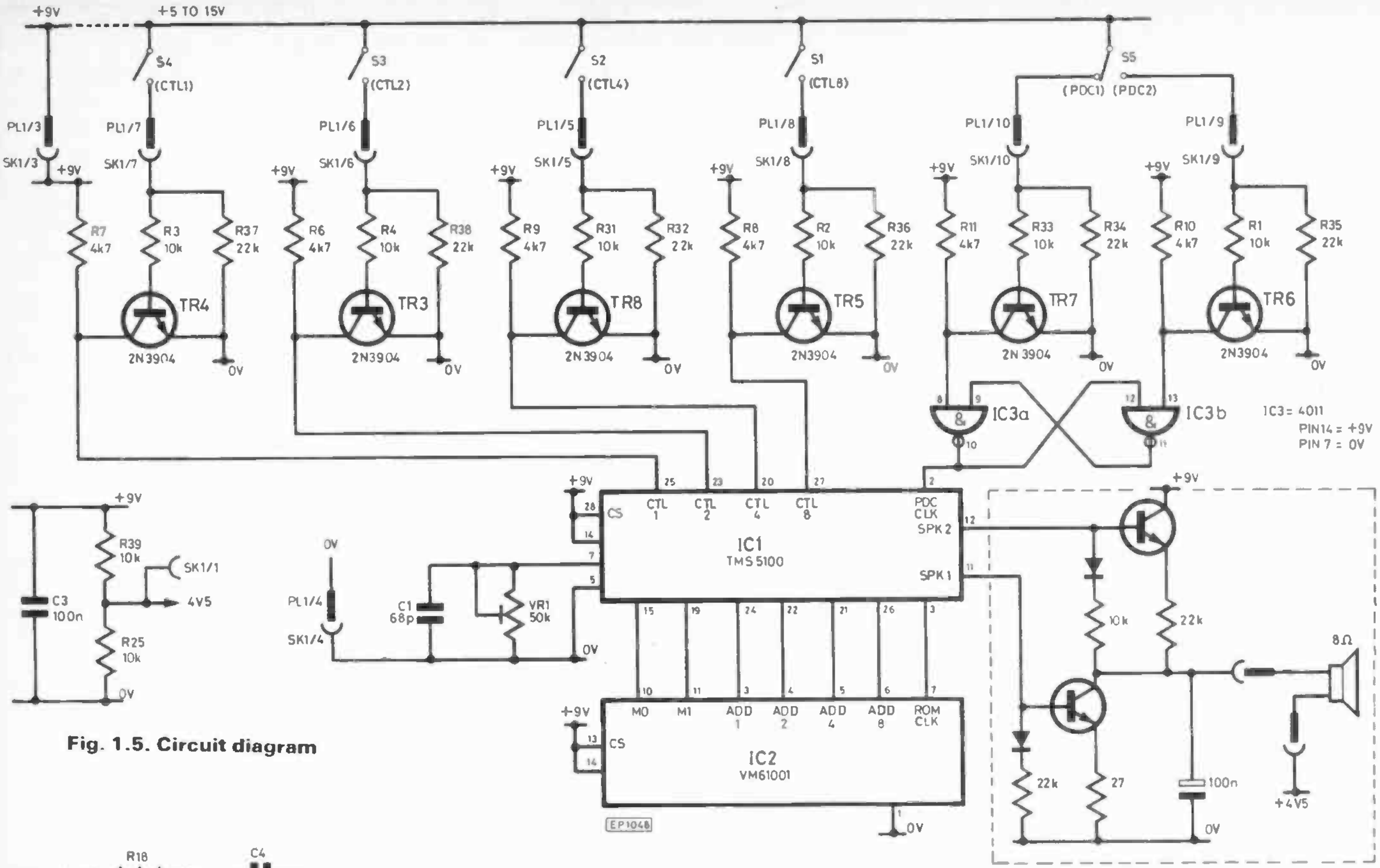


Fig. 1.5. Circuit diagram

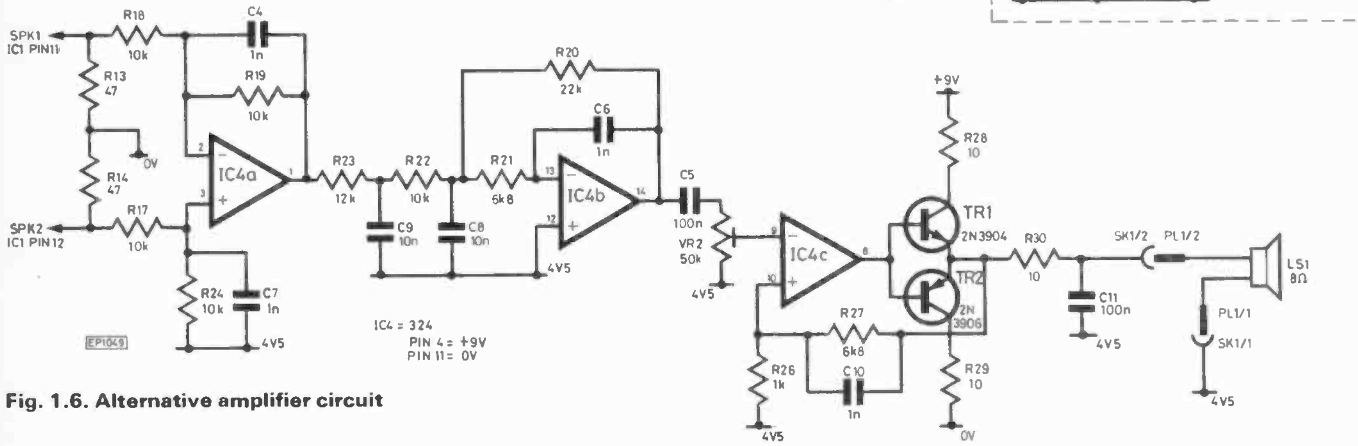


Fig. 1.6. Alternative amplifier circuit

CIRCUIT DESCRIPTION

The circuit shown in Fig. 1.5 can either be driven by a microcomputer or by manual switches. If the latter is used, care must be taken to debounce the PDC switch. Processor timing is provided by a RC network connected to pin 7 of the TMS 5100. When adjusted it will produce a frequency of 640kHz. This is divided down to give the CPU clock of 320kHz and the ROM clock of 160kHz. Three power rails are needed to run the system. The processor uses a 0 to 9 volt rail, whereas an intermediate voltage of 4·5 volts is needed for the audio output stage. The TMS 5100 loads an address to the VM 61001 by means of the M1 control output and the ADD bus. As the PDC is brought high during the address portion of a load address sequence, the TMS 5100 brings M1 high and gates the CTL bus to the ADD bus. When the PDC is brought low, M1 goes low and the TMS 5100 stores the nibble in its address register. Data is transferred from the ROM to the TMS 5100 in a serial form over the ADD 8 line. Toggling MO instructs the ROM to transfer the next bit. As the PDC is brought high during the Read instruction, the TMS 5100 toggles MO and accepts the new bit into its four bit buffer over the ADD 8 line. The first MO after a load address sequence changes the direction of the bi-directional ADD 8 line from transmit to receive.

The audio stage of the TMS 5100 shown in Fig. 1.5 has been optimised for high production runs. An alternative circuit is shown in Fig. 1.6. This circuit significantly improves the quality of the output and consists of a differential amplifier and integrator followed by a low pass filter. The gain of the circuit is controlled by VR2, which in turn drives a non-inverting amplifier and push-pull output stage.

PROGRAMMING

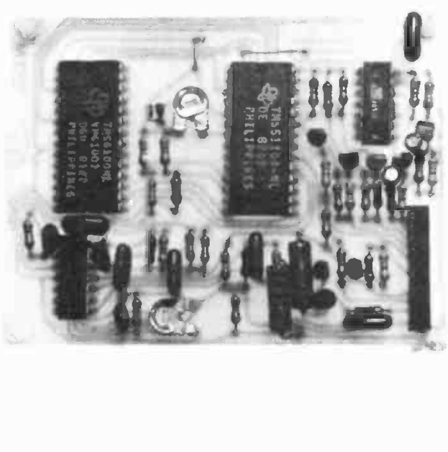
There are two ways in which the system can be operated. *Direct Addressing:* The start address of the speech data held in the ROM (Fig. 1.7) is toggled into the TMS 5100 via the

LPC VOCABULARY DATA IN VM61001 (MALE SPEAKER NO. 6)

WORD PHRASE	LOOK-UP TABLE	START ADDR	WORD PHRASE	LOOK-UP TABLE	START ADDR	WORD PHRASE	LOOK-UP TABLE	START ADDR	WORD PHRASE	LOOK-UP TABLE	START ADDR
ZERO	0002	019A	GOLF	0068	0EC6	UNIT	00CE	1F42	FLOW	0134	2FC6
ONE	0004	01F7	HENRY	006A	0EFF	SWITCH	0000	1F94	FREQUENCY	0136	2FFA
TWO	0006	0248	INDIA	006C	0F49	START	0002	1FE2	FROM	0138	3065
THREE	0008	0282	JULIET	006E	0F96	STOP	0004	2021	ABOUT	013A	30BE
FOUR	000A	02C5	KILO	0070	100C	TIMER	0006	205B	GAGE	013C	30FC
FIVE	000C	0313	LIMA	0072	1063	VALVE	0008	20A1	GATE	013E	316A
SIX	000E	0360	MIKE	0074	108F	LINE	00DA	2133	GET	0140	31A5
SEVEN	0010	039D	NOVEMBER	0076	1001	MACHINE	000C	21B0	GO	0142	31E0
EIGHT	0012	03F3	OSCAR	0078	1138	UP	000E	2236	GREEN	0144	3233
NINE	0014	0422	PAPA	007A	1190	DOWN	00E0	226A	HIGH	0146	3270
TEN	0016	046B	QUEBEC	007C	1105	OFF	00E2	22C4	HOLD	0148	32CC
ELEVEN	0018	049E	ROMEO	007E	1216	ON	00E4	2308	INCH	014A	333D
TWELVE	001A	0504	SIERRA	0080	126D	IS	00E6	2362	INSPECTOR	014C	3375
THIR-	001C	0556	TANGO	0082	12C4	NUMBER	00E8	239E	INTRUDER	014E	33DF
FIF-	001E	057E	UNIFORM	0084	131B	TIME	00EA	240E	LEFT	0150	3440
-TEEN	0020	05A8	VICTOR	0086	1377	CONTROL	00EC	2458	LOW	0152	3460
TWENTY	0022	05D4	WHISKEY	0088	13C3	ALERT	00EE	24BC	MANUAL	0154	34C1
HUNDRED	0024	0619	X-RAY	008A	13FB	OUT	00F0	2523	MEASURE	0156	3534
THOUSAND	0026	0692	YANKEE	008C	1453	AUTOMATIC	00F2	255E	MILL	0158	3596
A	0028	070F	ZULU	008E	14A2	ELECTRICIAN	00F4	25C0	MOTOR	015A	3500
B	002A	074D	AND	0090	14E6	ADJUST	00F6	2632	MOVE	015C	3635
C	002C	0788	THE	0092	1550	POINT	00F8	2692	NORTH	015E	36AB
D	002E	07CB	AMPS	0094	158B	WAIT	00FA	2604	OF	0160	36F9
E	0030	0815	HERTZ	0096	15CB	AT	00FC	2704	OPEN	0162	3730
F	0032	083F	FARAD	0098	1618	BETWEEN	00FE	272F	OVER	0164	3799
G	0034	0783	WATTS	009A	1686	BREAK	0100	2792	PASS	0166	37D5
H	0036	08A2	MEGA	009C	16D6	SMOKE	0102	27CE	PASSED	0168	3815
I	0038	08DC	MICRO	009E	1733	RED	0104	2820	PERCENT	016A	3855
J	003A	0911	MILLI	00A0	17A6	MINUTES	0106	2857	PLUS	016C	38A4
K	003C	095C	METER	00A2	17DE	HOURS	0108	28B1	POSITION	016E	38D8
L	003E	099F	PICO	00A4	1829	ABORT	010A	2906	PRESS	0170	395F
M	0040	09EA	OHMS	00A6	185F	ALL	010C	2960	PROBE	0172	39C0
N	0042	0A28	CAUTION	00A8	18B2	BUTTON	010E	29A3	PULL	0174	3A1A
O	0044	0A5F	DANGER	00AA	1902	CALIBRATE	0110	29F3	PUSH	0176	3A49
P	0046	0A87	FIRE	00AC	1970	CALL	0112	2A5D	RANGE	0178	3A7E
Q	0048	0AB0	AREA	00AE	19CB	CANCEL	0114	2AA1	READY	017A	3AEC
R	004A	0AE8	LIGHT	00B0	1A28	CLOCK	0116	2B08	REPEAT	017C	3B2F
S	004C	0B14	PRESSURE	00B2	1A79	CRANE	0118	2B38	RIGHT	017E	3B80
T	004E	0B3B	POWER	00B4	1ACA	CYCLE	011A	2BA2	SAFE	0180	3BD2
U	0050	0B8A	CIRCUIT	00B6	1B10	DAYS	011C	2C00	SET	0182	3C0D
V	0052	0BB7	CHECK	00B8	1B5A	DEVICE	011E	2C5A	SHUT	0184	3C3D
W	0054	0BE9	CHANGE	00BA	1B8F	DIRECTION	0120	2CBF	SLOW	0186	3C7D
X	0056	0C30	COMPLETE	00BC	1BE0	DISPLAY	0122	2D3D	SOUTH	0188	3CC5
Y	0058	0C56	CONNECT	00BE	1C49	DOOR	0124	2D8A	SPEED	018A	300C
Z	005A	0C98	DEGREES	00C0	1C9B	EAST	0126	2DB8	TEST	018C	3D91
ALPHA	005C	0CF0	MINUS	00C2	1CFB	ENTER	0128	20F1	TOOL	018E	30E6
BRAVO	005E	0D40	REPAIR	00C4	1D62	EQUAL	012A	2E3A	TURN	0190	3E1F
CHARLIE	0060	0D85	SECONDS	00C6	1DD9	EXIT	012C	2E90	UNDER	0192	3E5A
DELTA	0062	0008	SERVICE	00C8	1E44	FAIL	012E	2ECF	VOLTS	0194	3EA0
ECHO	0064	0E16	NOT	00CA	1E8A	FEET	0130	2F23	WEST	0196	3EFE
FOXTROT	0066	0E51	TEMPERATURE	00CC	1ECA	FAST	0132	2F6D	YELLOW	0198	3F42

Fig. 1.7. Vocabulary for the VSB

control lines. As 18 bits are needed to address one location in a memory of this size, and there are only 4 control lines, then 5 nibbles of 4 bits are used. Each nibble is preceded by a load instruction. After all 5 nibbles have been loaded a 'Read Bit' instruction is toggled into the processor. This instruction reverses the bi-directional memory bus and when a 'Speak' instruction is toggled in, data is transferred from the ROM to the TMS 5100. This data is then processed and fed to the audio output via the 10 bit digital to analogue converter.



Indirect Addressing: The second method is to use an indirect 'Read and Branch' instruction. Fig. 1.8 shows the flow chart for this instruction. At the bottom of the ROM there is a look-up table which holds all the start addresses of all the words held in the memory. If the 'Read and Branch' instruction is used the address of the look-up table which holds the

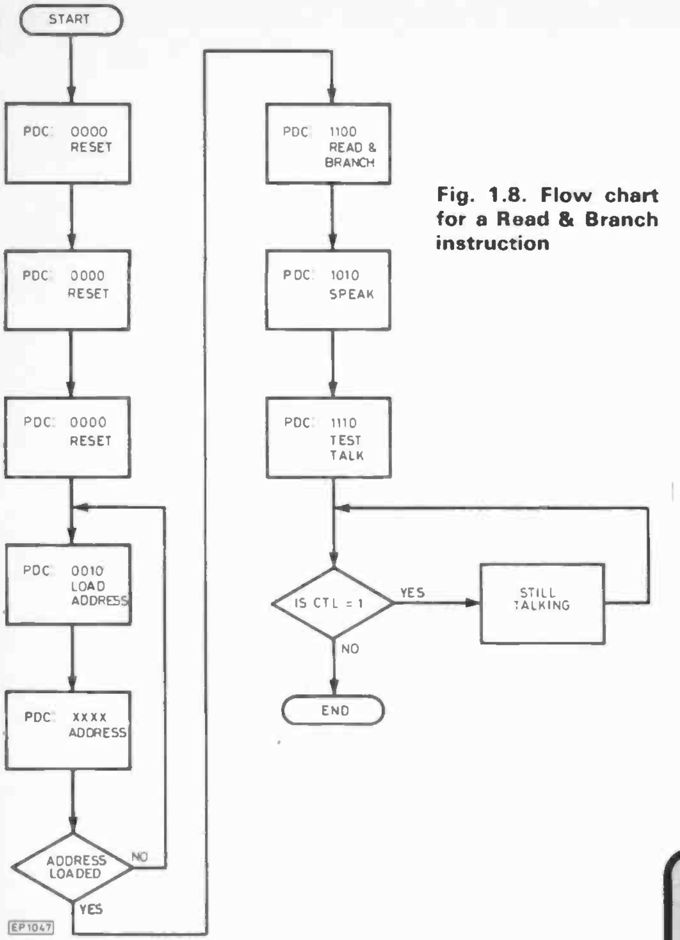


Fig. 1.8. Flow chart for a Read & Branch instruction

some typical speech scenarios

burglar alarms

RED ALERT. INTRUDER AREA ONE.

video games

RANGE: TWO THOUSAND FEET.
DIRECTION: THIRTY-NINE DEGREES EAST.
ALPHA BRAVO TO (use TWO) WHISKEY FOXTROT.
POSITION SAFE.
MOVE FAST.

personnel security

STOP. DOOR IS AUTOMATIC.
INSERT PASS.
PRESS ENTER BUTTON ON RIGHT.
WAIT TEN SECONDS. CHECK NOT COMPLETE.
CAUTION.
FAIL. PASS NUMBER IS NOT O K.
CALL MANUAL INSPECTOR.
CANCEL PASS. ABORT CYCLE.

safety

GET SERVICE UNIT.
DANGER: TEN THOUSAND VOLTS.
LINE VALVE PRESSURE HIGH.
GET ELECTRICIAN.
REPEAT TEST ON TIMER SWITCH.

COMPONENTS . . .

Resistors

R1–4, R17, R18, R19, R22, R24, R31, R33	10k (11 off)
R6, R7, R8, R9, R10, R11	4k7 (6 off)
R13, R14	47 (2 off)
R23	12k
R20, R32, R34, R35, R36, R37, R38	22k (7 off)
R21, R27	6k8 (2 off)
R26	1k
R28, R29, R30	10 $\frac{1}{2}$W (3 off)

All resistors $\frac{1}{4}$W 5% unless otherwise stated

Potentiometers

VR1, VR2	50k (2 off)

Capacitors

C5, C3, C11	100n (3 off)
C1	68p
C4, C7, C6, C10	1n (4 off)
C9, C8	10n (2 off)

Integrated Circuits

IC1	TMS 5100
IC2	VM 61001
IC3	4011
IC4	324

Transistors

TR1, TR3–TR8	2N3904 (7 off)
TR2	2N3906

Miscellaneous

8 ohm loudspeaker
10-way printed circuit connector

Constructor's Note

The TMS 5100 is available from the **Warwick Design Group** at £14, the VM61001 at £16, the printed circuit board £5. A full kit of components is available for £37 from the Warwick Design Group, 12 St. George's Road, Leamington Spa CV31 3AY.

starting address of the required word is first toggled into the TMS 5100 via the CTL lines. A 'Read and Branch' instruction is then executed, and on receiving a 'Speak' instruction, the audio output is activated.

CONCLUSIONS

The voice synthesis board described above can be used as a basic building block in many different applications. It can be interfaced directly to a microcomputer or used to enhance an existing instrument such as a digital voltmeter, frequency meter, digital clock, or CB radio read out.

NEXT MONTH: A method for interfacing the voice synthesis board with a 3 digit, 7 segment display will be described.

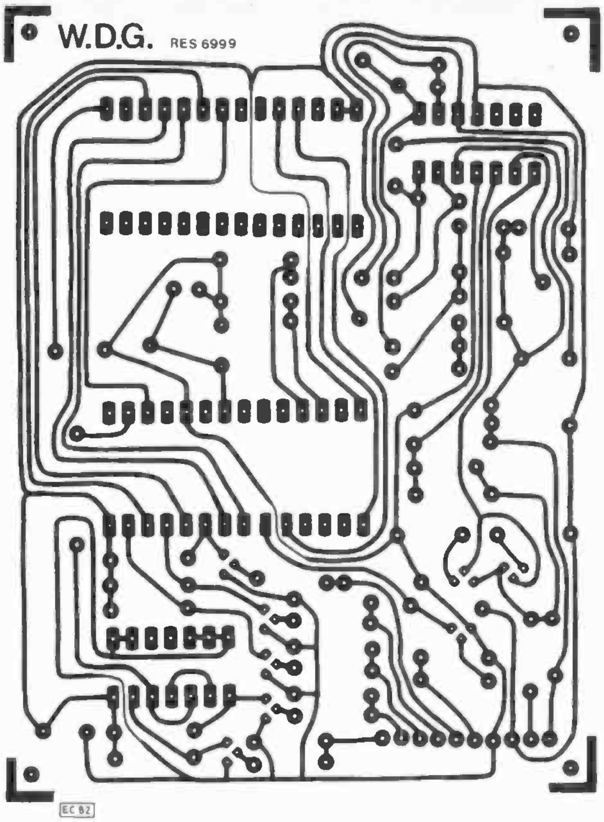


Fig. 1.9. Printed circuit board

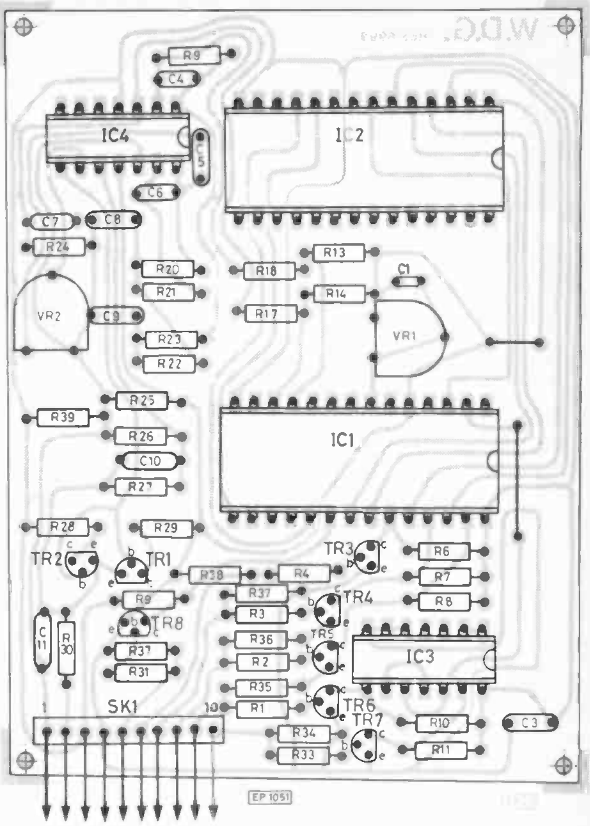


Fig. 1.10. Component layout

BAZAAR

WANTED Buy or borrow, handbook manual for Ferrograph series Four, also require bulk tape eraser. Robert Du Pontet, 55 Staplegrove Road, Taunton. Tel: (0823) 72909.

WANTED Circuit or manual for miniature oscilloscope type CT52. Buy or borrow. W. D. Goodwin, 1 Long Meadow, Natland, Kendal, Cumbria LA9 7QZ.

ACORN Atom fully expanded TV monitor, cassette recorder, p.s.u., tool kit, ROM, 36 software tapes inclusive, £220·00. Mr. R. W. Hearn, 10 Speedwell Close, Pakefield, Lowestoft, Suffolk NR33 7DU. Tel: Lowestoft 66026.

MAPLIN matinee organ for sale, complete and working. £370. Tel: 01-578 5448 (Greenford). D. J. Comber, 66 Chinnor Cres., Greenford, Middx. UB6 9NX.

UK101 32 x 48 12K BASIC 16K RAM Motherhood, EPROMS + Programmer sound 1MHz 3/600B software, £280 o.n.o. N. Brooks, 103 Drake Rd., Harrow, Middlesex HA2 9DZ. Tel: 01-868 9524.

WANTED, to buy or borrow, handbook for telequipment oscilloscope type D56. G. V. B. Russell, North Yeo, Instow, Bideford, Devon EX39 4JJ. Tel: (0271) 860570.

ZX81 32K with "Fuller" keyboard, p.s.u. and case. 3-D maze game. Three books, Sinclair manual, £100. M. Bond, 2 The Grange, Eastbourne Road, South Godstone, Surrey RH9 8JQ. Tel: 034-285 3168.

CASIO FX702-P pocket computer with printer, cassette interface and 5 rolls of paper. £115 o.n.o. S. J. Riddle, 51 Marshalswick Lane, St. Albans, Herts. AL1 4UT. Tel: (0727) 53946.

WANTED Cosser type 23D cathode ray tube. A. F. E. Riley, 1 Boulton Sq., West Bromwich, Staffs.

LOGIC cards: 6 FND800 displays and CD4511, £3·00. PSU +5/−12 with power-on reset, £6·00, p.p. extra. Norman Simons, 187 Ladbroke Gr., London W10. Tel: 01-969 6150.

MARSHALL 100 watt amp transistorised, lead good condition. £100 o.n.o. Mr. A. C. Clews, 5 Hedgerow Dr., Kingswinford, West Midlands DY6 7SA. Tel: 271404 (0384).

PHILIPS 1700 V.C.R. with tapes, faulty head, £80. Buyer collects, Cash please. J. Gray, 9 New Road, Hextable, Swanley, Kent BR8 7LS. Tel: Swanley 64486.

WANTED circuit diagram of ZX80. Will pay photostating, postage etc. Robert Forsyth, 45 Cyclamen Road, Swanley, Kent BR8 8HH. Tel: Swanley 64394 after 6pm.

UK101 8K, Cegmon, new Basics, 1,3,4,16/32x48 screen, cased, PE extension boards (No i.c.'s) £80 o.n.o. Somerton 72663 evenings.

6 VOLUMES Radio TV servicing 1968 to 1974 mint condition £14.50 carriage extra, weight 18lbs. D. Clark, 2 Eriskay Avenue, Hamilton, Strathclyde, Scotland. Tel: Hamilton 421757.

UK101 plus 610bd. 32K RAM 2 x Mini Disk drives, SEK 65D 3·3 DOS, Link 65 Cegmon b/w monitor £450 o.n.o. Stuart Higgins, 138 Lower Farnham Road, Aldershot, Hants. Tel: Ald 28796.

UK101 8K-32L cased Cegmon resident Basics 1,2,3,4,5, T/KIT II, Codekit + cassettes Assembler, Forth, Exmon, games £200. p/exch? Tel: 0252 546739, Farnborough, Hants.

WANTED Reasonably priced synthesised shortwave receiver, also spool type VRT. Write first: 16 Rosalind House, Stanway St., London N1 6RR.

2 x 5 Octave keyboard 2 x 5 Octave PC/B key switch assemblies, 2 x foot controls S/L reverb unit, unused, £80. F. L. Mebhurst, 168 Maesglas Cres., Newport, Gwent NPT 3DA.

TWO ±15V power supplies complete, uncased, £10 ea. Four RC4195 ±15V regulators, £3 ea. Paul Blackburn, 33 St. Annes Rd., New Marske, Redcar, Cleveland. Tel: Redcar 485127.

MONO DX TV for sale, pro. conversion, isolated chassis, all bands, video/audio in/out, £25 o.n.o. Mr. A. Bouskill, 129 Lyminster Rd., Sheffield, S. Yorks S6 1HY. Tel: 0742 311191.

WANTED Good quality Gould oscilloscope, double beam, 10MHz min. or similar. Must have good triggering. Anthony Collins, 34 Lock Assynt, East Kilbride, Glasgow G7H 20W.

SOLDERING iron, Weller TCP 24V/48W (needs transformer to use), plus bench stand. Unused present, £15 including postage. Tel: Oxford (0865) 779855.

WANTED circuit diagram of ZX80. Will pay photostating, postage etc. Robert Forsyth, 45 Cyclamen Road, Swanley, Kent. BR8 8HH. Tel: Swanley 64394 after 6pm.

UK101 8K, Cegmon, new Basics, 1,3,4,16/32x48 screen, cased, PE extension boards (No i.c.'s) £80 o.n.o. Somerton 72663.

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Patents Review

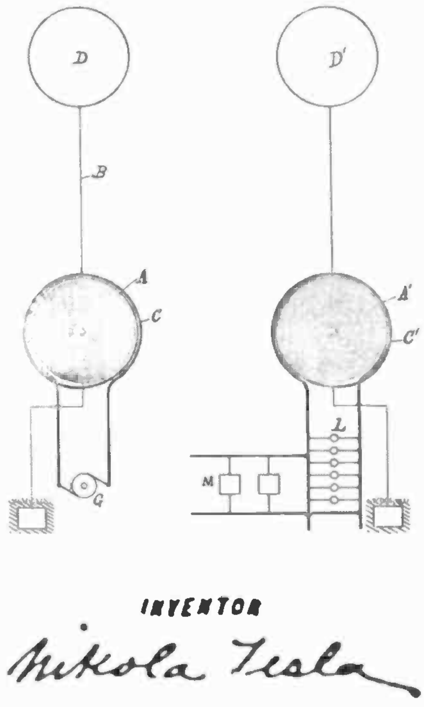
Copies of Patents can be obtained from:
the Patents Office Sales, St. Mary Cray, Orpington, Kent. Price £1.60 each.

BACK TO TESLA

Something *old* for a change. There's been a lot of interest recently in the life and work of Nikola Tesla, largely due to the publication of a new biography. Tesla's American patent, number 645576 of March 1900, is well worth a read, even today. You can read it on micro film at the Science Reference Library, attached to the British Patent Office, in Chancery Lane, or you can buy a photo copy made from micro film for around £1.

Tesla's patent, entitled 'System of transmission of electrical energy' was filed in 1897. At first sight it may look like a re-invention of Marconi's first ideas for radio. But Tesla wasn't talking about the transmission of low-powered message signals, he was proposing the transmission of electric power in bulk over long distances, without wires. 'I contemplate employing my invention on an industrial scale', he wrote 'for lighting distant cities or districts from places where power is obtainable'. Was he a hundred years ahead of his time, or a fool?

In the drawing the transmitter is a transformer with a primary C and a secondary A. The secondary is wound from thin wire and connected to a steel cable B suspended high in the air by baloon D. Intermittent power is input from source G, for instance a capacitor.



The receiver is of similar construction, with lamps L as the load. Tesla built a small scale model and claimed that he could transmit power from one unit to the other in a vacuum environment with a potential of around 4 million volts. 'It was easy under these conditions', he wrote in the patent, 'to transmit with fair economy considerable amounts of energy He claimed that by cranking the voltage up to about 50 million volts, with a secondary 50 miles in length, and suspended aerials 35,000 feet above sea level, it would be possible to transmit 'many thousands of horse power — many hundreds and even thousands of miles'. The system, he said, could also be used to transmit messages. Another idea was to manufacture materials like nitric acid and fertilisers, from gases occurring naturally in the upper atmosphere.

Tesla was at pains in the patent not to claim the apparatus, just the method of transmitting electrical energy through the upper air strata. Reports, perhaps not as crazy as they at first sound, suggest that the Russians may have recently been putting Tesla's patent theories to the test using modern technology.

SPEAKER IMPROVEMENTS

Celestion, the Ipswich loudspeaker manufacturers, have received considerable critical acclaim for their SL6 unit. The company have been cagey about giving technical details on fine points of construction, but their patent applications are now being published.

European patent application 0065882 covers the HF tweeter dome which is an important factor in the sound of the SL6. Conventionally radiating domes have been made out of impregnated cloth, plastics or metals like aluminium or titanium. The snag has been poor heat dissipation. When the speaker is playing loud music, especially pop with synthesizers in the orchestration, there is a considerable amount of high frequency energy to be reproduced. The drive coil heats up and may burn out. Cooling fluids have been used as a heat sink. Now Celestion have killed two birds with one stone by making the dome radiator serve as its own heat sink.

The patent lists a wide range of possibilities, but essentially the dome is formed from one or two layers of a metal which is a good heat conductor. Although silver and gold are usable, they are too expensive, so copper is chosen in practice. The dome is less than 1mm thick, and formed by metal deposition, for instance in a vacuum or by RF sputtering. If acoustic damping is needed, the dome can be formed from two layers of metal separated by a filler layer of plastics or rubber. It can also be protected by a very thin coating of non-metallic material.

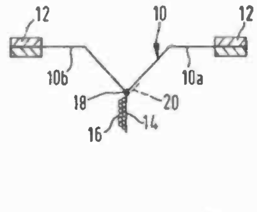


FIG.1.

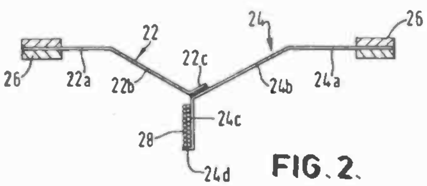


FIG.2.

Celestion has also filed a European patent application, number 0065883, on a different way of securing a ring radiator to its clamps, so that the unit doesn't fall apart when driven at high power. Fig. 1 shows the conventional way of securing a diaphragm 10 between ring clamps 12. The drive coil 16 is wound on tubular former 14 and secured to the apex of the diaphragm at butt joint 18, by glue. Because the area of adhesive contact is so small, the joint is liable to fail under load.

To overcome this Celestion makes the diaphragm in two halves, one half also serving as the former for the drive coil. Fig. 2 shows one half of the diaphragm 22 with an angled tongue 22C at the end. The other half of the diaphragm 24 has a large flange 24C which serves as the former for coil 28. The two halves of the diaphragm are glued together at the tongue 22C, so there is a much larger area of adhesive contact and less likelihood of failure under load.

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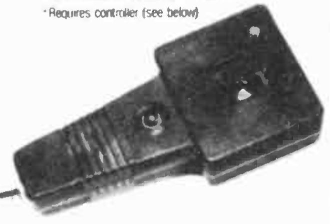

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Z80ACPU	3.45
Z80CTC	2.64
Z80ACTC	2.95
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2716 450ns 3 Rail	5.95
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4010	0.39
4011	0.11
4012	0.15
4013	0.24
4014	0.74
4015	0.49
4016	0.19
4017	0.37
4018	0.67
4019	0.41
4020	0.49
4021	0.69
4022	0.65

4116 150ns	0.85
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4034	1.90
4035	0.94
4040	0.49
4041	0.77
4042	0.44
4043	0.69
4044	0.64
4045	1.69
4046	0.64
4047	0.49
4048	0.54
4049	0.24
4050	0.24
4051	0.44
4052	0.59
4053	0.77
4054	0.84
4055	0.84
4060	0.59
4063	0.98
4066	0.29
4068	0.21
4069	0.15
4070	0.14
4071	0.14
4072	0.19
4073	0.14
4075	0.14
4076	0.45
4077	0.25
4078	0.25
4081	0.15
4082	0.20
4085	0.64
4086	0.51
4093	0.25
4502	0.89
4507	0.38
4508	1.29
4510	0.45
4511	0.44
4512	0.49
4514	1.14
4515	1.14
4516	0.54
4518	0.39
4519	0.28
4520	0.40
4521	1.09
4522	1.24
4526	0.69
4527	0.84
4528	0.69
4532	0.69
4541	0.99
4543	0.79
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4555	0.50
4556	0.50
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74LS SERIES	
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01	0.11
02	0.11
03	0.11
04	0.11
05	0.11
08	0.11
09	0.11
10	0.11
11	0.13
12	0.11
13	0.15
14	0.29
15	0.12
20	0.12
21	0.12
22	0.13
26	0.12
27	0.12
28	0.12
30	0.12

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Device	Price
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38	0.12
40	0.12
42	0.27
47	0.34
48	0.45
49	0.60
51	0.14
54	0.14
55	0.15
73	0.19
74	0.16
75	0.19
76	0.17
78	0.24
83	0.34
85	0.47
86	0.15
90	0.28
91	0.60
92	0.31
93	0.25
95	0.40
109	0.27
112	0.20
113	0.20
114	0.22
122	0.35
123	0.35
125	0.24
126	0.25
132	0.39
136	0.23
138	0.27
139	0.29
145	0.70
148	0.69
151	0.39
153	0.28
155	0.34
156	0.34
157	0.25
158	0.29
160	0.35
162	0.35
163	0.34
164	0.39
165	0.54
166	0.63
173	0.64
174	0.40
175	0.44
181	0.90
190	0.38
191	0.44
192	0.44
193	0.44
194	0.34
195	0.34
196	0.45
197	0.45
221	0.54
240	0.55
241	0.65
242	0.64
243	0.64
244	0.59
245	0.69
247	0.40
248	0.40
249	0.68
251	0.29
253	0.30
257	0.34
258	0.35
259	0.57
261	1.95
266	0.19
273	0.59
279	0.59
283	0.39
290	0.57
293	0.40
365	0.29
366	0.29
367	0.29
368	0.39
373	0.59
374	0.64
377	0.69
378	0.45
379	0.65
386	0.34
390	0.49
393	0.41
629	1.21

Device	Price
DIL sockets low profile	

Pins	Tin	Gold	W/W
8	7	22	25
14	9	29	35
16	9	31	35
18	13	33	52
20	14	35	60
22	17	40	70
24	19	42	70
28	25	54	80
40	29	81	99

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Single ended 24"	
14 PIN	1.40
16 PIN	1.60
24 PIN	2.35
40 PIN	3.25
Double Ended 6"	
14 PIN	1.90
16 PIN	2.05
24 PIN	3.10
40 PIN	4.85
Double Ended 12"	
14 PIN	2.00
16 PIN	2.15
24 PIN	3.25
40 PIN	5.10
Double Ended 18"	
14 PIN	2.05
16 PIN	2.25
24 PIN	3.40
40 PIN	5.25

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40 PIN	8.80

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MALE S ENDED (18" CABLE)	5.83
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14 PIN	1.22
16 PIN	1.34
20 PIN	1.46
26 PIN	1.76
34 PIN	2.08
40 PIN	2.32
50 PIN	2.70
60 PIN	3.20

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16 PIN	2.10
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26 PIN	3.24
34 PIN	3.80
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Z80CTC	0.90
Z80ADART	0.80
Z80ADMA	1.10
Z80PIO	0.90
Z80ASIO	2.00
MK3886	6.75
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6502	1.60
6520	0.85
6522	2.80
6532	1.10
8080 FAMILY DATA	
8085A	2.00
8251	2.40
8255	1.00
DATA CONVERTERS DATA	
ZN425	0.75
ZN427	0.75
ZN428	0.75
ZN432	0.75
ZN433	0.75
ZN447/8/9	0.75
UPD 7002	0.75
MISC. SUPPORT CHIPS DATA	
AY-3-1015	1.20
AY-3-1270	0.50
AY-3-8910	1.00
AY-5-1013	1.30
AY-5-3600	3.25
AY-5-2376	3.25
DP8304	0.85
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5803C	1.00
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WIPER DELAY

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

WINDSCREEN wipers have featured on modern motor vehicles since their earliest days. At first, drivers considered themselves lucky to have even a single electrically-driven wiper blade, usually running at a fixed speed, and requiring manual parking when no longer required. With the passage of time, improvements in the form of twin-bladed wipers, switched speeds, self parking and intermittent wash/wipe facilities have been introduced. Although considered by some to have detracted from the 'character' of the earlier cars, these changes have undoubtedly been of significant benefit to the motorist at large. Typically now even the basic models feature two-speed self-parking twin front wipers, usually with intermittent wash/wipe facilities, as standard equipment.

The advent of the popular hatchback style has seen the introduction of tailgate wash/wipe on many cars. The normal arrangement is to provide a single-bladed, slower-running wiper running at a fixed speed with self-parking, and in many respects this is often adequate. There are situations, however, in typically English periods of wet weather when the rain, although continuous, is not really heavy enough for the rate of wipe provided. This can lead to the driver continuously switching the wiper on and off, which is both distracting and tiresome. The alternative is a wiper which tends to 'drag' across the rear screen surface, resulting in a screen which is more smeared than wiped; the noise in itself is often as distracting as the reduced visibility is hazardous.

The unit to be described will provide a variable speed control for a rear screen wiper to help overcome some of the problems described above. It uses a small number of low cost components, and can be fitted with the minimum of rearrangement to the existing vehicle wiring. When installed, the unit can be used to select any rate of wipe between once every minute and the maximum of the rate fitted as standard. The existing wiper controls are retained, allowing drivers unused to the additional facilities to drive as normal.

CONSIDERATIONS

A typical tailgate wash/wipe circuit is shown in Fig. 1 with the controls set in the 'wipe' position. The +12V lead labelled 'a' is permanently connected to the wiper motor, and provides power for self parking when the driver moves the control from 'wipe' to 'off'. The motor housing itself contains another switch which disconnects the winding from lead 'a' when it reaches the parked position. Lead 'b' is connected to ground in the 'off' position to help prevent the motor overshooting the parking position (thereby starting another wipe cycle) by collapsing the motor field when 'a' becomes disconnected. In the 'wipe' position, 'b' ensures that the motor continues turning through the parking position, thereby producing continuous operation of the wipers. Internally within the motor, 'a' and 'b' are both connected via a diode and a rotating switch arrangement to one end of the motor winding, while the other end is permanently grounded.

One consideration in producing a wiper delay unit is that, although intended to be used when the normal wiper control is set to 'off', it should not interfere with the wiper if used when the control is set to 'wipe'. The basic principles of the unit to be described are shown in Fig. 2. The delay unit, when switched on, produces a continuous stream of pulses to drive switch S1. The duration of each pulse is chosen to be long enough to 'kick' the wiper out of its parked position, but not so long as to exceed one complete wipe cycle (which on a small hatchback is typically just under two seconds). Varying the interval between these pulses then gives the method of varying the rate of wiping. The unit described allows variation from one wipe every minute, up to the maximum rate supplied of approximately 30 to 40 wipes per minute. As can be seen from the schematic in Fig. 2, if both the delay unit and the normal wiper controls are both switched 'on', the wiper will operate continuously at the standard fixed speed without difficulty.

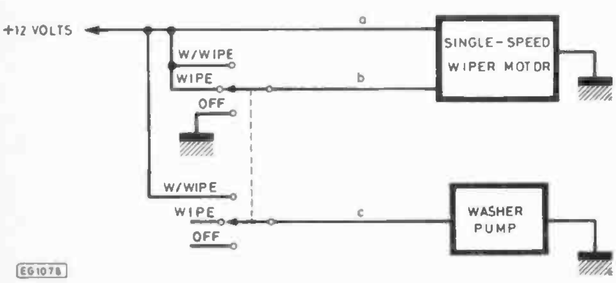


Fig. 1. Conventional tailgate wash/wipe circuit

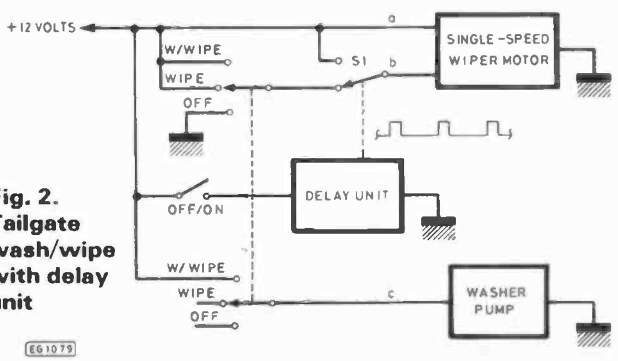
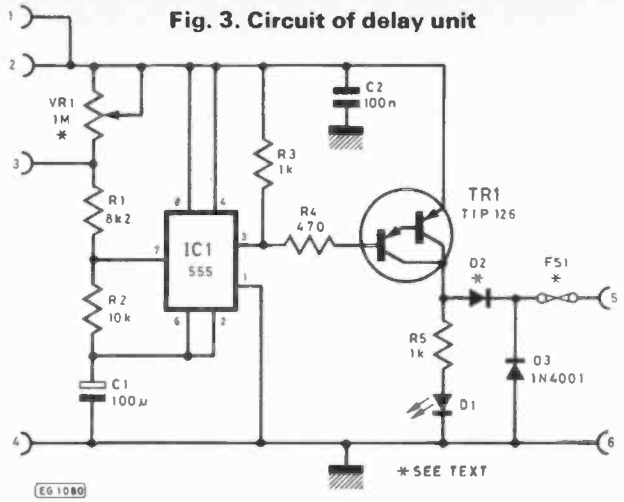


Fig. 2. Tailgate wash/wipe with delay unit

Fig. 3. Circuit of delay unit



CIRCUIT

The wiper delay unit is designed around a general purpose circuit board which may be readily adapted for use with a wide variety of wiper configurations. The circuit diagram for this basic module is shown in Fig. 3. The basic timing element is the ubiquitous 555 monolithic timer, IC1, which is used here in a conventional astable configuration. The output low period from pin 3 of IC1 is set by R2 and C1, according to the equation $T_L = 0{\cdot}7\ R2\ C1$, while the output high period for fixed values of R2 and C1 is set by R1 and VR1, according to $T_H = 0{\cdot}7\ (R1 + VR1 + R2)\ C1$; both equations give times in milliseconds for resistances in kilohms and capacitances in microfarads. The component values shown in Fig. 3 will produce a fixed low output period of 0·7 seconds, while the output high period will vary from approximately 1·3 seconds (minimum VR1), up to around 70 seconds (maximum VR1). This produces a useful range of pulse-to-pulse intervals, but without the need for any unusual component values.

The series switching device is a Darlington power transistor, TR1, which is operated in common emitter mode. The load is connected in its collector with a fuse, FS1, included for protection, and an l.e.d. gives an indication of the output state. In this configuration, the load is switched on when the output of IC1 is low. With the transistor specified mounted on a suitable heatsink, loads of up to 5 amps may be controlled. This would allow the older type of wiper without self-parking facilities to be controlled directly; simply adjust the value of R2 to give an output low period which is equal to the time taken for the wiper to complete one wipe cycle. In simple applications the load is connected between terminals 5 and 6 of the delay unit, and FS1 and D2 are chosen to have ratings appropriate to the load concerned. There is, however, no simple, cheap and robust method of using semiconductor switching when the load is a self parking wiper, and so the load on TR1 will be the relay coil for the switch S1 which is shown in Fig. 2. In this case, the ratings of D2 and FS1 may be significantly reduced; 1 amp will allow a useful number of relays all to be connected to the same output without overload.

The general purpose circuit described above may be used for a wide range of applications simply by changing the timing components to give the required on/off periods. Alternative values may be calculated from the equations given.

CONSTRUCTION

The basic delay unit described above and shown in Fig. 3 is built on a small single-sided p.c.b., the foil layout of which is shown adjacent. The corresponding component layout (on the top side of the p.c.b.) is shown adjacent. For low power loads such as relay coils, and other loads up to approximately 1 amp, the use of a heatsink for TR1 is not essential, but will render the unit more robust. Above 1 amp, the use of a heatsink is recommended; one rated at around 10°C/W is suitable and will fit on the p.c.b. shown. The metal tab of the TIP126 is connected to the collector and hence in some applications it may be desirable to insulate the tab from the heatsink using a standard mounting kit.

Care should be taken to ensure the correct orientation of the polarised components but otherwise no special handling procedures are required. The use of a d.i.l. socket for IC1 is optional, and connections to the p.c.b. are made using terminal pins which are a push-fit and then soldered to the copper track. The component layout for the unit is in no way critical, and constructors may prefer to use a small piece of Veroboard in place of the p.c.b. shown.

The track layout for the p.c.b. allows either a preset resistor or a fixed resistor to be fitted in the place shown for VR1. This allows the provision of a single preset wiper speed in applications where this will suffice, or where there is insufficient space to mount a variable control on the dashboard. In the majority of applications, however, it is expected that neither a fixed resistor nor a preset will be mounted on the p.c.b., and instead a potentiometer will be wired between pins 2 and 3 and mounted on the dashboard; the unit on/off switch is most conveniently combined with VR1. In situations where the delay unit will be mounted away from easy access, it may be useful to fit a 5 amp fuse in the p.c.b. holder, and then use a standard in-line automotive fuseholder with a more appropriate fuse to protect against overloads and faults. In general, FS1 (or the in-line fuse) and D2 should be chosen to have a rating approximately twice that of the continuous rated load current. In relay-driving situations, a 1 amp fuse and 1N4001 diode or similar are suitable components.

COMPONENTS

Resistors

R1	8·2k
R2	10k
R3, R5	1k (2 off)
R4	470
VR1	1M variable potentiometer with switch

Capacitors

C1	100µ 16V elect.
C2	100n ceramic

Semiconductors

IC1	555
TR1	TIP126
D1	0·2in l.e.d.
D2	See text
D3	1N4001

Miscellaneous

Terminal pins (6 off)
12 volt changeover relay (see text)
Printed circuit board
Tap-in connectors (4 or 5 off — see text)
P.c.b. fuse holders (2 off) plus fuse (see text)
Insulating hardware for TR1 (optional)
Socket for IC1 (optional)

TESTING

When the p.c.b. assembly is complete, it should be carefully checked for dry joints and solder bridges between adjacent tracks. The board may then be mounted in a small plastic or diecast box if required, prior to some pre-installation tests. A 12 volt supply, preferably with an electronic over-current trip or at least with a 1 amp line supply fuse, should be connected between pins 1 and 4. A short wire link should temporarily be fitted between pins 2 and 3. Turning on the supply should cause the l.e.d. to begin to flash every 2 seconds, with a mark:space ratio of approximately 1:2. The supply current should vary between approximately 5mA (l.e.d. off) and 50mA (l.e.d. on). As a final check, the voltage between pins 5 and 6 should fluctuate between just below the supply voltage and 0 volts, following the indication of the l.e.d. on/off, respectively. Removal of the shorting link between pins 2 and 3, and substitution with a resistor should cause the l.e.d. to remain extinguished for a period which is progressively longer as the resistance is increased.

INSTALLATION

The installation of the delay unit, relay and switch/optional speed control follows the wiring diagram shown in Fig. 5. If only a fixed speed is to be used in conjunction with a p.c.b. mounted component for VR1, then the two wires marked with asterisks in the drawing are simply omitted. The first step is to identify the two wires from the normal wiper controls which are marked 'a' and 'b'. This is best done with the aid of the wiring diagram for the car, but may easily be done with the wiring to the dashboard switch exposed. In case of doubt, wire 'a' will carry +12 volts whenever the ignition circuit is switched on, whereas wire 'b' will carry +12 volts only when the ignition is on *and* the wiper controls are on.

When leads 'a' and 'b' have been identified, switch off the ignition and use four tap-in connectors (coded 1 to 4 in the diagram) to complete the circuit. It will be necessary to cut wire 'b' as shown between connectors 2 and 3, and in many cases a fifth connector may be used to connect p.c.b. pin 4 to ground via one of the leads on the normal wiper switch.

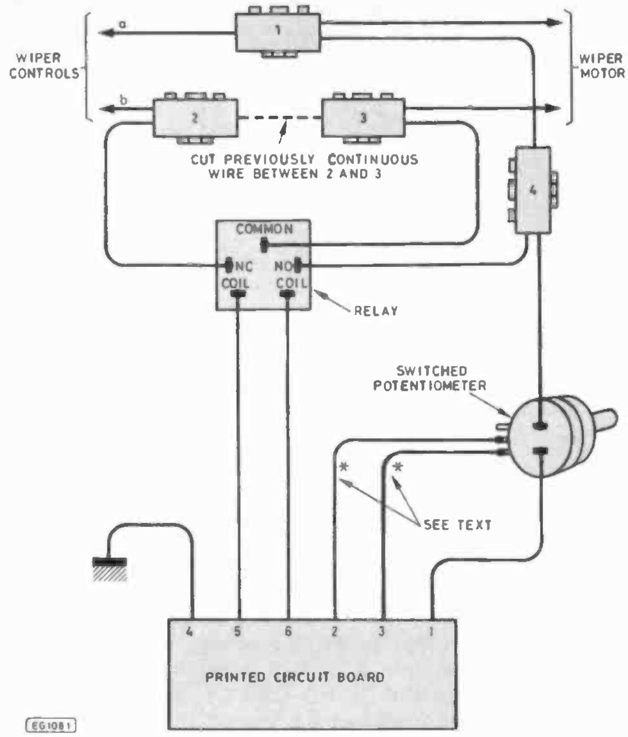
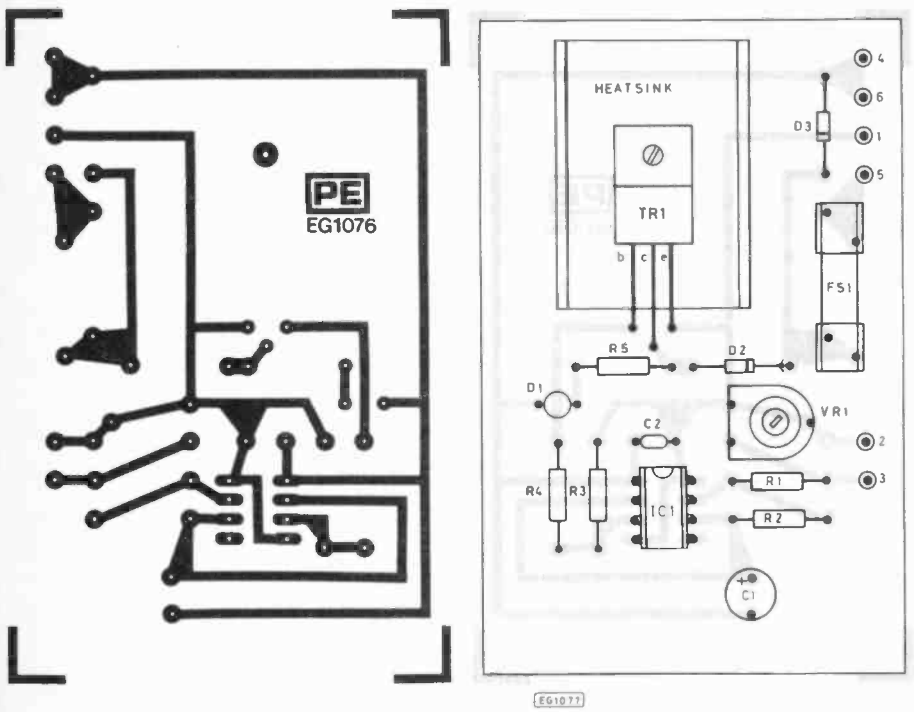


Fig. 5. Details of unit installation

The relay shown may be mounted either in the same box as the p.c.b. or secured anywhere convenient. This relay may be almost any changeover relay fitted with a 12 volt coil; car accessory shops usually stock these for headlight changeover and similar purposes.

Fig.4. Foil pattern for p.c.b. and board layout (right)



CHECK OUT

When installation is complete, ensure that the delay unit is switched off, and turn the ignition back on. Check that the normal tailgate wiper control still functions correctly. If the wiper runs continuously regardless of the control setting, it is likely that the connections to the relay switch contacts have been confused, and these should be checked. When all is satisfactory, the normal wiper control should be returned to 'off', and the delay unit switched on. Turning VR1 fully clockwise should produce a wiping speed very close to the normal speed. If the control appears to work the other way round, simply move the lead from p.c.b. pin 3 to the unused pin of VR1.

The final check should be to set the unit to the slowest wipe rate (VR1 fully anti-clockwise), and then turn on the normal wiper control. The result should be to restore the normal wipe rate.

The unit is now ready for use on the road in the next wet period; an opportunity to use it in anger will not normally be long delayed! ★

MODULES FOR SECURITY & MEASUREMENT

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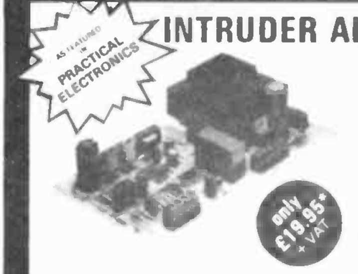

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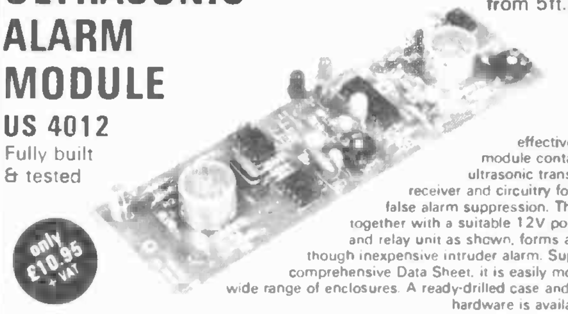

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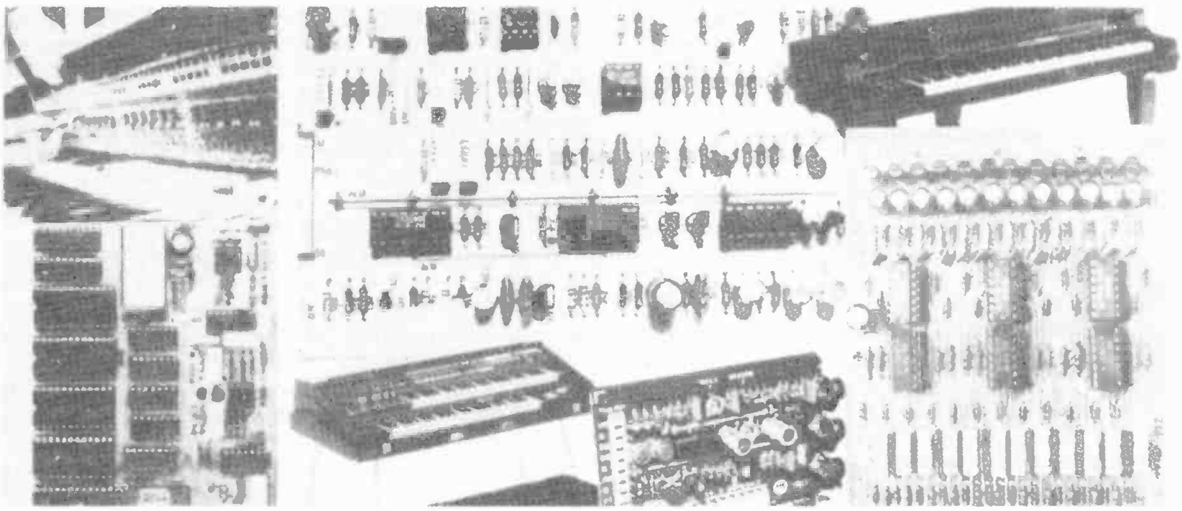

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Switched Capacitor PHASER

R. A. PENFOLD

THE popular phasing musical effect is produced using a filter which has one or more notches of deep attenuation that are automatically swept up and down over the audio frequency range. The two normal methods of obtaining this effect are to use either a delay-line or phase shift networks to generate an output which is out-of-phase with the input at certain frequencies, and then by simply mixing the input and output signals the required notches of high attenuation are produced by a simple cancelling process.

This phaser unit uses a simple alternative which is made possible by the advent of practical switched capacitor filters, and the unit is built around the two filters of this type in the MF10CN device. Each half of the MF10CN actually has two filter sections plus some additional circuitry so that two state-variable filters are produced using a single MF10CN, and depending on the mode of operation selected these each provide notch, bandpass, and lowpass outputs, or highpass, bandpass, and lowpass outputs.

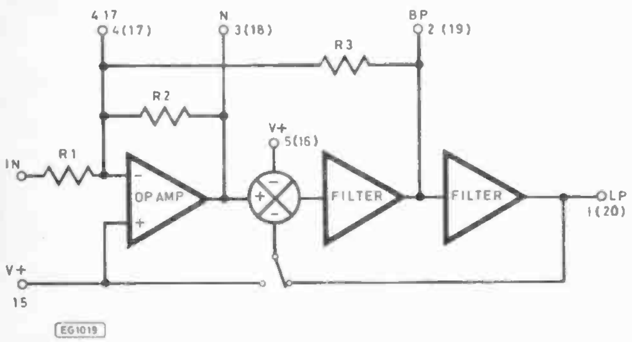

Fig. 1. Block diagram showing one section of the MF10CN

Fig. 1 shows in block diagram form one section of the MF10CN, and this also shows the mode of operation employed in this project. The MF10CN has a 20 pin d.i.l. plastic package, and the diagram shows the pin numbering for one-half plus the equivalent pin numbers for the other half, in brackets. Pin 15 is common to both halves of the device. R1 and R2 are used to set the closed loop voltage gain and input impedance of the input operational amplifier at suitable figures, and R3 introduces negative feedback from the bandpass output which produces the required notch response at the output of the operational amplifier. The Q of the filter is determined by the value given to R3.

BLOCK DIAGRAM

Fig. 2 shows the block diagram for the entire unit. As its name implies, a switched capacitor filter consists of electronic switches which connect the input signal to (and disconnect it from) the filter capacitors, and the switching rate is determined by a clock signal. This type of filter is very useful since the operating frequency of the filter is directly related to the clock frequency, and for the MF10CN the operating frequency can be either one-hundredth or one-fiftieth of the clock frequency. By making the clock frequency adjustable, the operating frequency of the filter can be controlled, and by using a voltage controlled oscillator (V.C.O.) to provide the clock signal the operating frequency of the filter can be automatically swept up and down using a low frequency oscillator to provide the control signal.

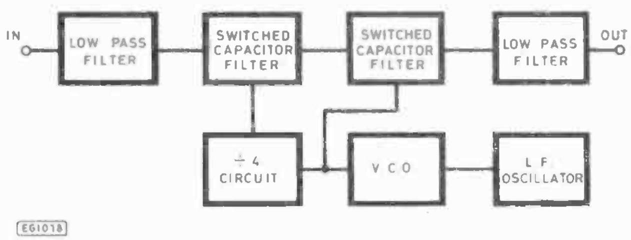

Fig. 2. Block diagram of entire unit

In this design the two filters of the MF10CN are connected in series and are obviously used as notch filters. A simple lowpass filter is used at the input to eliminate any r.f. signals which might otherwise be fed into the input due to stray pick-up, and which could heterodynes with the clock signal or its harmonics. The clock signal only breaks through to the output at a low level (about 10mV r.m.s.) and is not likely to cause any problems, but another low pass filter is used at the output to further attenuate the clock signal.

The clock signal is generated by a simple V.C.O. Which is controlled by a low frequency oscillator having a roughly triangular output waveform. Obviously the two filters must provide notches at different frequencies, and the two simple ways of achieving this are to either use separate clock oscillators with a common sweep oscillator or to feed the output of the V.C.O. to a divider circuit to produce a second, lower frequency clock signal. In practice, the second method seems to be the cheaper and more satisfactory solution, and is the one adopted in the final circuit. A divide by four circuit puts the two notches a couple of octaves apart, and in practice this spacing seems to be about optimum.

THE CIRCUIT

The circuit of the filters is shown in Fig 3, and Fig 4 shows the circuit diagram of the sweep oscillator, V.C.O., and divider stages of the unit.

C2 gives d.c. blocking at the input and R3 plus C3 form a simple r.f. filter. R4 and R5 set the input impedance and voltage gain of the first notch filter at 33k and unity respectively, and R6 gives the filter a fairly low Q value. Making R6 higher in value gives a higher Q value, but the notch produced then tends to be so narrow that the phasing effect becomes barely noticeable with most signal sources. A lower value for R6 gives reduced Q and broader notches which give a more extreme effect, and if desired constuctors can experiment with the value of this resistor in order to obtain the effect that they consider to be most suitable. The output of the first notch filter is direct coupled to the input of the second filter, and this second stage is identical to the first. R10 and C4 form the output lowpass filter and C5 gives d.c. blocking at the output. S1 enables the circuit to be bypassed when the phasing effect is not required.

The MF10CN has a number of terminals which must be connected to the appropriate voltages in order to obtain correct operation of the filters. Pins 13 and 14 are negative supply terminals for the digital and analogue circuits of the device respectively, and pins 8 and 7 are the equivalent positive supply terminals. These two sets of supply terminals can be decoupled separately, or simply wired together as in this case. Pin 6 controls the switch in each half of the device (see Fig. 3), and in the filter mode used here it must be taken to the positive supply voltage. Pin 9 is the level shift input, and for single supply operation this is connected to the

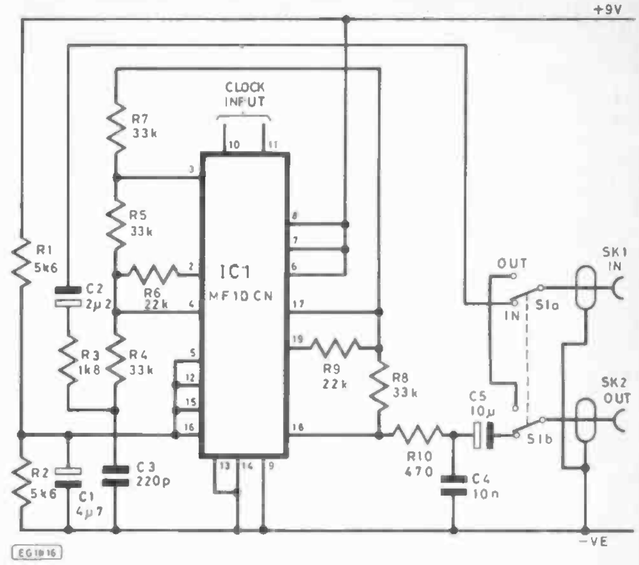

Fig. 3. Circuit diagram of the filters

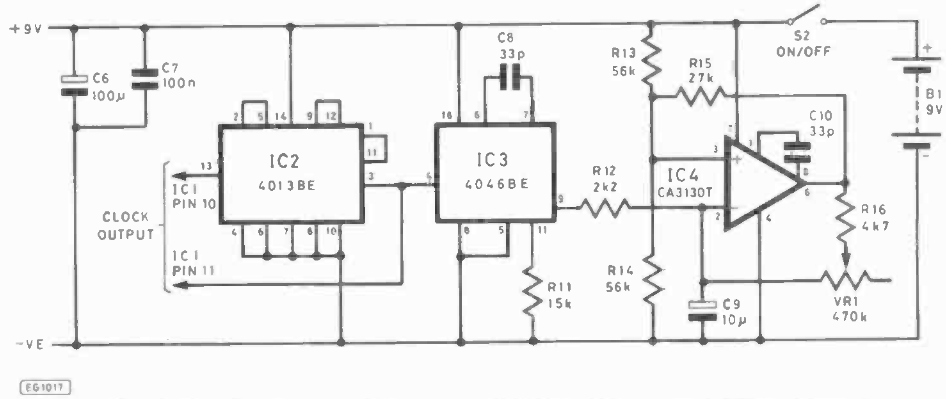

Fig. 4. Circuit diagram of the sweep oscillator, V.C.O, and divider stages

negative supply rail. The device is then compatible with TTL and CMOS clock signals.

A number of pins are biased to half the supply potential, including pin 15 which connects to the non-inverting inputs of the operational amplifiers in the device. Pins 5 and 16 are unused inputs of the MF10CN and must be biased to half the supply voltage in order to give proper operation of the circuit. Pin 12 is the 50/100 clock input and is tied to half the supply potential to give a filter operating frequency which is one-hundredth of the clock frequency (as in this circuit), or high to give an operating frequency which is one-fiftieth of the clock frequency. Having the clock at one hundred times the filter frequency is advantageous in this application since it enables the lower frequency notch to be swept down to around 200 Hz without the clock coming down into the audio frequency range and producing audible breakthrough. A minimum notch frequency of only about 400 Hz is possible with the clock at fifty times the filter's operating frequency.

CLOCK AND SWEEP OSCS.

The sweep oscillator uses IC4 in a well-known configuration, and R16 is given a comparatively low value so that the circuit has a high enough voltage swing across C9 to give an adequate sweep range from the V.C.O. The non-linear triangular waveform across C9 is at a very high impedance, but loading on this by the input of the CMOS V.C.O. is negligible.

The V.C.O. uses the 4046BE CMOS device which is actually a low power phase locked loop, but this makes an excellent V.C.O. if the phase comparators are just ignored. The only two discrete components required are C8 and R11 which set the operating frequency range of the oscillator.

The divide-by-four circuit is a CMOS 4013BE dual D type flip-flop which has each section connected as a straightforward divide-by-two circuit, and they are connected in series to give divide-by-four operation.

Phaser Unit

The MF10CN is designed for use with either dual 5 volt supplies or a single 10 volt supply, but it will operate satisfactorily down to a supply voltage of ± 4 volts or 8 volts, and can therefore be used with a 9 volt battery supply. The average current consumption of the circuit is approximately 8mA.

COMPONENTS . . .

Resistors

R1,R2	5k6
R3	1k8
R4,R5,R7,R8	33k (4 off)
R6,R9	22k (2 off)
R10	470
R11	15k
R12	2k2
R13,R14	56k (2 off)
R15	27k
R16	4k7

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Potentiometer

VR1	470k logarithmic carbon

Capacitors

C1	4μ7 63V axial elect
C2	2μ2 63V axial elect
C3	220p ceramic
C4	10n polyester
C5	10μ 25V radial elect
C6	100μ 10V axial elect
C7	100n polyester
C8,C10	33p ceramic plate 2% (2 off)
C9	10μ 16V tantalum

Semiconductors

IC1	MF10CN (Rapid Electronics)
IC2	4013BE
IC3	4046BE
IC4	CA3130T or CA3130E

Miscellaneous

SK1/S2	Standard 6·35mm jack with d.p.d.t. contacts
SK2	Standard 6·35mm jack socket
S1	d.p.d.t. heavy duty push button switch
B1	9 volt PP3 battery and connector

150x80x50mm diecast aluminium box (M.E.S. type DCM5005 or similar). Printed circuit board. Control knob. Veropins, i.c. sockets, wire, etc.

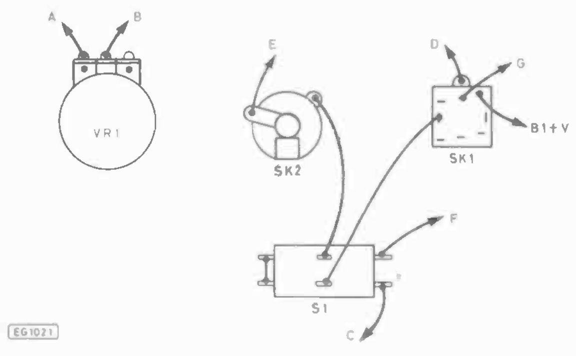
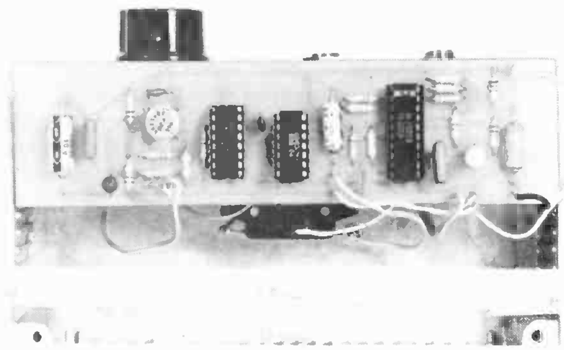


Fig. 5. Wiring diagram.

CONSTRUCTION

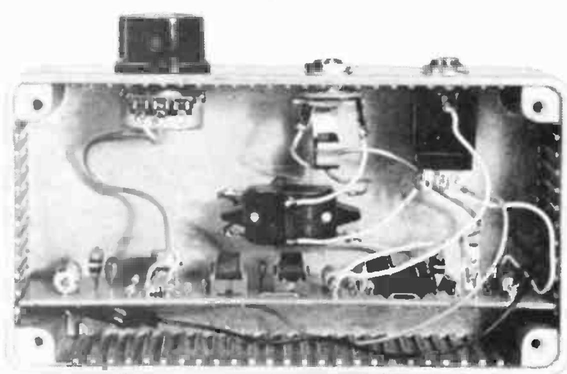
S1 is a heavy-duty push-button switch which is fitted centrally on the top panel of the case so that it can be operated by foot. It is necessary to use a strong case since it will have to withstand a fair amount of pressure each time S1 is operated, and a diecast aluminium box measuring 150 by 80 by 50mm is ideal. The two sockets and VR1 are mounted on one of the 150 by 50mm sides of the case.



P.C.B. withdrawn from unit showing component assembly

Fig 5 shows the wiring of the potentiometer, sockets and foot switch; the corresponding designations being shown in Fig 7 with the component layout. Fig 6 shows the p.c.b. design. There is ample space within the unit to house the PP3 battery which should be securely positioned. All four integrated circuits are CMOS types and the usual MOS handling precautions should be observed when dealing with these. SK1 has d.p.d.t. contacts, but these are only used here as a single set of make contacts which automatically switch the unit on when a jack plug is inserted into SK1. However, on/off switch S2 can be a separate switch if preferred. VR1 controls the phasing speed, and this is a logarithmic potentiometer used in reverse (i.e. clockwise rotation gives a decrease in phasing rate). This control covers a wide frequency range of about 0·1 Hz to 10 Hz, and this method gives easier control of the phasing speed than that obtained using a linear potentiometer, especially at the high frequency end of the range. Note that IC3 has the opposite orientation to the other three integrated circuits, and that this device could easily be damaged if the unit is switched on with it connected the wrong way round.

If the specified case is used the printed circuit board will



Final assembly showing P.C.B. in position

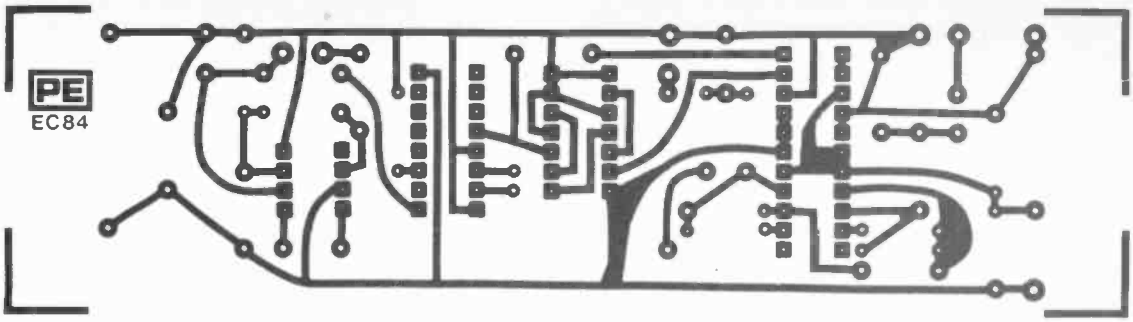


Fig. 6. P.c.b. design

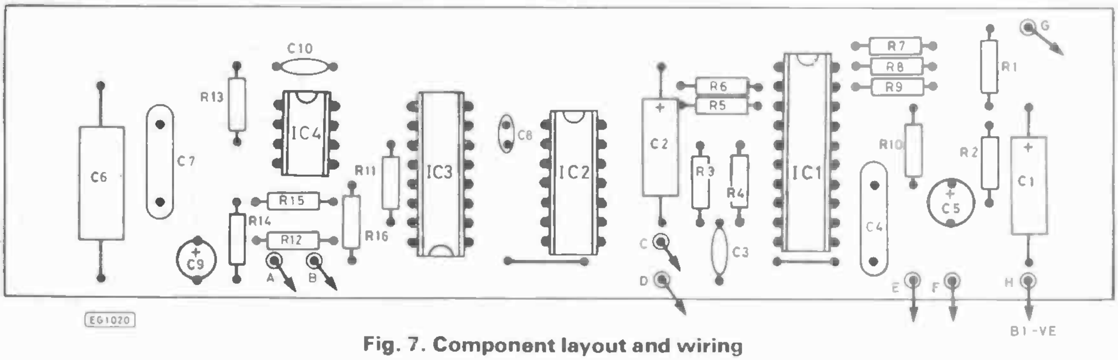


Fig. 7. Component layout and wiring

slot into place in the guide rails at the rear of the case. There is ample space for mounting holes to be drilled in the board if a different case is used.

Provided the unit is used with an input level of a few hundred millivolts r.m.s. or more it will provide a good signal to noise ratio of 60dB or better. The maximum input level the unit can handle without clipping and producing severe distortion is more than adequate at about 2 volts r.m.s. ★

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Space Watch...

THE EXTRA-TERRESTRIAL PROBLEM

In this issue of *Spacewatch* we will deal with the question of extra-terrestrial intelligence. It must be made clear that this does not mean that it is proposed to deal with UFO sightings, or the value of reports which come into various centres at a rate in excess of one hundred a week. To avoid confusion it is necessary to clarify the origins of the phrases 'Flying Saucer' and 'Unidentified Flying Object'. The term 'Flying Saucers' probably originated from a 'recorded' sighting early in the last century in southern United States, when a farmer described an object as, "It looked like a cup saucer". After that reports were frequent which led to speculation on "Flying Saucers". Because so many of such reports were the result of faulty observation or imagination, it was decided to rename all sightings and call them—"Unidentified Flying Objects." By that time many more frequent reports were coming in and unfortunately the new name made the situation worse because instead of making the claims for seeing flying saucers, the reports were of UFO's, which became synonymous with "Flying Saucers" throughout the media. The meeting which made this brave attempt to regularise matters in 1947 led to an enormous increase in sightings.

It is often mistakenly stated that, if a large number of people "see" something and describe it similarly then it means that such an event must be true and accepted. This is still the case, even now, when there is so much evidence of the extreme lack of reliability in these observations. How then to deal with the subject of the possibility of extra-terrestrial intelligence. The first step is to decide the place from which the experiment is to be carried out. This must, if dictated by the Einstein view of the cosmos, be from the Solar System. At the present state of knowledge in matters of communication the electromagnetic spectrum determines the limits. Such an attempt began in 1974 from the 1,000ft. diameter radio telescope at Arecibo, Puerto Rico. The signals were directed to a globular cluster of about a million suns, known to astronomers as Messier 13. It will take about 24 thousand years for the coded signal to reach that vicinity and the time at least, for a return signal to be received back on Earth will also be 24 thousand years. This serves to emphasise the limitations of the system of communication. Within the solar system itself there are time delays in communications that are necessary, even for the short distance to the moon, and from the Voyager spacecraft still longer delays, increasing as time goes by.

The original project for the search was known as Ozmar and was organised by Frank Drake, then at Greenbank, West Virginia. It operated between 1959 and 1960—a coded signal was sent out in the direction of Epsilon Eridani and Tau Ceti and this was continued for only a few weeks. Of course there was not much success and the co-operation was lukewarm. In any case a few weeks was not likely to afford much data since, ideally at least 100 thousand or so stars would need to be studied. Later the construction of a 600 foot dish was begun and this project failed but a number of other attempts were made and because there was little enthusiasm, not many people had much interest in the matter. There is a project in Canada, and the Russians have a station which has now been turned into a full scale search with the RATAN-600 telescope. Half the observing time is spent on extra-terrestrial work with this telescope. Now that a much wider view of the matter is taken, and with the development of improved receiving techniques together with spaceborne telescopes, much more can be done. In spite of all this it is difficult, under present thinking, to lay down a definite programme which could offer positive proof within a lifetime.

Another project which has been partly carried out for reaching deep into space, is an American venture. This when completed will consist of a "Mills Cross" so named after the originator B. Y. Mills from Australia. This is in the form of a number of lines of parabolic dishes set up in the form of a cross, each arm being 12·5 miles in extent. This will behave as though it is in fact a 25 mile diameter dish.

It would be even better if one telescope was on the Moon and the other on Earth, and better still if there was one also on Mars. However all this makes certain suppositions which might be set out as;

—The manner of thinking must be the same as the Earth's inhabitants

—They must be at the same stage of development as the Earth is. In the case of the Messier 13 cluster this would mean that the inhabitants of a planet would have existed 24 thousand years before our time *unless* they have at the time of the arrival of the signal from Earth, a system of communication which could cover all future developments and still conform to the present theories used on Earth. This is an unknown. That being the case then any project has to make certain assumptions. In the projects so far suggested or attempted it has been assumed that any other beings would be humanoid like ourselves and have the same physiology. This had to be, though there were those who suggested that no matter what the form, the physics of the universe must be readable in terms of mathematics. This latter assumption is not justified on the present state of knowledge. There is not enough space in one issue to deal with this at length but suffice to say for the moment that any alternative view has to depart from mathematical concepts based on the work of Einstein. This is a matter which still exercised the great man's mind until his death.

So far although the Universe as a whole has been mentioned as a source for the possible signals from extra-terrestrials, it is perhaps wise to look at the problem from the point of view of the Solar system and our own Galaxy. Consider then that in our Galaxy which has spiral arms and rotates. The extent of Galaxy is about 100,000 light years in diameter and at its thickest part is about 20,000 light years. The Solar system is situated at a point some 32,000 light years from the galactic centre. Since the Solar system rotates with the galaxy it takes something around 225 million light years for the Solar system to complete this journey. The total number of stars is enormous and they are in various states of birth, growth and death. Among the many millions of stars suppose there are one million which with a developed technology would use the electromagnetic spectrum as a means of communication. Let the distribution be random and the average distance between them be of the order of 300 light years. With communication techniques available to the denizens of the Earth the shortest time for a signal to be sent and an answer received is 600 years. If it is assumed that during the period that attempts have been made to transmit coded signals, deliberately made that is, somewhere the signal is received and returned. In order that that signal may be received the same technique must remain in operation on Earth as that used for the original transmission. This raises many serious problems.

It will be necessary to install a receiver which will continuously operate from some specially built station timed to come into operation in 600 years time from transmission of the original signal. The technology will need to be the same as that of the original transmission. This requires that the site shall not, for that period be disturbed by effects no matter what the cause, terrestrial, extra-terrestrial or internal earth changes. The power supplies must be able to have survived and in working order no matter what may have happened in the vicinity of the site. Records and operational instructions must be known and available. This would be extremely costly and subject to the frailties of the inhabitants of the Earth. So many sources of change are not only from the natural development but from political and religious cults. Indeed it is long enough beyond a single span of a lifetime even with the inevitable increase of that life span to double the norm in the foreseeable future. This is the real point; it is unlikely that funds to execute and maintain such a project would be forthcoming. Is there another solution?

One that springs to mind is the possibility of a beacon in the form of a long time scale satellite with a life to be determined. Since the present techniques available make this an ordinary matter it leaves the problem at the point of the technology of the receiving unit. Power is continuously available with back-up. The question left is continuous operation, this also is within forseeable control. The ground station however remains or at least an apparatus is preserved to be brought into use unless of course the population is moved to a permanent abode on a space station which encloses the Earth.

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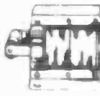

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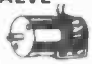

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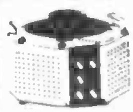

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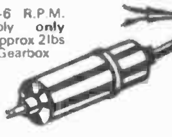

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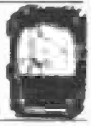

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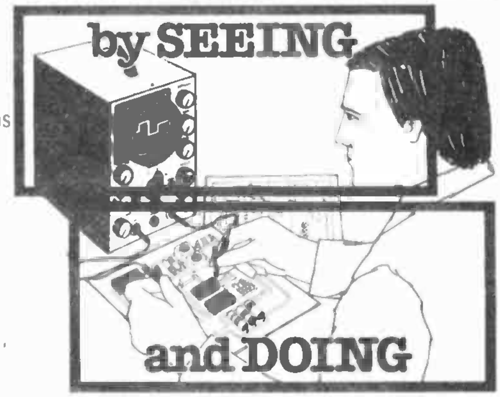

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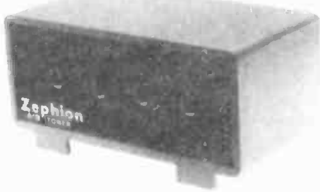

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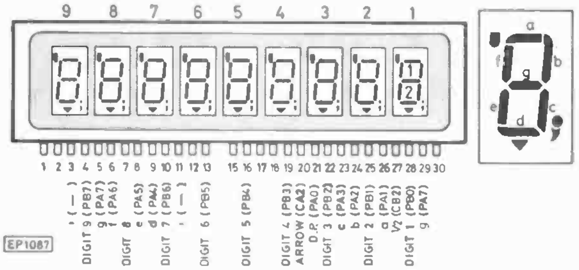
PE MICROCONTROLLER: DATA SHEET 3

DISPLAY MODULE

THE display module in the Microcontroller is a multiplexed 9-digit Futaba gas discharge unit, type 9-LT-03. In the original application two such units, each mounted on separate p.c.b.s, were connected in parallel to each controller board. On the display p.c.b. digit number 8, the apostrophe and comma are supplied unconnected. In the Microcontroller pins 7 and 22 have been connected together to form the display field separator characters, and hence digits 3 and 8 will always have the same indication.

In order to illuminate any particular display segment it is necessary to set the appropriate digit select line (PBØ to PB7 on IC12) to a logic '1', and then set the corresponding segment select line (PAØ to PA7 on IC12) to a logic '1'. Any number of segments/digits may be selected at a particular instant, but all selected segments in all selected digits will be illuminated simultaneously, so the display driver in DISBUG scans each digit in turn. In addition, the period for which a digit is selected must be chosen to avoid visible flicker, but not be so fast as to render the overall display unreadable. The DISBUG monitor routines which provide these facilities will now be described.



DISPLAY SCAN ROUTINE

The Microcontroller's display is scanned by a subroutine called DISPLAY. This routine includes a delay to cause each digit to be illuminated for approximately 2 milliseconds, before moving on to the next digit. DISPLAY assumes that the display PIA has been correctly set up by the DISBUG initialisation routine (which is executed automatically at power-up), and it uses a maximum of six bytes of stack space. The scan routine is called by 'JSR DISPLAY', which is coded as BD F8 14. There are no entry or exit parameters passed in the CPU registers, and all registers except SP are corrupted by the routine.

The display is actually scanned once each time DISPLAY is called, with digits 1 to 7, and 9 illuminated in turn. The character displayed at each digit position is determined by reading the DISBUG RAM locations 03F8 to 03FF; the locations are used to drive the display PIA as shown in Table 1. Each bit position corresponds to one of the segments 'a' to 'g' or the decimal point, and so a wide range of characters may be displayed, e.g. a code of EC would display 'H', and a code of E8 would display 'h'. The display table locations may be written to directly (e.g. CLR to location 03FA will blank digits 3/8), or the routines describe below may be used to insert display codes for numeric values into the display table.

In order to produce a stable display, user programs should ensure that DISPLAY is called regularly within the infinite loop of the control program, otherwise the display will flicker or be erratic. The way in which DISBUG uses this routine is shown in Part 3 of the Microcontroller series.

	PA7	PA6	PA5	PA4	PA3	PA2	PA1	PA0	*PIA Line*
	7	6	5	4	3	2	1	0	*Memory bit*
03FF	Digit 9								
03FE	Digit 7								
03FD	Digit 6								
03FC	Digit 5								
03FB	Digit 4								
03FA	Digits 3/8								
03F9	Digit 2								
03F8	Digit 1								
	g	f	e	d	c	b	a	.	*Segment*

Table 1. DISBUG display table format

CONVERSION ROUTINES

The information provided above is sufficient to allow any character which can be represented by the available segments to be displayed. The process is simply a matter of inserting the appropriate code into the display table, and then calling DISPLAY. A very common requirement is to display a numerical value which may be held in a register or memory/PIA location. This task may be greatly simplified by the use of two routines provided within DISBUG.

The first routine is DIGIT and is called via 'JSR DIGIT', which is coded as BD F8 DO. The routine converts the number in the least significant four bits of rA into the appropriate display code, and then inserts this code into the display table at the address contained in the index register. Thus, for example, if DIGIT is called with rA = 4B, and In = 03F8, then the routine will insert the value 'F8' (the display code for 'B') in location 03F8 (the display table entry for digit 1). DIGIT uses one byte of stack space, and preserves all register values except the index register, whose contents are incremented by one.

The second routine is TWODIG and is called via 'JSR TWODIG', which is coded as BD F8 F7. This routine converts the number in rA into two display codes, and inserts the code representing the LS 4 bits of rA in the location indicated by the entry value of In, and then inserts the code for the MS 4 bits of rA in the next location. In the example above, a call to TWODIG rather than DIGIT would result in a code of 'F8' in location 03F8 and a code of 'CC' (for '4') in 03F9. TWODIG uses three bytes of stack space, and preserves all register values except the index register, whose contents are incremented by two.

M. Tooley BA and D. Whitfield MA MSc.

into the REAL WORLD part 3

CONTROL CIRCUITS

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

FOR applications such as the voltage control of oscillators, attenuators etc, the digital to analogue converter will be able to directly drive an externally connected load. The minimum recommended value of load resistance is, however, 1kohm for the normal output (V_{out}) and 100ohm for the complementary output ($\overline{V_{out}}$). Note that, since the complementary output exhibits a lower output impedance than the normal output, in some applications its use is to be preferred. In such cases it will, of course, be necessary to use the 1's complement of the data word. This can be quite easily obtained using the appropriate op. code within the machine language program.

When the digital to analogue converter is used to drive very low impedance loads (such as d.c. motors) an additional power amplifier stage will be required. A typical circuit for an "add-on" power amplifier module is shown in Fig.1. This uses a single monolithic integrated circuit which is, incidentally, capable of providing a power of up to 21W in a nominal 4ohm load when operating from plus and minus 18V supply rails. In this particular application, the device is configured for unity gain (non-inverting) and the recommended maximum value of output current is 1A. The TDA2030 features internal short circuit protection, thermal shut-down, and safe operating area protection. The output current is internally limited to 3·5A, however, it is recommended that some form of current limiting (at around 1·5A, or less) be included in both the positive and negative supply rails. A power supply capable of meeting the requirements of both

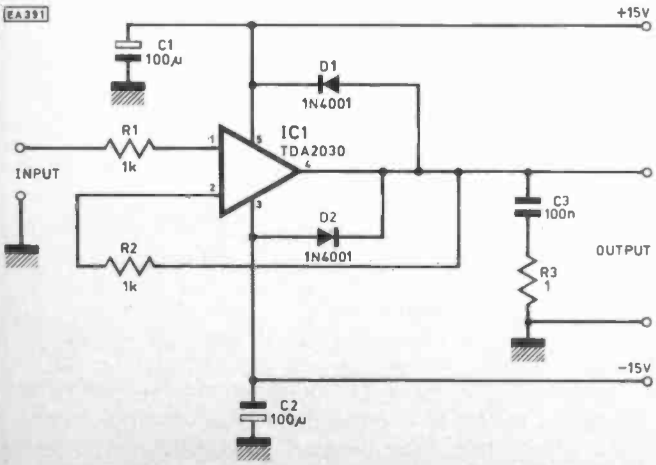


Fig. 1. Circuit diagram of the power amplifier module

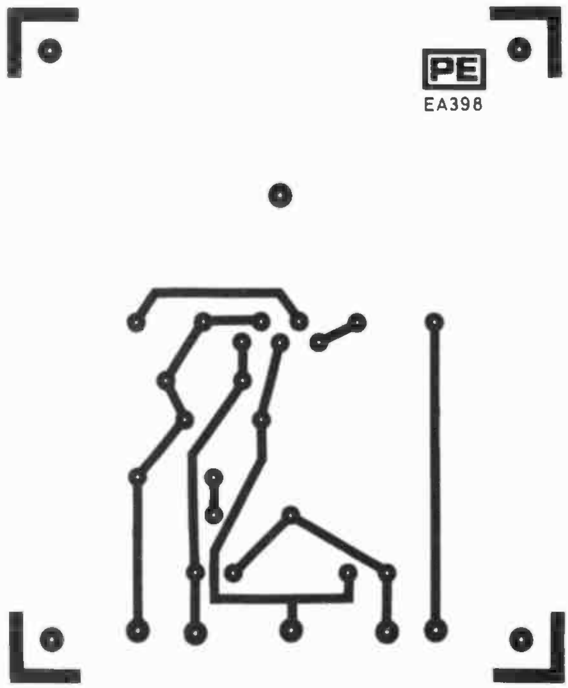


Fig. 2. P.c.b. layout for the power amplifier module

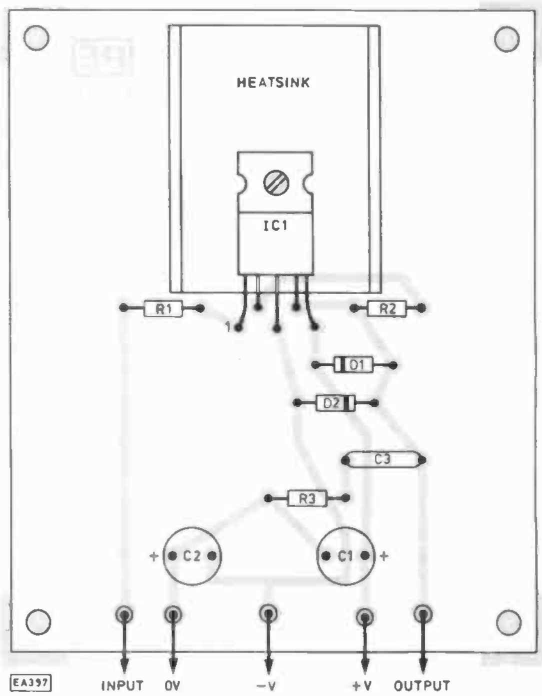


Fig. 3. Component layout for the power amplifier module

COMPONENTS . . .

POWER AMPLIFIER MODULE

Resistors
R1, R2 — 1k (2 off)

Capacitors
C1, C2 — 100μ 16V p.c. electrolytic (2 off)
C3 — 100n polyester

Semiconductors
D1, D2 — 1N4001 (2 off)
IC1 — TDA2030

Miscellaneous
PCB terminal pins (5 required) heatsink

Constructor's Note
Components and PCB are available from **Howard Associates, 59 Oatlands Avenue, Weybridge, Surrey KT13 9SU (s.a.e. for details).**

STEP	SWITCH SETTINGS	DESIRED OUTPUT VOLTAGE (V_{out})	ADJUSTMENT
1	S1–S8 open S9 open	0V	VR1
2	S1–S8 closed S9 open	V_{FS}—V_{LSB}	VR3 (and VR2 if necessary)
3	S1 closed S2–S8 open S9 open	$\frac{1}{2}V_{FS}$	none should be necessary
4	S1 closed S2–S8 open S9 open	Check that $V_{out} = -\frac{1}{2}V_{FS}$	none should be necessary
5	S1 closed S2–S8 open S9 open then closed	$\frac{1}{2}V_{FS}$	none should be necessary
6	S1–S8 open or closed S9 closed	$\frac{1}{2}V_{FS}$	none should be necessary

TABLE 3 Adjustments and tests required for unipolar operation

STEP	SWITCH SETTINGS	DESIRED OUTPUT VOLTAGE (V_{out})	ADJUSTMENT
1	S1 closed S2–S8 open S9 open	0V	VR1
2	S1–S8 open S9 open	$+V_{FS}$	VR2
3	S1–S8 open S9 open	$+V_{FS} - V_{LSB}$	VR3
4	S1 closed S2–S8 open S9 open	0V	none should be necessary
5	S1 and S2 closed S3–S8 open S9 open	$\frac{1}{2}V_{FS}$	none should be necessary
6	S1 open S2 closed S3–S8 open S9 open	$-\frac{1}{2}V_{FS}$	none should be necessary
7	S1 and S2 closed S3–S8 open S9 open	Check that $V_{out} = \frac{1}{2}V_{FS}$	none should be necessary
8	S1 and S2 closed S3–S8 open S9 open then closed	$\frac{1}{2}V_{FS}$	none should be necessary
9	S1–S8 open then closed S9 closed	$\frac{1}{2}V_{FS}$ (i.e. no change)	none should be necessary

TABLE 4 Adjustments and tests required for bipolar operation

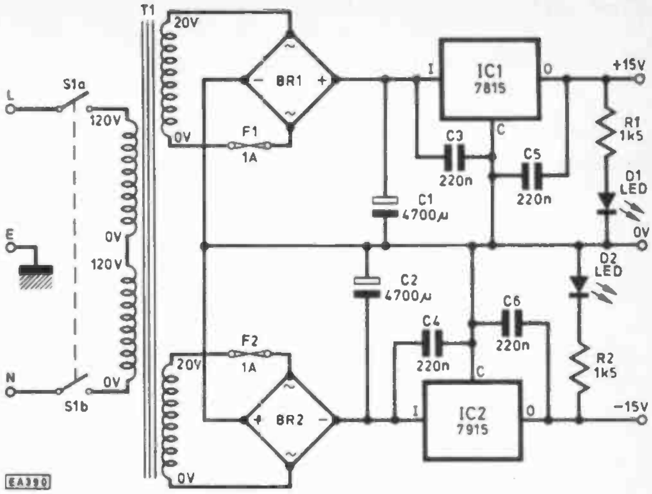


Fig. 4. Typical power supply circuit for use with the D to A converter and associated power amplifier modules

the digital to analogue converter together with one, or more, power amplifier modules is shown in Fig. 4.

The p.c.b. layout for the power amplifier module is shown in Fig. 2 together with the corresponding component overlay which is given in Fig. 3. Assembly is extremely straightforward and, since no adjustment is required, detailed constructional and testing information is unnecessary.

USING THE D TO A CONVERTER

The digital to analogue converter, together with any associated power amplifier modules, can be used in a variety of particular configurations depending upon the requirements and constraints of the particular system. Fig. 5 shows

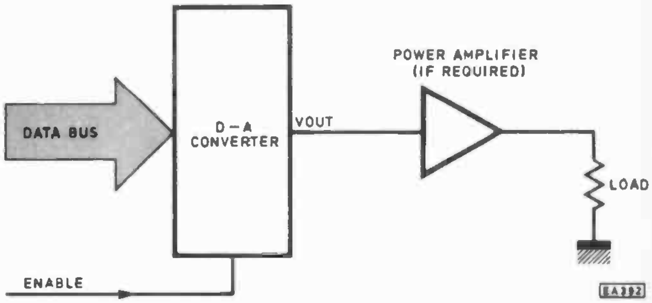


Fig. 5. Conventional single ended output configuration

a conventional 'single ended' arrangement. A bridge arrangement using two power amplifiers, driven from the complementary outputs of the digital to analogue converter, is shown in Fig. 6. This configuration effectively doubles the output voltage swing developed across the load. Fig. 7 shows how several power amplifier modules can be connected to a single digital to analogue converter. Note that, to reduce the loading on the converter where more than one power amplifier is employed, the values of R1 and R2 within the power amplifier module should be correspondingly increased. A value of 10kohm for both R1 and R2 will be adequate for the parallel connection of up to ten power amplifier modules. If desired, loads may be driven in a complementary fashion, as shown in Fig. 8. Finally, several digital to analogue converters may be operated simultaneously from the same data bus. This arrangement makes use of the

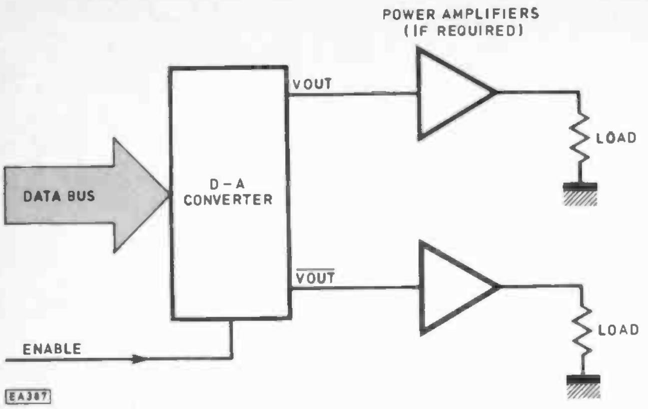


Fig. 6. Bridge output arrangement which doubles the effective voltage swing across the load

latching facility of the ZN428, the $\overline{ENABLE}$ inputs being driven from the address bus such that each digital to analogue converter can be individually addressed (Fig. 9).

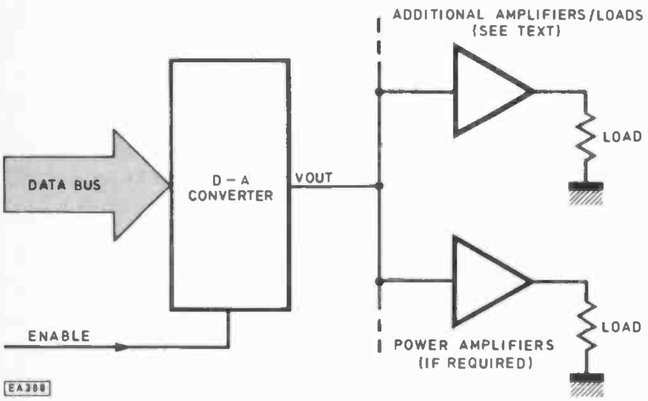


Fig. 7. Method of driving several output loads using a single D to A converter

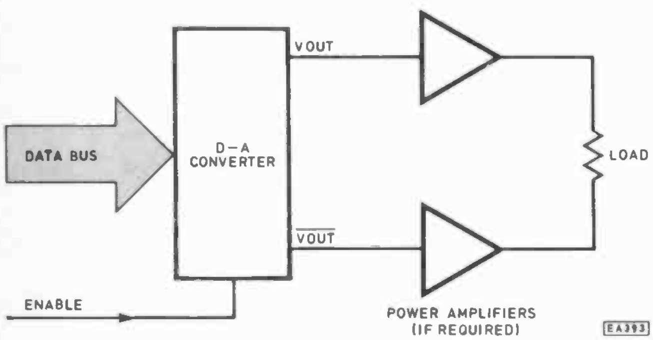


Fig. 8. Complementary driving of loads

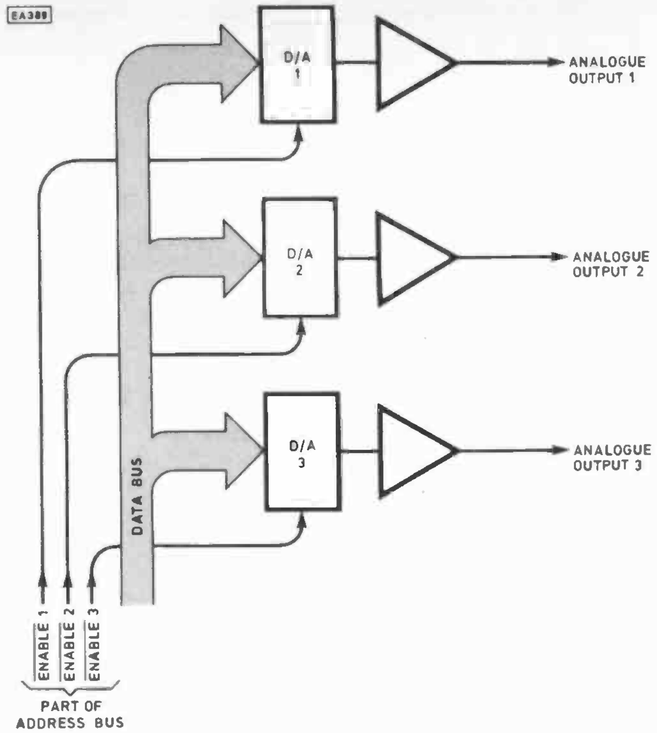


Fig. 9. Technique for driving multiple D to A converters

ANALOGUE TO DIGITAL CONVERSION

The purpose of an analogue to digital converter is that of generating a digital code which approximates to the actual input voltage level at the instant of sampling. One commonly used method of analogue to digital conversion involves the use of a clock and counter in conjunction with a digital to analogue converter. The clock and counter generate a binary sequence such that the output of the digital to analogue converter is sequenced from zero to full scale. The output voltage from the counter is compared with the input signal voltage using a comparator and the count is stopped when the digital to analogue converter output is just greater than the signal input voltage. The state of the digital lines thus provides a digital code which is an approximation of the analogue input. The disadvantage of this technique is primarily attributable to the relatively low speed of conversion. In a worst possible case it would be necessary for the counter to produce a full sequence before arriving at the full scale input value. In an 8-bit converter, for example, this worst case condition would necessitate 255 clock cycles. With a 1MHz clock this yields a maximum conversion time of a quarter of a millisecond!

A much better method of analogue to digital conversion involves the use of a technique known as successive approximation. This involves a series of comparisons between the analogue input signal and the output of a digital to analogue converter in which each bit is set in turn, commencing with the most significant bit, MSB. A decision, based upon whether the analogue input is greater or less than the output of the digital to analogue converter, is then made as to whether or not the bit should be retained. The output thus becomes successively closer to the input value; hence the name! The maximum conversion time for such a converter is generally (n + 1) clock cycles, where n is the number of bits employed. An 8-bit successive approximation analogue to digital converter would, for example, require a maximum of 9 clock cycles for conversion; more than twenty times faster than a counter type arrangement! Simplified block diagrams showing the two methods of conversion are given in Figs. 10 and 11.

THE ZN427 A TO D CONVERTER

The ZN427 is a versatile monolithic 8-bit successive approximation analogue to digital converter which incorporates tri-state output buffers to permit direct connection to a microprocessor data bus. The device offers a guaranteed maximum conversion time of 15µs (clock frequency = 600kHz) and, like its digital to analogue counterpart the

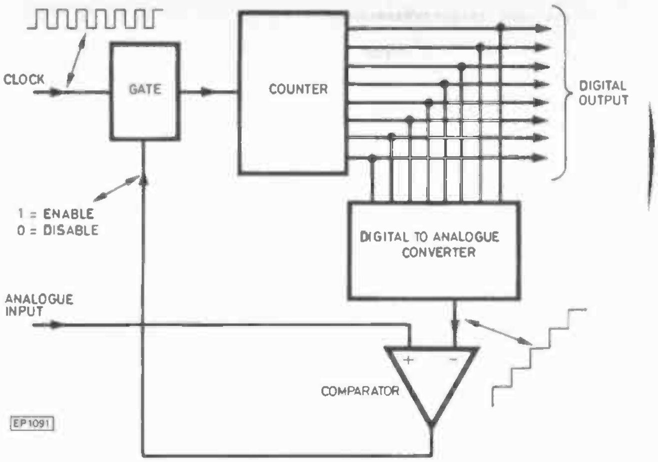


Fig. 10. Simplified block schematic of a counter type A to D converter

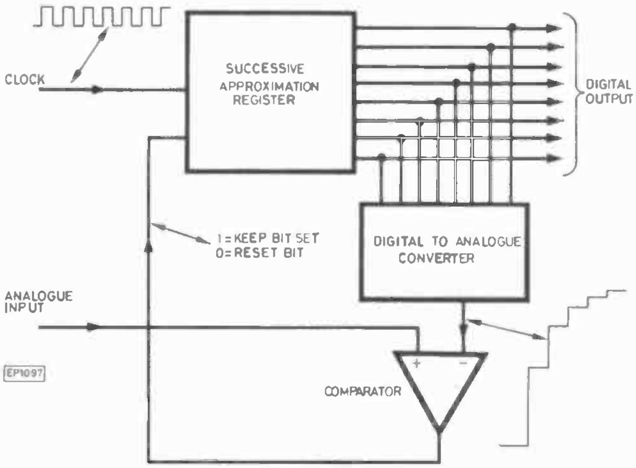


Fig. 11. Simplified block schematic of a successive approximation type A to D converter

ZN428, it also incorporates an accurate voltage reference. The data outputs are fully TTL compatible and the i.c. requires supplies of +5V and −3 to −30V. This latter voltage rail is merely required to establish a constant 'tail' current within the internal voltage comparator.

The internal architecture of the ZN427 is shown in Fig. 12. The principal internal elements of the ZN427 are; a high speed comparator, a successive approximation register, a switch array, an R-2R resistor network, an output buffer array, and a 2·5V precision voltage reference. When a low-to-enable start conversion (SC) pulse arrives, the most significant bit is set to a 1 and all the other bits are set to 0 regardless of their previous state. The analogue output from the R-2R ladder network will then be exactly half the reference input, V_{REF}. The input voltage, V_{IN}, is then compared with this value and a decision made on the next falling clock edge. The MSB will be set to 0 if $0{\cdot}5V_{REF} > V_{IN}$ or kept at 1 if $0{\cdot}5V_{REF} \leqslant V_{IN}$. The second most significant bit is also set to 1 on the same falling edge and, on the subsequent falling clock edge, a similar decision is made concerning the second most significant bit. The process continues until all eight bits have been examined such that, on the ninth consecutive falling clock edge after receipt of the start conversion (SC) pulse, an end of conversion (EC) signal is generated which indicates that the digital output from the converter is a valid representation of V_{IN}. The digital output data remains latched until the next SC pulse arrives. An output enable (EN) is provided so that data may be read from

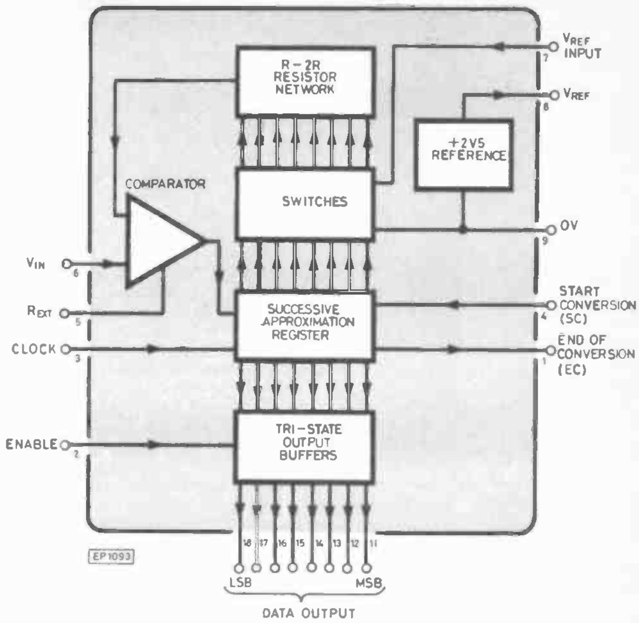


Fig. 12. Internal architecture of the ZN427 successive approximation A to D converter

the converter into the system data bus by means of the tri-state output buffer array. A typical timing diagram for the digital word 01010110 is shown in Fig. 13.

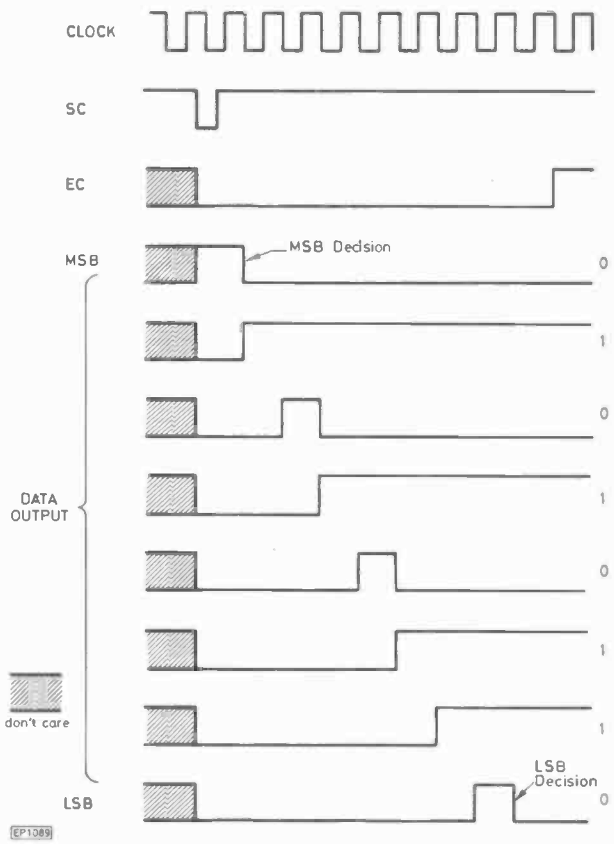


Fig. 13. Timing diagram for the ZN427 A to D converter

The decision as to whether the output of the D to A section is greater, or less than, V_{IN} is made by means of a high speed comparator, the simplified equivalent circuit of which is shown in Fig. 14. This is essentially a differential 'long-

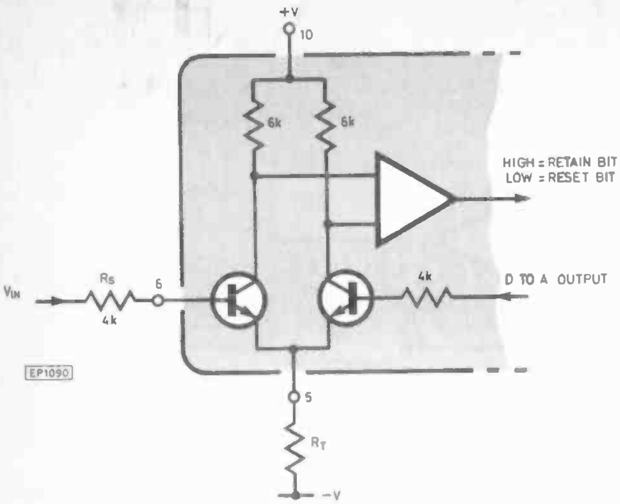


Fig. 14. Simplified equivalent circuit of the high speed comparator section of the ZN427 A to D converter

tailed' pair which is designed to operate with a total emitter ('tail') current of 65μA. The 'tail' current must be derived from an external negative voltage rail in the range −3 to −30V and the constant current characteristic may be produced simply by inserting an appropriately high value of series resistor. Various values of negative supply voltage and required series resistance are shown in Table 1.

NEGATIVE SUPPLY VOLTAGE (−V)	TAIL RESISTANCE (R_T)
−3V	47k
−5	82k
−10	150k
−12	180k
−15	220k
−20	330k
−25	390k
−30	470k

Table 1 Recommended values of tail resistance and negative supply voltage

The outline circuit diagram of a practical analogue to digital converter is shown in Fig. 15. Whilst it is possible to use a separate low frequency clock within the analogue to digital converter, it is usually expedient to make use of the system clock of the host microcontroller or microcomputer. Such a clock is, nowadays, unlikely to operate at a frequency of much less than 1MHz and therefore it will be necessary to

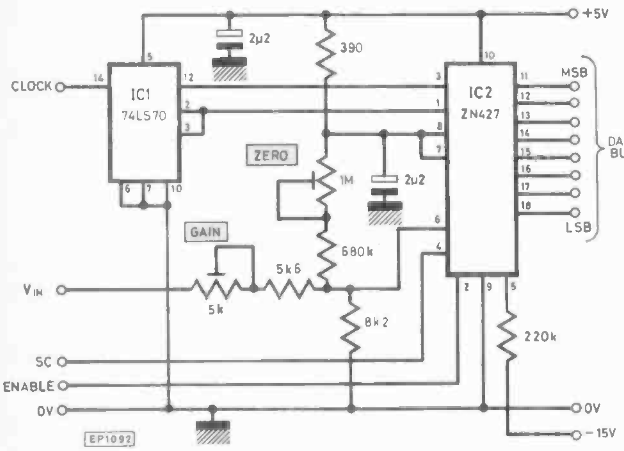
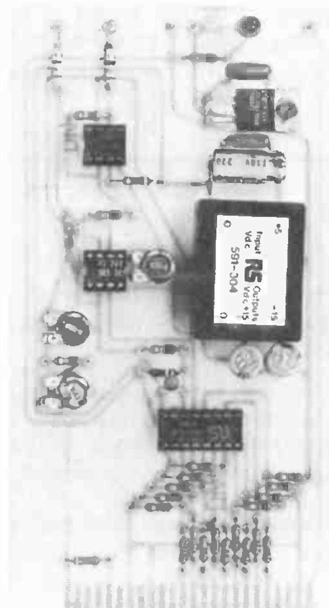


Fig. 15. Outline circuit diagram of a practical A to D converter

incorporate one, or more, stages of frequency division between the system clock and the clock input of the ZN427. In the case of the PE Microcontroller, which has a system clock at 894·75kHz, a single divide-by-two stage is all that is required. In the arrangement of Fig. 15 this frequency division is accomplished by means of a positive edge triggered J–K bistable, IC1. Other division ratios may be easily calculated from the relationship; $N = f_{sc}/f_c$ where f_{sc} is the system clock frequency and f_c is the ZN427 clock frequency (maximum 600kHz). The +5V and −15V rails may be derived from the power supply circuit of the Digital to Analogue Converter board described in Part 2 of the series (PE March 1983). To avoid duplication, full constructional details have not been given and readers are therefore recommended to refer to the previous part of this series and to Part 7 of the series on *'Interfacing Compukit' (PE July 1981)*.

USING THE A TO D CONVERTER

Provided that appropriate signal conditioning can be applied, the analogue to digital converter is suitable for use with virtually any type of analogue transducer. The normal full-scale input voltage for the circuit of Fig. 15 is +10V however larger or smaller input voltages may be catered for by means of appropriate modification of the input potential divider. Where the transducer produces a very low level of



The A to D converter

output, additional amplification may be necessary and this may be provided by means of one or more operational amplifiers. In general, the full-scale input voltage is given by; $V_{FS} = G \times V_{IN}$ where G is the attenuation of the input network. The resolution of the converter is $V_{FS}/256$. Without any input attenuation (G = 1) the value of V_{FS} will be the same as V_{REF} and, since the internal reference is 2·56V, the resolution will be 10mV/bit. The R-2R ladder network exhibits an impedance of 4kohm thus, to provide an accurate match (minimising offset problems within the comparator), the input attenuator/amplifier should ideally exhibit an output impedance of approximately 4kohm.

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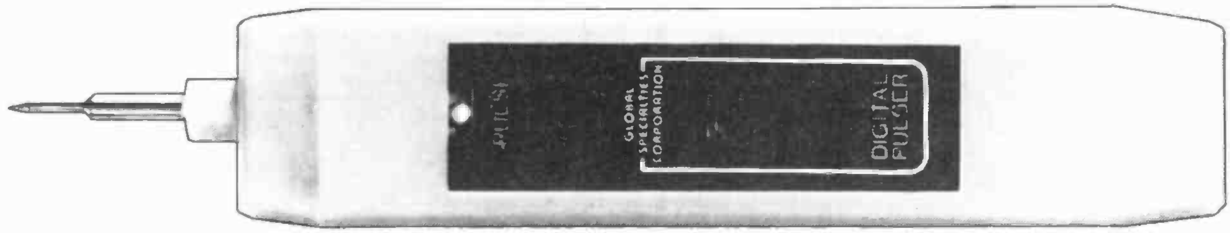

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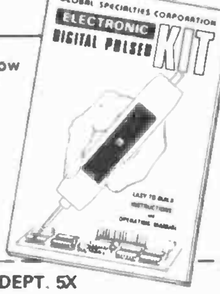

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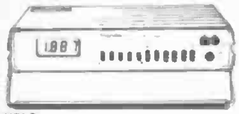

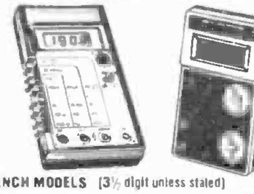

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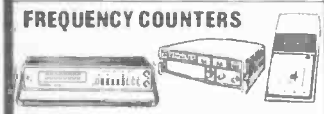

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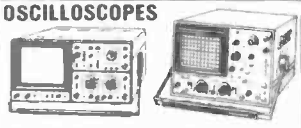

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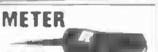

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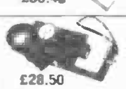

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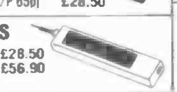

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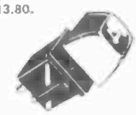

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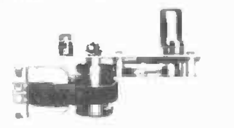

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-5V	1.5A	TO3	190p
+6V	0.5A	TO220	35p
+12V	0.5A	TO220	35p
-12V	1.5A	TO3	140p
12V	1A	TO220	40p
-12V	1.5A	TO3	190p
+15V	1A	TO220	40p
-15V	1A	TO220	40p
-24V	1A	TO220	70p

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723 30p
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EMOS

SEMICONDUCTOR UPDATE

R.W.Coles

FEATURING EB2 BB1 LH3 HC16 TFT 3000

SWANSONG

This, dear readers, is the very last *"Semiconductor Update"* column to appear in Practical Electronics, following an unbroken run since 1975. *(Semiconductor Circuits will replace it next month—Ed.)*

While pondering on a suitable content for this exodus edition, I at first considered a nostalgic look back at some of the more exotic devices that have appeared here over the years. But nostalgia is hardly the stuff of which this column is made, and so I took a bold step *forward* instead, by persuading two of the most avant-garde research groups in the country to lift the veil on the electronic future as they see it—with astounding results!

Any doubts you may have harboured concerning the viability of British industry in the 1990s and beyond are about to be dispelled, so step with me now into the brave, new, electronic world which awaits us all . . .

IN-BODY ENTERTAINMENT

Down in Poole, Dorset, of all places, I tracked down Frank N. Stone, boyish head of the new bio-electronic empire, Sceletronic Calcipart. Most of the work down there is still secret, but Frank was kind enough to show me around their BIO-CHIP diffusion facility which is producing a wide range of semiconductor dice for direct implantation in living tissue.

Although electronic implants have been produced before, as heart pace-makers for example, the work at Sceletronic is very different because the integrated circuits are not packaged but are placed directly into a suitable body cavity with the necessary neural connections being achieved with the aid of laser bonding.

Devices of all sorts can be implanted in this way to correct natural deficiences or to provide an enhancement of natural abilities, but the project which sparked my imagination the most was described by Frank as "In-Body Entertainment".

Sceletronic are working feverishly on a set of four CMOS BIO-CHIPS which together will make the "Walk-man" concept of personal entertainment about as obsolete as a stone axe. Integrated onto four thumbnail sized silicon dies will be a complete entertainment system which does not require the lucky recipient to wear headphones or to have a wristwatch TV screen, because the whole thing will be totally internal!

One of the devices, a video processor and display coded EB2, is slipped behind each eyeball to provide back-projection video facilities capable of displaying both off-air and recorded programs. A second chip, the BB1, acts as an exchangeable storage device of 100 gigabyte capacity which is used to hold a user selectable mix of stimulating audio visual entertainment. This chip has to be more easily accessible and so will be fitted into the trendy owner's navel, or any other orifice of their choice.

Adding yet another dimension to this scintillating ensemble is the LH3 audio processor which is capable of delivering a quadrophonic neural stimulus equivalent to 110 dB's acoustic. In addition to this direct neural audio, which works best at high frequencies, there will also be an optional "cranial woofer" which provides direct internal audio stimulation. Users opting for this extra facility will have to wear the black anodised ear extenders for cooling purposes says Frank.

To complete the set there will be the HC16 microprocessor based controller chip which will transmit tone, volume, and hue adjustment via existing neural pathways. Inputs will be received directly from analogue-to-digital chemo-receptors integrated onto the surface of the chip. Various other control options will be available, including a panic suppression mode triggered by adrenalin levels which causes all external auditory and visual reception to be suspended in favour of a restful program of soft music and seascapes.

Installation may pose problems, but a survey by Sceletronic revealed that most existing 17 year old hi-fi salesmen can be retrained in the simple technique of laser surgery in a matter of hours.

While I was in the Sceletronic lab I was introduced to Igor who had already been fitted up with a breadboard version. Igor's scars were healing nicely, and apart from a tendency to go cross eyed occasionally, there seemed to be no serious side affects. Unfortunately I was unable to question Igor in depth because he had just been fitted with a new BB1 containing material of Danish origin which appeared to be causing some technical difficulties.

This new technology will revolutionise the lives of all joggers, roller skaters and lecture goers!

SEE YOU LATER PROPAGATOR

A couple of years ago I revealed to you the amazing progress being made by Lliys Electronics over in South Wales. I know that if any firm could provide a stimulating glimpse into the future it had to be them, so off I went with my notebook and recorder.

The last time I was there Lliys were into hyper-power transistor technology, but things have moved on since then, and I found the research department, headed by the Polish émigré Zarcy Pudsti, hard at work on a revolutionary new microprocessor device.

Apparently Lliys have made a breakthrough in speeding up the operation of digital logic circuits and have got their latest device running at an amazing 2 giga hertz clock rate. Propagation delays in the gates have been cut down to just a few pico-seconds with the aid of a new and secret doping material developed and patented by Lliys.

While I was there they started to test the latest version of this incredible device, the TFT 3000, and the results were impressive to say the least. Apparently one of the chemists had added too much of the dopant to the silicon melt, and during the tests it became apparent that the gate delays had become negative, i.e. pulses were leaving the output of gates *before* an input signal was received!

While Zarcy and I pondered about the implications of this new effect, we saw the 64 pin leadless chip carrier containing the TFT 3000 begin to metamorphose. Within ten minutes we were left with ten 40 pin dual in line packages, within half an hour these were replaced by one hundred 16 pin d.i.p.s, then four hundred circuit boards containing large numbers of transistors. Just in time, Jim the lab assistant shouted a warning and we escaped with only minor scorch marks and bruises as the whole of Lliys labs was transferred into a glowing mass of EF86 valves.

After the EF86s, the Babbage style analytical engines and the Chinese abacus wielders were tame by comparison, and Zarcy and I retired to the nearby computer room to carry out an analysis of what could be expected next. Zarcy calculated that the TFT 3000 would reappear in about 3 weeks following a reversal of entropy at the genesis of the known universe, and perhaps he is right.

Personally, I hoofed it, after a quick 999 call to the local fire brigade, but everyone at Lliys seemed to think it was a great success. They still plan to market the TFT 3000 after some readjustment of the dopant levels, but if you are interested you had better place your order early, before stocks disappear.

(Readers requiring more information on these items should note the cover date of this issue—Ed)

Ultimum Computer Interface Part 6

WILLIAM EDWARDS WATFORD ELECTRONICS

WE CONTINUE our series of cards for the ULTIMUM motherboard with a peripheral card capable of producing speech. It uses a low cost, custom integrated circuit which provides most of the functions needed to produce an almost unlimited vocabulary using the phoneme method of speech production.

SYNTHESISING SPEECH

There are many different techniques available for generating speech using a computer. Ultimately, they all require some method of regenerating the basic elements of speech by modelling the human vocal tract. The heavy handed approach is to sample analogue speech waveforms and convert them to a digital form which may be subsequently regenerated through an analogue-to-digital converter. The number of samples is necessarily high (about 5,000 samples. sec^{-1}) and this means that a large amount of memory is required; a few words would exhaust the memory of most home computers.

There are two, more practical solutions. Firstly, some form of data compression can be used in conjunction with digital circuitry to restore the original signal. This circuitry usually takes the form of a complex digital filter. National Semiconductor, and Texas Instruments have both evolved methods of encoding phrases in such a compressed form, the best known being a system called Linear Predictive Coding. This is the technique employed in the commercial, speaking toys and teaching aids. The drawback is that the encoding process requires complicated equipment and lies beyond the scope of amateurs, so that one is limited to pre-defined vocabularies supplied in ROM form. Against this, the quality of speech is quite good (albeit with a heavy American drawl in nearly all cases). The second method relies on the fact that speech can be broken into a limited number of basic components. There are several such subdivisions, the smallest of which is called the allophone, or more commonly (but incorrectly) the phoneme. Early phoneme generators used analogue circuitry to reconstruct an electronic equivalent of the vocal cords and the rest of the vocal tract, using operational amplifiers as oscillators, filters and noise generators. Digital versions of these analogue predecessors make full integration much simpler, because the discrete components are largely eliminated.

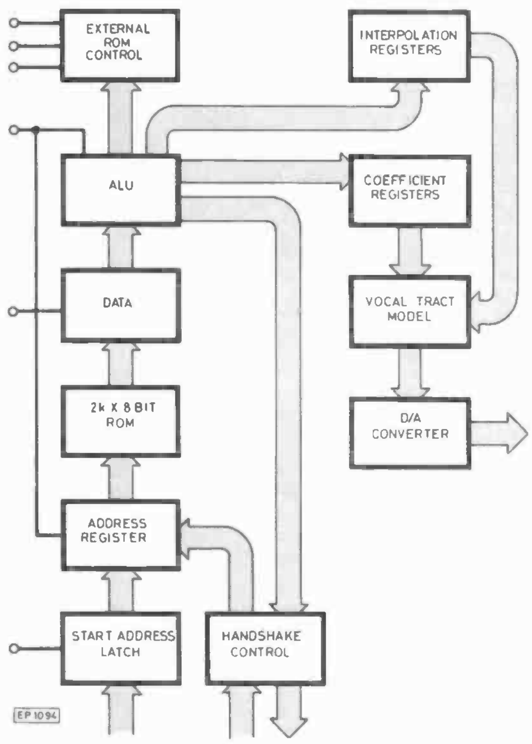


Fig. 6.1. Block diagram of Speech unit

THE SP-0256 SPEECH CHIP

Over the last year or so several new *all digital* speech chips have been introduced. The SP-0256 (General Instruments) has been chosen for this design because it combines low cost with simplicity. Allophones are encrypted in a 2k x 8 ROM. On selecting an allophone by supplying a count and a strobe pulse, the appropriate area of ROM is accessed and the data is passed to the vocal tract model which then regenerates an allophone. The 2k x 8 ROM stores code for all the allophones as well as periods of silence which are very important in the reconstruction of realistic speech. There are no words or phrases. These have to be put together by the host computer as a string of allophones. This is not difficult, and imposes only a light load on the computer. It is quite possible to produce a reasonable vocabulary without resorting to machine code. The store required for each word is only a handful of bytes.

THE BOARD

Fig. 6.1 is a block diagram of the Speech system. There are three basic elements, the speech generator, amplification and the interface to the ULTIMUM motherboard. Fig. 6.2 gives the complete circuit diagram.

The speech board occupies only one memory location (the location to which the allophone code is to be sent (see later). The decoding uses four four-bit magnitude comparators (ICs 1-4) which compare all 16 address lines against a value set on the links 0–15. The magnitude comparators are gated with the Read and Write signals from the motherboard to provide a valid access signal to the speech chip. When the selected location is written to, the byte written is sent to the speech chip. When the same location is read, the two status bits (BUSY and LOAD REQUEST) are put onto the bus (D7 and D6 respectively). Reading these bits allows the programmer to establish whether the speech chip is ready to accept another command or still busy issuing the last allophone. As speech is comparatively slow by computer standards, it is quite acceptable to poll these status lines periodically, rather than resort to the more complicated interrupt lines, although this is also possible, as all that is needed is to connect the load request line from the speech chip to the interrupt request line on the edge connector.

The speech chip provides a pulse width modulated signal which has to be converted to an analogue waveform suitable for amplification. This can be done with a simple diode/CR network, but we have chosen the more complete four stage filter (IC9), which imparts a much better 'shape' to the audio signal.

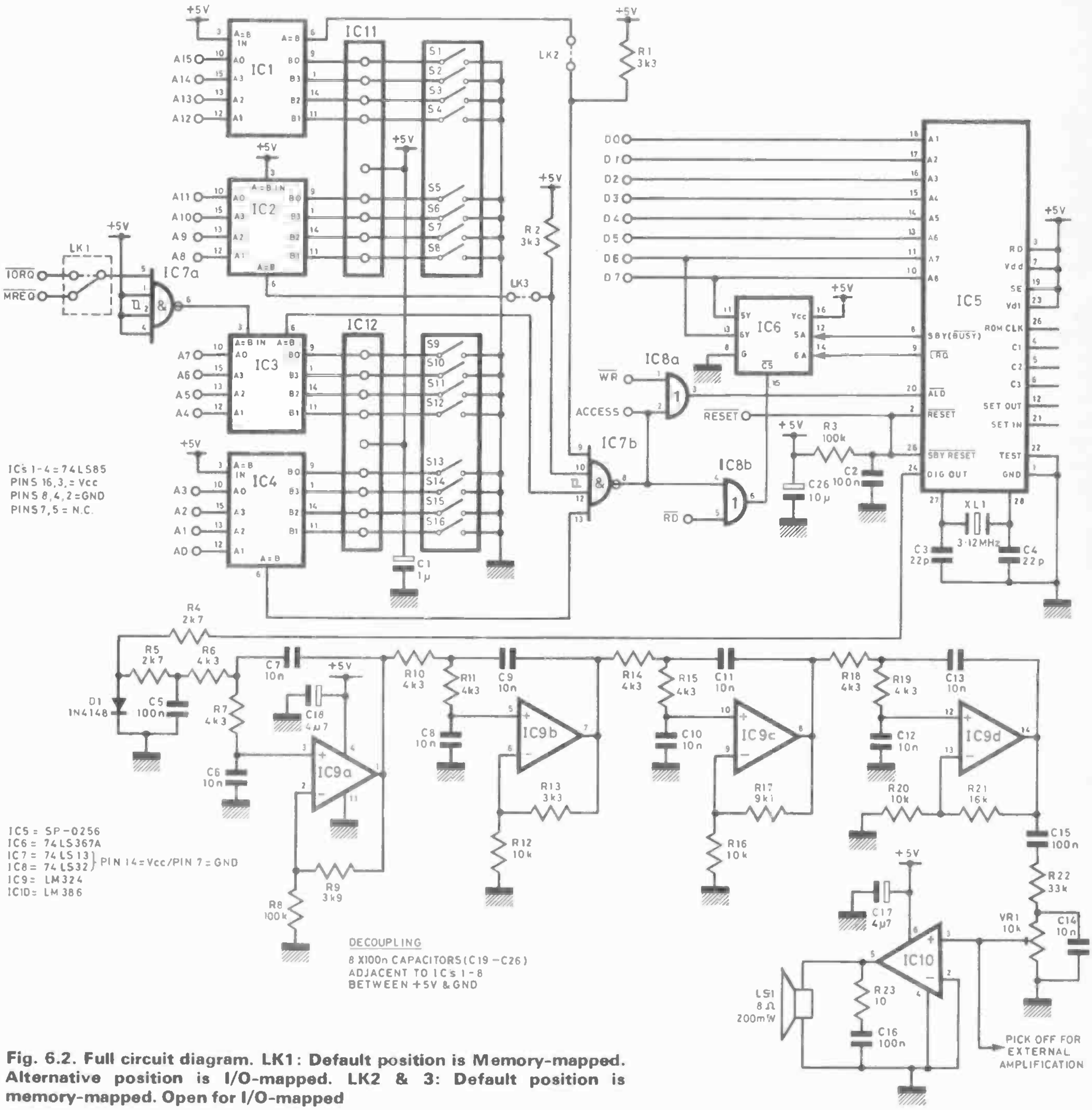


Fig. 6.2. Full circuit diagram. LK1: Default position is Memory-mapped. Alternative position is I/O-mapped. LK2 & 3: Default position is memory-mapped. Open for I/O-mapped

Finally, an amplifier (IC10) is included to drive a small speaker. Alternatively, a 'pick-off' point is available for external amplification, or for mixing with the Sound Card (see next month's article).

ASSEMBLING THE BOARD

Refer to the overlay (Fig. 6.3) for details of component placement. This board has many discrete components (mainly used in the filter).

We suggest that these are inserted *after* you have placed the i.c sockets. The crystal (XTAL1) which provides the timing for the speech chip, should be inserted with care. Avoid bending the leads at the base, as strain can fracture the internal connections. The SP-0256 is the most expensive component on the board, so before inserting it, check for shorts by powering the board up, and check that 5 volts appears on pins 7 and 23 of IC5 (the SP-0256 socket).

The d.i.l. switches (0-15) should be set up as follows:

1) Find an unused location in memory.
2) Write down the binary value of that location (eg. 0113 hex is 0000000100010011 in binary.
3) Set the switches according to this binary pattern ie. if bit 0 (the least significant bit) is 0 then close switch (shown in the overlay, Fig. 6.3, and on the board itself).
4) Repeat 3 for each switch.

TESTING THE BOARD

The board should be tested with the other cards removed from the ULTIMUM just in case there is a short circuit. Do not insert the board with the power on. The SP-0256 is automatically reset as power is applied. Run the BASIC program listed in Table 6.1, noting that you must set the PEEK and POKE location (LOC1 in the listing) to that set up on the speech board. If nothing happens, check the switches are correct and that the speaker is connected.

MAKING SPEECH

Table 6.1 lists all the allophones and the code which has to be fed to the SP-0256. The basic sequence required to feed allophone codes is as follows:

1) When load request is low, issue of any of the listed allophone codes by writing to the location set up on the decoding switches is possible

```
10 LET LOC1=(speech location)
20 RESTORE
30 READ D
40 IF D=>64 THEN 80
50 IF (PEEK(LOC1) AND 128)<>0 THEN 50;
   ready to load?
60 POKE LOC1,D
70 GOTO 30
80 GOTO 20; repeat indefinitely
          56,1,23,3,17,4,48,15,11,4,13,31,4,29,29,39,19,4
100 DATA 40,50,4,40,6,35,4,55,55,12,12,41,55,4,55,55,
   7,39,15,11,4
110 DATA 20,2,17,4,56,6,12,4,13,7,11,64
120 END
```

Table 6.1. BASIC test program for Speech board

2) While the allophone is being "spoken" the busy line will go low to indicate that the word is being issued. As can be seen, this allows for very simple programming.

There is no one-to-one correspondence between allophones and the written word, so we have to convert each word into its component parts before we can pursuade the speech chip to reproduce it. Of course, the best way of doing this is to write a "speech assembler" program which will break down the word and prepare the code for you, and we have no doubt that some readers will try this, as this kind of program has lots of applications, including speaking documents. The starting point must be to manually assemble your code by breaking up each word, and select the appropriate allophones yourself. To make this a little easier, Table 6.3 includes sample words which illustrate the type of sound associated with each allophone. Once the allophone list has been prepared, all that is required is to send single bytes to the SP-0256 in sequence. We have written a simple BASIC program to send a test phrase:

A bird in the hand is worth two in the bush.

Table 6.2. For sample program use these data

```
80 STOP        ; preserve sanity
90 DATA 20,2,63,52,0,21,2,12,11,2,18,19,2,27,26,11,
   0,21,3
100 DATA 12,43,2,46,52,29,2,13,31,2,12,11,2
110 DATA 18,19,2,63,30,37,64
```

Hex	Dec.			Hex	Dec.			Hex	Dec.		
00	0	Delay	10ms	16	22	uw1	to	2B	43	zz	zoo
01	1	Delay	30ms	17	23	ao	aught	2C	44	ng	anchor
02	2	Delay	50ms	18	24	aa	hot	2D	45	ll	lake
03	3	Delay	100ms	19	25	yy2	yolk	2E	46	ww	wool
04	4	Delay	200ms	1A	26	ae	hat	2F	47	xr	repair
05	5	oy	boy	1B	27	hh1	he	30	48	wh	when
06	6	i	sky	1C	28	bb1	rib	31	49	yy1	yes
07	7	eh	end	1D	29	th	thin	32	50	ch	church
08	8	kk3	comb	1E	30	uh	book	33	51	er1	letter
09	9	pp	pal	1F	31	uw2	food	34	52	er2	bird
0A	10	jh	dodge	20	32	aw	out	35	53	ow	sew
0B	11	nn1	thin	21	33	dd2	do	36	54	dh2	they
0C	12	ih	sit	22	34	gg3	wig	37	55	ss	vest
0D	13	tt2	two	23	35	vv	vest	38	56	nn2	no
0E	14	rr1	rural	24	36	gg1	guest	39	57	hh2	hoe
0F	15	ax	succeed	25	37	sh	ship	3A	58	or	store
10	16	mm	milk	26	38	zh	azure	3B	59	ar	alarm
11	17	tt1	part	27	39	rr2	brain	3C	60	yr	clear
12	18	dh1	they	28	40	ff	food	3D	61	gg2	got
13	19	iy	see	29	41	kk2	sky	3E	62	el	saddle
14	20	ey	beige	2A	42	kk1	can't	3F	63	bb2	business
15	21	dd1	could								

Table 6.3. SPO256 AL2 allophones

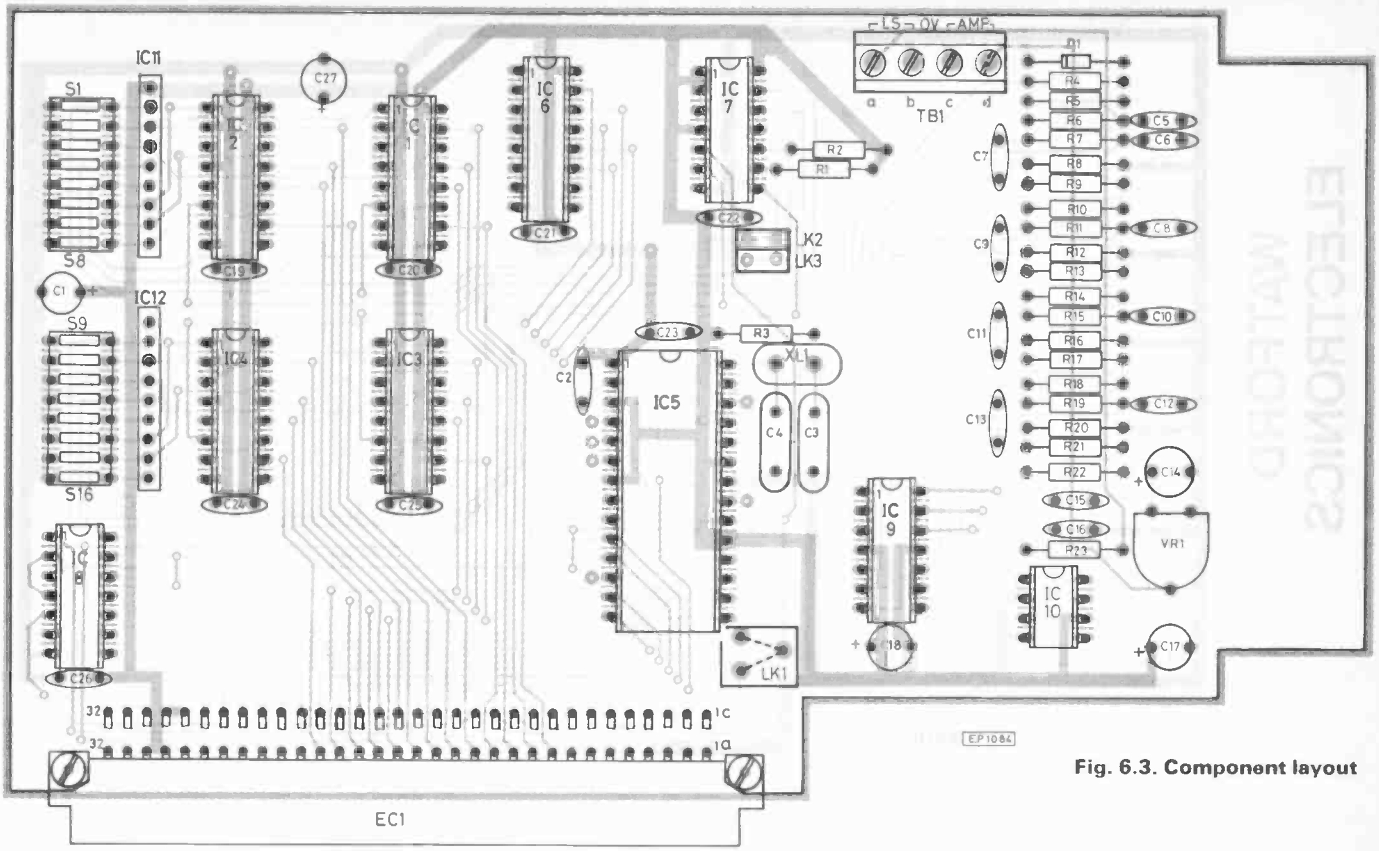


Fig. 6.3. Component layout

The program is given in Table 6.2b. The PEEK and POKE locations will depend on where the speech board is located in memory, and need to be adjusted accordingly.

NEXT MONTH: The Sound board.

COMPONENTS . . .

Resistors

R1, R2, R13	3k3 (3 off)
R3, R8	100k (2 off)
R4, R5	2k7 (2 off)
R6, R7, R1, R11, R14, R15, R18, R19	4k3 (8 off)
R9	3k9
R12, R16, R20	10k (3 off)
R17	9k1
R21	16k
R22	33k
R23	10

All resistors ¼W 5%

Potentiometers

VR1	10k Min. Vert. preset

Capacitors

C1	1μ/16V elect.
C2, C5, C15, C16, C19–27	100n cer. (12 off)
C3, C4	20p cer. (2 off)
C6–14	10n cer. (9 off)
C14, C17	4μ7/16V elect. (2 off)
C28	10μ/10V tant.

Semiconductors

IC1–4	74LS85 (4 off)
IC5	SP0256AL2
IC6	74LS367A
IC7	74LS13
IC8	74LS32
IC9	LM324
IC10	LM386
IC11, IC12	4k7 x 8 d.i.l. resistor

Miscellaneous

8 pin d.i.l. socket
14 pin d.i.l. socket (3 off)
16 pin d.i.l. socket (7 off)
28 pin d.i.l. socket
8-way SPST d.i.l. switch (2 off)
3·12MHz crystal XL1
Speaker 8 ohm, 2 in. LS1
2 x 32 way rt. angled Euro plug (DIN41612 A+C)
P.c.b. terminal block
1 metre twin standard cable
WE08 SPK p.c.b.

Constructor's Note

All kits for the Ultimum system are available from **Watford Electronics** (see advertisers' index). Send SAE for price lists of boards now available.

Ingenuity Unlimited

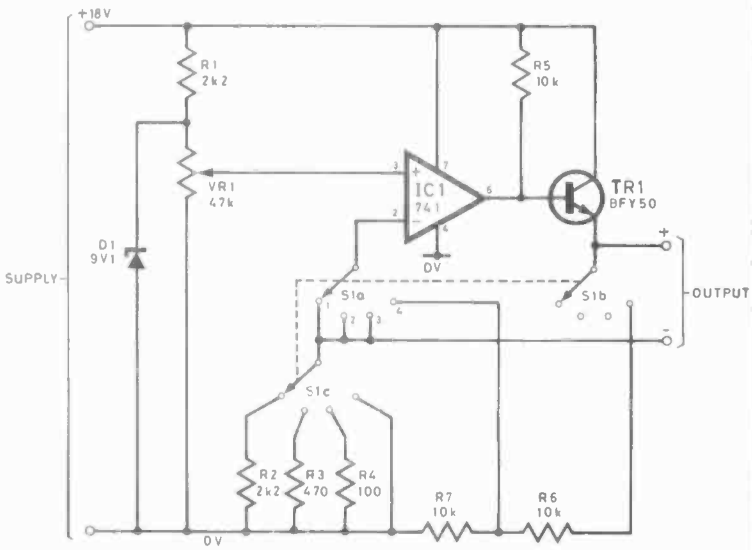
A selection of readers' original circuit ideas.

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

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. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

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 in the text.

CONSTANT CURRENT VOLTAGE SOURCE



EG1012

FOR any purpose needing a constant-current supply, such as charging Ni-Cad cells, this unit provides a remarkably stable current—even shorting the output causes no detectable change in current. The circuit shows switching of three ranges by means of a three pole four way switch, and the fourth position changes the circuit to an equally stable constant voltage supply, a desirable addition to the versatility of the unit only needing two more resistors.

Operation is as follows—the Zener diode provides a reference voltage, part of which is tapped off by VR1 to the non-inverting terminal of the op amp. The output current from the emitter of the transistor is returned to 0V via the resistors R2–4, and the consequent positive voltage at the top end of these is fed to the inverting terminal. The potential of the op amp output provides the bias for the base of the transistor; if the output current tends to increase, the potential changes, thus reducing the current supplied to the output, so that a stable state is set up. The actual amount of current is governed by the proportion of the Zener voltage supplied to the i.c., so VR1 forms a panel control which can be calibrated.

The characteristics of the circuit overall are not quite linear, so a separate dial calibration is needed for each of the resistors R2–4. Their values can be found experimentally for any required current range. The quickest way is to put a meter across the output, and substitute a wire wound variable for the resistor. Rotating VR1 will give the range limits for any given value of the variable, which can be measured, and a suitable fixed resistor chosen.

The ranges of the prototype are given for the values in the drawing, but the current can if necessary be increased to any desired amount, provided only that the transistor used can take it if properly heat-sinked. For currents over about 250 ma, obviously a power transistor is required, but up to that figure a BFY50 on a good heat sink should cope.

The fourth switch position for constant output voltage connects the output return directly to 0V, and puts a resistance across the output. Half of the voltage appearing across this is applied to the i.c., and controls the transistor as before. Positions 1, 2 and 3 of S1 provide the constant current ranges of 1–4 ma, 5–20 ma and 20–85 ma. Position 4 has the constant voltage range of 4–18V.

S. A. R. Guest,
Grampound, Truro.

LIGHTING EFFECTS UNIT

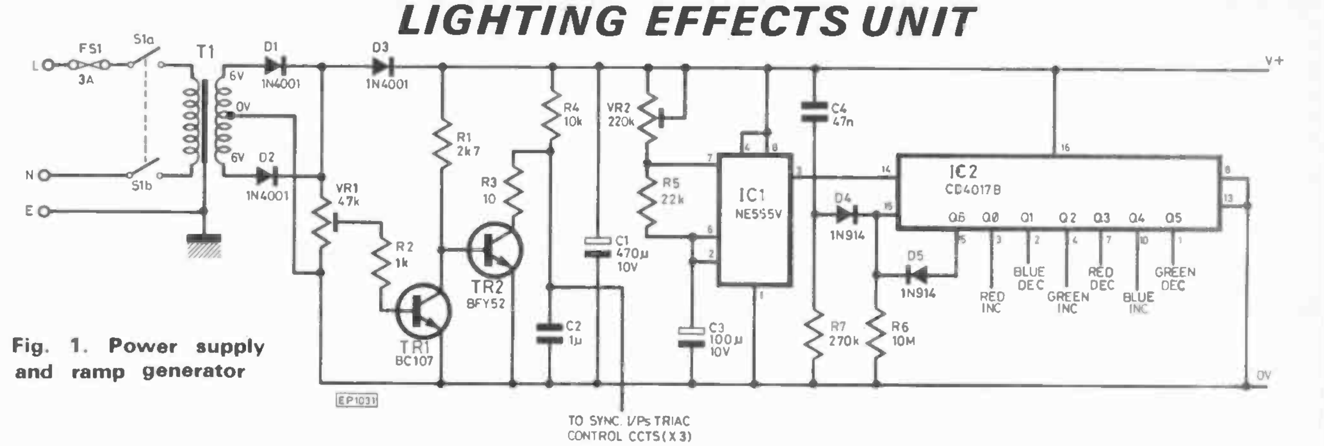


Fig. 1. Power supply and ramp generator

MANY circuits exist to provide exciting effects using coloured lighting, examples such as Sound-to-Light units and Chasers springing immediately to mind; but few exist that may be deployed successfully in a household environment for extended periods of time providing an interesting but slower and more relaxing type of display. Presented here is such a unit which may be used protractedly without excessive fatigue. It may also be of interest to many readers since it contains a voltage controlled dimmer which operates without resort to the more usual and unpredictable arrangement using a light dependant resistor.

The circuit aims to provide the following effect. At switch-on, all three bulbs illuminate. After a time, a regular cycle is set up during which the red bulb slowly increases in brightness until it reaches a maximum when the green bulb begins to light. After this too has reached its maximum level, the red bulb dims. When fully extinguished, the blue bulb begins to switch on whereupon the green bulb is extinguished, to be followed by the lighting of the red bulb and dimming of the blue bulb. The cycle then repeats.

The result of all this is that the colour of the light emitted by the unit cycles approximately every 25 seconds through the entire colour spectrum, beginning at red and changing through yellow-green-blue-magenta and then back to red.

The circuit may be broken down into three sections, these being the ramp generator and power supply, voltage controlled dimmers and logic elements. The ramp generator generates slowly rising and sharply falling waveforms which are synchronised with the mains so that the falling edge of the ramp occurs at mains zero-crossing (see Fig. 1). It operates as follows: unsmoothed d.c. from the transformer is fed via potential divider VR1 and resistor R2 to the base of TR1, so that when the mains voltage is not close to zero, TR1 is switched on. This removes the base current from TR2, cutting it off and preventing it from discharging the capacitor C2. The voltage across C2 therefore represents the type of ramp previously described, and although the rising edge is in fact exponential rather than linear, the approximation is satisfactory in this case.

This ramp is sent to the 'sync' input of the mains control circuits and is compared with the voltage across the capacitors (C101 to C301) by the CA3140 comparators, the output of which drive the triac opto-isolators. The higher the voltage across the tantalum capacitors, the more time must elapse before the sync voltage exceeds this voltage, so that the opto-isolator's l.e.d. is energised, and the later in the cycle the main triac is fired. Proportional control of the power delivered to the load is therefore obtained, the power beging inversely proportional to the voltage across the capacitor. Three mains control units were constructed, one each for the red, green and blue lamps.

The rest of the circuit consists of the logic required slowly to charge and discharge C101 to C301 in the appropriate manner. A one-of-ten output decade counter (IC2) is connected to an oscillator. If the 555 used is not of the recently available CMOS type (often numbered 7555) then it is strongly recommended that a 22µF/10V electrolytic decoupling capacitor be connected directly across the supply pins of the NE555, otherwise the rest of the circuit may suffer from transients introduced on the supply lines when the chip changes its output state. The period of the oscillator is variable between about a second and approximately 15 seconds or more. During setting up, care should be taken never to set VR2 to its minimum value. The 4017 is connected so that it cycles between only six of the ten outputs (Q0–Q5), since when Q6 goes high, the device is immediately reset. A reset pulse is also applied at switch on via C4 and R7 to ensure that normal operation commences as soon as possible. Should problems arise during setting up, it should be remembered that the output increasing the light level is the one connected to the transistor discharging C101. Diodes D101, D102 and D103 through to D301, D302 and D303 are necessary to stop the associated capacitor discharging as soon as the corresponding output on the 4017 goes low.

Setting up is accomplished as follows. The presets determining the increase and decrease time (VR101–VR302) should be turned down to their minimum setting. The bulbs should now switch almost instantly between being on and off, rather than fading. VR1 should be adjusted so that the bulbs are as bright as possible while the unlit bulbs remain fully extinguished. VR2 may then be set up to give the required oscillator period (remembering that the full cycle will take six times longer), observing the previously stated precaution. The fade timing presets must now be set up. Wait until the appropriate part of the cycle, then select an 'increase time' preset (i.e. one that discharges C101, C201 or C301) and increase its value. After several cycles have past, the preset should be adjusted so that the bulb just lights fully in the time that the increase input is high. This procedure should then be repeated for all the increase potentiometers. Similarly, the 'decrease' pots should be adjusted so that the associated bulb just extinguishes during the time that the 4017 output is true. This setting up procedure is lengthy and time consuming, but time spent here pays dividends in enhancing the effect.

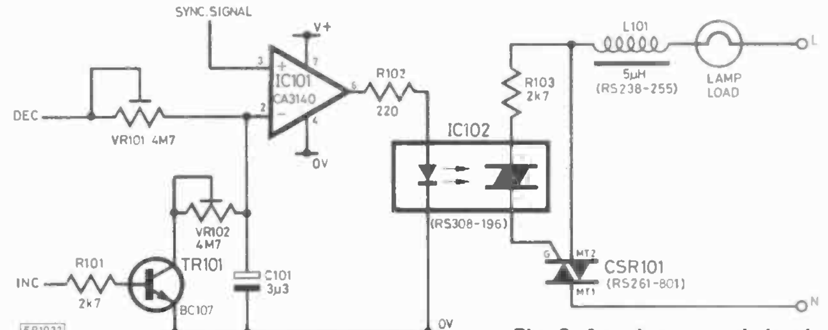


Fig. 2. A mains control circuit

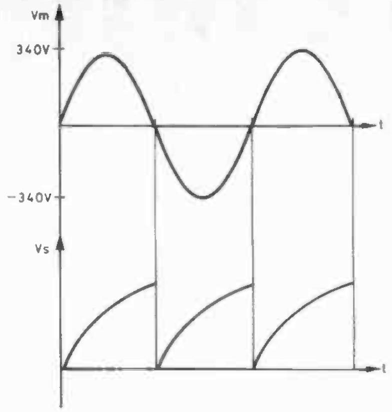
The bulbs used may be any type of 240V mains bulbs although special care should be exercised in the choice of the blue lamp, since many spotlamp bulbs labelled 'blue' produce a blue/green shade. If spotlamps are employed, then use ones that cast a fairly diffuse pool of light rather than producing three separate spots which would spoil the effect. The prototype currently in operation uses 100W coloured reflector bulbs similar to, but slightly larger than, those used in sound-to-light units, etc. There is of course no reason why larger loads should not be driven providing that the following points are taken into consideration:

1. Make sure that the mains choke is rated for the maximum r.m.s. bulb current plus a suitable safety margin (say 10%).
2. The triac should be rated at about 6 to 8 times the bulb r.m.s. current to allow for the switch-on surges in cold filaments.

It is also probably a good idea to add a fuse on the live side of the bulbs in addition to the single 3A link to protect in the event of any short circuits. All the components are fairly easy to obtain with the exception of the triac opto-isolator which may be obtained from Maplin Electronic Supplies.

N. J. Bailey,
Yatton, Bristol.

Fig. 3. Showing the relationship between the mains voltage V_m and the sync signal V_n



VERSATILE CONTROLLER

THE uses of this controller have turned out to be virtually legion—originally developed as a precision temperature control for a colour developer water bath to within 0·25°C, it can be used to control beer fermentation, greenhouse and propagator temperature, to turn lights on or off at dusk or when the sun shines, to turn on or off a water pump at some predetermined level, to provide a rain or frost warning—and so on. The only change to suit any particular purpose is in the sensor arrangements, and since these can be included in a DIN plug housing, the unit input is deliberately made universal by means of a DIN socket.

The basic circuit is quite simple, using an input resistance bridge composed of the chain R1–4 and VR1 for two arms, and the sensor socket between both A–B and B–C for the other two. Pin 2 of the i.c. can have the voltage on it altered by rotating VR1, thus setting the operating point, and the line to pin 3 carries a voltage varying with the momentary condition of the sensor. When pins 2 and 3 are at the same voltage, there is ideally no output on pin 6. If pin 3 is positive to pin 2 by even the slighest amount, pin 6 goes into positive saturation—and vice versa. If pin 6 is positive, TR1 turns on and closes the relay. Since the inputs are in bridge formation, the actual value of the supply voltage makes no difference to the operation.

Two features in the diagram may need explanation. The resistor chain R1–4 is broken into sections at three switched sockets, so that VR1 can be plugged in at three different voltage points, giving three overlapping ranges and a much more open scale than if a single potentiometer of say 47k were used across the supply instead. The other odd looking feature is the wiring of the indicator l.e.ds. Obviously the easiest way is to use a set of changeover contacts on the relay, but in the prototype the miniature relay used had only one set of contacts, of mains size, so another method had to be devised. The red l.e.d. for "off" D1 is lit by current sunk by pin 6 when negative, but to avoid damage to the i.c. make R5 as high as will permit an indication. The green l.e.d. D2 is lit by current passing through the relay coil when on. Before connecting D2 choose R8 to allow the relay to just close, and then choose R7 to provide a parallel path which will light D2 and allow the relay to close.

Various sensors may be used; for temperature control a Siemens K164 bead thermistor with a nominal resistance of 22k is ideal. If used in air, all it needs for protection is two or three coats of oil based paint (not cellulose) on it and the wires and joints—probe insulation is vital, and must not be open to moisture. Response will be almost instantaneous. Rx, the balancing resistor, should be about the same resistance as the sensor, whatever kind is used, at the normal state, so 22k is used for the thermistor mentioned. It is mounted inside the DIN plug housing. The sensor lead should be carefully screened to avoid interference, and the screen returned to 0V.

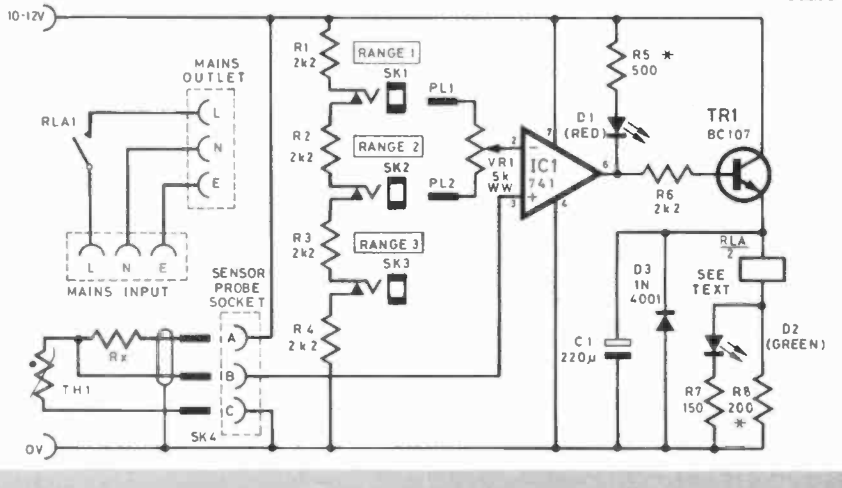
For use in water (or beer!) etc., mount the bead in a little piece of the very thin brass $\frac{1}{4}$in tubing available at model shops, one end closed by a bit of sheet soldered on; fill the closed end for about $\frac{1}{4}$in with heat sink grease, wrap the bead assembly in a bit of polythene sheet (it must be perfectly insulated from the brass) and push it down into the grease. Seal the cable exit securely with wax or pitch, topped with polyurethane glue to make all tight. If the fluid being monitored will corrode brass or be contaminated by it, a little glass tube will have to be used, which will slow the response but not impair the accuracy.

For light sensing purposes, a CdS l.d.r. is used, with the same proviso about Rx.

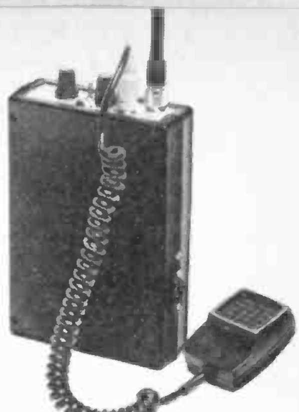
For water level detection, a pair of wires about an inch apart and carefully insulated from one another are set to dip into it at the required level. For rain or moisture, a little bit of copper track board is used face up, the tracks connected alternately to the leads. One drop of water bridging them is sufficient to activate the controller. Note that in these cases, the sensor is normally open circuit, so that a high resistance, typically 220k, must be connected both from A to B and from B to C, so as to preserve the d.c. balance of the bridge. To operate with these leakage sensors, the position of VR1 with the probe dry should be such that the relay just does not close. First class insulation is more than ever necessary in these cases.

The rule in working out any operation is always the same—a reduction in the resistance between B and C will turn the controller off, and conversely a reduction of resistance between A and B will turn it on, and if the reverse of this is needed (as for instance if a rise in temperature is to turn something on) change over the A and C leads at the plug, together with Rx.

S. A. R. Guest,
Grampound,
Truro



I.F. FILTER/AMPLIFIER



for PE RANGER – R.F. MILLINGTON

ONE of the major problems encountered with the PE Ranger CB transceiver (Sept-Dec 1981) was adjacent channel interference. The circuit described here attempts to overcome this problem by increasing the IF selectivity at comparatively low cost.

The CFM2455D IF filter supplied with the Ranger kit is excellent compared to its cost (around 75p), but as its response curve shows its rejection of adjacent channel transmissions is not good. The Ranger board was studied to see how a better filter could be fitted. Consideration was given to the cost of such a modification and it was decided to mount a piggy-back board in a similar manner to the transmitters' output filter board. The circuit uses a small piece of 'Veroboard' which has the same hole spacings as FL100. (0·1").

To overcome the cost of a highly selective ceramic ladder or crystal filters, the circuit in Fig. 1 uses an idea from a model radio control receiver* which cascades the filter

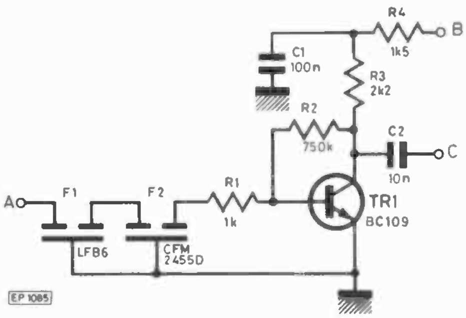


Fig. 1. Circuit diagram of the I.F. Filter/Amp

FL100 with a low cost ceramic ladder filter type CFU455H or LFB6. This arrangement gives an IF curve which has very steep sides, as compared to the sloping sides of the curve given by FL100 only. The extra insertion loss proved to be too much though, reducing the Ranger to a 'locals only' receiver. Selectivity, the object of the exercise, was much improved.

The following IF amp was then evolved to return the gain of the now reduced IF signal to its original level. 6·2V is available at the centre pin of the FL100 position (marked B) and –Ve return is made by soldering the unused tracks of the 'Veroboard' to the can of L106/L107, which also gives the board mechanical stability.

R1 is the CFM2455D output impedance matching resistor. The output impedance of this filter is stated as being 2kohm, but as the input impedance of TR1 is about 1kohm, R1 was made 1kohm.

A BC109, although classed as an audio transistor was used for TR1 and this seemed to work well. R4 and C1 provide decoupling for the supply and the output is taken from the collector of TR1 via C2, which then feeds straight to pin 5 of IC100. (Marked C). The input is from L107, marked A.

R2 is given as 750kohm. Preferred values for the E12 range are 680k and 820k, and either should do if the stated value is not available. There is room for experimentation here, but remember that too much gain will overload the limiting amp in IC100, thereby clipping the wanted signal and causing distortion.

It has been recommended that the oscillator voltage stabiliser diode D100 be reduced to 2·7V to reduce the amount of RF produced. With this filter/amp it was found that the oscillator was now too weak, so the original 5·6V Zener was used. The 100ohm across L105 and the 47kohm from pin 1, IC100 to ground were left in circuit.

CONSTRUCTION

Carefully remove FL100 from the Ranger circuit board, being sure not to overheat the leads or the track on the board, which will lift and tear away. Once removed, use FL100 in position F2 on the filter/amp board.

The components should be laid out on the Veroboard as shown in Fig 2. Don't forget to cut the track in the appropriate places.

Mount all the components before soldering. The three leads for A, B, and C can be made from cut off component leads, and are best left long until the board is soldered to the can of L106/L107.

When the filter/amp board is completed, carefully insert the three leads, A, B, and C (Fig. 1) into the holes left by FL100, and marked A, B, and C in Fig. 2. Note where the link at H9 touches the top of the L106/L107 can, then put the board aside and tin that position on the can, using a fair amount of solder. It is then an easy matter to solder the H9

COMPONENTS . . .

Resistors

R1	1k
R2	750k
R3	2k2
R4	1k5

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

Capacitors

C1	100nF disc ceramic
C2	10nF disc ceramic

Transistor

BC 109

Filters

F1	CFU455H or LFB6
F2	CFM2455D

Miscellaneous

Veroboard.

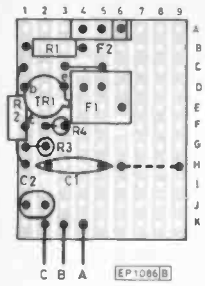


Fig. 2. Veroboard layout for the I.F. Filter/Amp

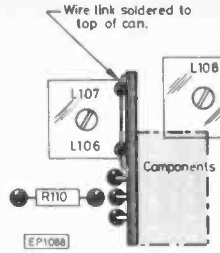


Fig. 3. Mounting details for the I.F. Filter/Amp

link to the can. (Note that this link is soldered to the track side of the board, bridging the unused tracks. Solder leads A,B, and C to their respective pads on the Ranger circuit board.

Do not try to fit the filter/amp board flush with the Ranger board as the amplified signal from the limiting amp in IC100 can be picked up by C2 and fed back in, causing instability. With a gap of about ¼" no feedback problems were experienced on the prototype.

SETTING UP

The core position of L106/L107 may need to be slightly retuned to match the new filter, as with L102/L103. Coil cores should not have to be altered more than ¼ of a turn, and with a correctly tuned receiver it is worth while making a mark on the can for that setting before any retuning is done. It is also worthwhile to study the receiver alignment procedure as given in the original article.

CONCLUSION

For an outlay of somewhere around £2·50p the filter makes a worthwhile improvement, putting all but the very close adjacent channel transmissions way down in the white noise, and it would seem that the majority of complaints of 'bleeding over' is more than likely due to poor IF filtering.

Other more expensive filters could also be used using the same mounting principle of a piggy-back board into the holes left by FL100, and in most cases would have the same insertion loss as FL100, so an additional amplifier would not be needed, but this combination of filters seems to be a very effective and low cost alternative. ★

ACKNOWLEDGEMENTS

**Radio Control Models and Electronics. May 1979.*
FM Digital Radio Control system by Terry Platt.

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PE BAZAAR APRIL '83

MICRO PROMPT

The hardware and software exchange point for PE computer projects

Table 1. Software

1F8C	58	CLI		This is the startup routine which simply enables
1F8D	60	RTS		interrupts
1F8E	8DFA1F	STA	$1FFA	Save Accumulator
1F91	8EFB1F	STX	$1FFB	Save X register
1F94	68	PLA		Pull Processor Status Word off stack
1F95	8DFC1F	STA	$1FFC	Save PSW
1F98	68	PLA		Pull PC low byte off stack
1F99	8DFD1F	STA	$1FFD	Save it
1F9C	68	PLA		Pull PC high byte off stack
1F9D	8DFE1F	STA	$1FFE	Save it
1FA0	A200	LDX	#$00	Clear screen pointer
1FA2	A928	LDA	#$28	Load Left Bracket character
1FA4	9D30D0	STA	$D030,X	Draw on screen
1FA7	E8	INX		Increment screen pointer
1FA8	ADFE1F	LDA	$1FFE	Get PC high byte
1FAB	20DC1F	JSR	$1FDC	Draw on screen
1FAE	ADFD1F	LDA	$1FFD	Get PC low byte
1FB1	20DC1F	JSR	$1FDC	Draw on screen
1FB4	A929	LDA	#$29	Load Right Bracket character
1FB6	9D30D0	STA	$D030,X	Draw on screen
1FB9	ADFE1F	LDA	$1FFE	Push PC high byte back onto stack
1FBC	48	PHA		
1FBD	ADFD1F	LDA	$1FFD	Push PC low byte back onto stack
1FC0	48	PHA		
1FC1	ADFC1F	LDA	$1FFC	Push PSW back onto stack
1FC4	48	PHA		
1FC5	98	TYA		Save Y register on stack—it will be used by
1FC6	48	PHA		delay count
1FC7	AEFF1F	LDX	$1FFF	Load delay count into X register
1FCA	ACFF1F	LDY	$1FFF	and Y register
1FCD	88	DEY		Decrement Y
1FCE	D0FD	BNE	$1FCD	If not zero loop back
1FD0	CA	DEX		Decrement X
1FD1	D0FA	BNE	$1FCD	If not zero branch back
1FD3	68	PLA		End of delay—pull Y reg data off stack
1FD4	A8	TAY		Restore Y register
1FD5	AEFB1F	LDX	$1FFB	Restore X register
1FD8	ADFA1F	LDA	$1FFA	Restore Accumulator
1FDB	40	RTI		Return i.e. execute next instruction
1FDC	48	PHA		Save the byte on stack
1FDD	4A	LSR	A	Move the top 4 bits
1FDE	4A	LSR	A	into the lower 4
1FDF	4A	LSR	A	
1FE0	4A	LSR	A	
1FE1	20E91F	JSR	$1FE9	Convert lower 4 bits to Ascii & output
1FE4	68	PLA		Get next 4 bits
1FE5	20E91F	JSR	$1FE9	Convert to Ascii & output
1FE8	60	RTS		Return
1FE9	290F	AND	#$0F	Mask off top 4 bits
1FEB	18	CLC		Prepare for addition
1FEC	D8	CLD		
1FED	6930	ADC	#$30	Add Ascii "zero"
1FEF	C93A	CMP	#$3A	If result more than 9 correct to
1FF1	3002	BMI	$1FF5	Ascii for A–F
1FF3	6906	ADC	#$06	
1FF5	9D30D0	STA	D030,X	Display on screen
1FF8	E8	INX		Increment pointer to screen
1FF9	60	RTS		Return
1FFA				Save accumulator
1FFB				Save X register
1FFC				Save Processor Status Word
1FFD				Save PC low byte
1FFE				Save PC high byte
1FFF				Delay count

1F8E is the interrupt service routine.

MACHINE CODE TRACE

Machine code in RAM can be traced by setting a sequence of breakpoints using the 6502 BRK instruction. If the software is in ROM, however, software interrupts are not possible and another means has to be found. Some processors have a "T-bit" in the status word which when set causes an interrupt after every instruction. This is ideal, but unfortunately not available on the 6502. The nearest solution to the problem is to supply the hardware interrupt input (IRQ) of the processor with a logic level shortly after the start of every instruction. This will cause a branch to an interrupt service routine where the current PC can be displayed on the VDU, allowing the operation of the Monitor and BASIC ROMs to be viewed.

The required signal is most closely provided by the SYNC output from the 6502 chip itself. This output indicates when the processor is carrying out an "instruction fetch" and as such becomes active shortly after an instruction has started. In practice, the SYNC signal must be inverted before feeding it to the IRQ input. This can be done using the circuit in Fig. 1 incorporating one of the spare inverters on the board.

The interrupt pushes the PC high byte, PC low byte and Processor Status Word onto the stack and disables interrupts. The routine given here pulls those bytes off the stack and displays the PC on the top RH line of the screen. This constantly updates and is "transparent" to the operation of BASIC or machine code.

After giving a memory size of 8075 bytes, the routine should be keyed-in using the machine-code monitor and then linked to the IRQ vector by POKE 549,76: POKE 550,142: POKE 551,31.

Once in memory, it can be SAVED to tape using the routine given in the UK101 manual. The trace speed can be changed by POKEs to 8191 (I = fast 127 = mid 0 = slow).

Interrupts are then enabled by including POKE 11,140: POKE 12,31: X = USR(X) to call the startup routine at $1F8C. Startup should be done from within a program and not in immediate mode, as this is not guaranteed to be successful. The toggle switch in the circuit diagram can be used to turn off the trace at any convenient time.

Two points about the routine—firstly the readout is bracketed to distinguish it from normal screen contents, and secondly it has been placed on the top screen line so that Line-Feeds do not destroy the screen.

Using this facility it is quite interesting to watch the amount of computing required by the various BASIC operations.

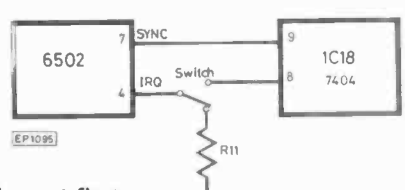

Fig. 1. Circuit diagram. R11 must first be disconnected from IRQ. Pins 8, 9 of IC18 are currently unused.

B. Beckett,
Blackpool.

TRANSFORMER DESIGNER

This program was sent in by *Peter Whittaker* of Kliprivier, South Africa. When running, it will take the user through a series of steps leading to the design of a low power transformer. The program takes care of all the calculations.

```
2 REM PETE WHITTAKER
3 REM DECEMBER 1981
4 REM AL MONITORS
5 REM
6 REM ADVERT
7 GOSUB128
8 IFX1=100ORY1=100THENGOTO17
9 ReADX1,Y1
10 POKEX1,Y1
11 DATA53547,150,53548,150,53549,150,53550,150,53551,150
12 DATA53580,156,53583,153,53612,156,53615,153,53644,156,53647,153
13 DATA53675,151,53676,151,53677,151,53678,151,53679,151
14 DATA53708,156,53740,156,53772,156,53804,156
15 DATA53805,69,53806,84,53807,69,100,100
16 GOTO8
17 PRINT"  TRANSFORMER DESIGNER"
18 FORX=0TO700STEP.1:NEXT
19 CLEAR:GOSUB128
20 PRINT"TRANSFORMER DESIGNER":PRINT"will design all power
21 PRINT"and audio transformers":PRINT"including stepup units":PRINT
22 PRINT"Full prompting allows":PRINT"multiple tap options":PRINT
23 PRINT"The user may call on":PRINT"program assumptions to"
24 PRINT"permit safe design on":PRINT"used cores":PRINT
25 PRINT"     HIT ESC KEY"
26 IFPEEK(57100)=222THEN28
27 GOTO26
28 GOSUB128
29 PRINT"*PRIMARY*":PRINT
30 PRINT"One to three primary":PRINT"taps at any voltages"
31 PRINT"of your choice may be":PRINT"selected":PRINT
32 INPUT"HOW MANY TAPS ";T1:PRINT
33 IFT1<1ORT1>3THENPRINT"(1 to 3 PLEASE)":PRINT:GOTO32
34 FORA=1TOT1:ONAGOTO35 ,36 ,37
35 INPUT"TAP 1 VOLTAGE ";V1:GOTO38
36 INPUT"TAP 2 VOLTAGE ";V2:GOTO38
37 INPUT"TAP 3 VOLTAGE ";V3:GOTO38
38 NEXTA:PRINT
39 PRINT"Frequency range may be":PRINT"between 20hz to 20khz"
40 PRINT" For wide range audio":PRINT"the mid frequency must"
41 PRINT"be input":PRINT
42 INPUT"DESIGN FREQUENCY";F1:PRINT
43 IFF1<20ORF>20000THENPRINT"OUT OF RANGE":GOTO42
44 PRINT"DO YOU WISH TO":INPUT"CORRECT INPUT";B$
45 IFLEFT$(B$,1)="Y"THEN32
46 GOSUB128 :PRINT"*SECONDARIES*":PRINT
47 PRINT"Two secondaries may be":PRINT"selected."
48 PRINT"Secondary one allows a":PRINT"choice of one to three"
49 PRINT"taps to ensure design":PRINT"of center or multitap"
50 PRINT"devices":PRINT
51 PRINT"The second winding is":PRINT"single ended"
52 PRINT"Total current must not":PRINT"exceed 30 amps ':PRINT
53 PRINT"Windings may be series":PRINT"connnected":PRINT
54 PRINT"*SECONDARY 1*":INPUT"HOW MANY TAPS";T2
55 IFT2<1ORT2>3THENPRINT"(1 to 3 PLEASE)":PRINT:GOTO54
56 GOSUB128 :PRINT"*SECONDARY 1*":PRINT
57 FORB=1TOT2:ONBGOTO58 ,59 ,60
58 INPUT"VOLTS TAP 1";V4:GOTO61
59 INPUT"VOLTS TAP 2";V5:GOTO61
60 INPUT"VOLTS TAP 3";V6:GOTO61
61 NEXTB:PRINT
62 PRINT"INPUT CURRENT ":INPUT"IN AMPS SEC.1";I1:PRINT
63 PRINT"DO YOU WANT A SECOND":INPUT"SECONDARY WINDING";C$:PRINT
64 IFLEFT$(C$,1)<>"Y"THEN67
65 INPUT"VOLTAGE SEC.2";V7:PRINT
66 PRINT"INPUT CURRENT":INPUT"IN AMPS SEC.2";I2:PRINT
67 PRINT"DO YOU WISH TO":INPUT"CORRECT INPUT";D$
68 IFLEFT$(D$,1)="Y"THEN54 :PRINT
69 GOSUB128 :PRINT"*CORE*":PRINT
70 PRINT"Required core area is":PRINT"dictated by the total"
71 PRINT"volt/ampere rating of":PRINT"the transformer":PRINT
72 PRINT"In turn it affects the":PRINT"number of turns/volt":PRINT
73 PRINT"the crossectional area":PRINT"is that of the core"
74 PRINT"center leg":PRINT"ie the area of the coil"
75 PRINT"hole opening":PRINT
76 PRINT "Magnetic properties of":PRINT"the core must be input"
77 PRINT"in lines/cm sq.If not":PRINT"known input 0":PRINT
78 INPUT"LINES/cm sq";L
79 IFL=0THENLETL=10000
80 V8=V4:IFV5>V4THENLETV8=V5
81 IFV6>V4THENLETV8=V6
82 VA=(V8*I1)+(V7*I2)
83 D=(6.5416*SQR(VA))/(5.58*.92):X$=STR$(D)
84 GOSUB128 :PRINT"TOTAL VA     ";VA:PRINT
85 PRINT"MINIMUM CORE"
86 PRINT"AREA REQUIRED";LEFT$(X$,6);"cm sq":PRINT
87 PRINT"WHAT SIZE CORE":PRINT"DO YOU WANT TO "
88 INPUT"USE cm sq please";E:PRINT
89 IFE<(.94*D)THENPRINT"TOO SMALL":GOTO87
90 REM T/VOLT
91 F=100000000/(4.44*F1*L*E)
92 X$=STR$(F)
93 GOSUB128 :PRINT"*PRIMARY*":PRINT
94 PRINT"TURNS PER VOLT";LEFT$(X$,6):PRINT
95 PRINT"NOTE:- all turns are":PRINT"given as total turns"
96 PRINT"from common":PRINT
97 FORX=1TOT1:ONXGOTO98 ,99 ,100
98 PRINTINT(F*V1);"TURNS TO":PRINTV1;" VOLT TAP":PRINT:GOTO101
99 PRINTINT(F*V2);"TURNS TO":PRINTV2;" VOLT TAP":PRINT:GOTO101
100 PRINTINT(F*V3);"TURNS TO":PRINTV3;" VOLT TAP":PRINT:GOTO101
101 NEXT
102 X$=STR$(VA/V1)
103 PRINT"PRIMARY AMPS";LEFT$(X$,5):PRINT
104 G=SQR((VA/V1)*1.08/(1.55*.7854)):X$=STR$(G)
105 PRINT"WIRE DIAMETER IS":PRINTLEFT$(X$,6);"mm":PRINT
106 PRINT"    HIT ESC KEY":PRINT"    TO CONTINUE"
107 IF PEEK(57100)=222THEN109
108 GOTO107
109 GOSUB128
110 PRINT"*SECONDARY 1*":PRINT
111 FORC=1TOT2:ONCGOTO112,113,114
112 PRINTINT(F*V4);"TURNS TO":PRINTV4;" VOLT TAP":PRINT:GOTO115
113 PRINTINT(F*V5);"TURNS TO":PRINTV5;" VOLT TAP":PRINT:GOTO115
114 PRINTINT(F*V6);"TURNS TO":PRINTV6;" VOLT TAP":PRINT:GOTO115
115 NEXTC
116 H=SQR(I1*1.06/(1.55*.7854)):X$=STR$(H)
117 PRINT"WIRE DIAMETER IS":PRINTLEFT$(X$,6);" mm":PRINT
118 IFV7=0 THEN123
119 PRINT"*SECONDARY 2*":PRINT
120 PRINT"TOTAL TURNS FOR":PRINT"SECONDARY 2";INT(F*V7):PRINT
121 I=SQR(I2*1.06/(1.55*.7854)):X$=STR$(I)
122 PRINT"WIRE DIAMETER IS":PRINTLEFT$(X$,6);" mm":PRINT
123 INPUT"RERUN PROGRAM";E$:PRINT
124 IFLEFT$(E$,1)="Y"THEN19
125 PRINT"BYE THEN"
126 END
128 FORX=0TO28:PRINT:NEXT:RETURN
OK
```

2716 PROGRAMMER

The circuit of the 2716 (5V) EPROM Programmer makes a simple stand-alone unit which is economical to build. It does not need a microprocessor for its working. In order to input an 8-bit (one byte) data, it employs the popular keyboard circuit published in P.E. Sept. '78. That circuit has become popular, because it directly gives a one byte data-word with two key pressings. Normal keyboard encoder i.c.s (such as the latest 74C922) can give only a 4-bit word, and one needs a micro to rotate the bits left four times to assemble an 8-bit word into the Accumulator of the microprocessor. As a proof of its popularity, it appeared, though somewhat modified, again in P.E. April '80, page 62. So, many P.E. readers will have the keyboard already constructed.

This keyboard, together with a few TTL i.c.s and some l.e.d.s can make a useful EPROM Programmer. The complete circuit is given in Fig. 1. There is a 10 pole 2 way slide switch connecting the keyboard output to the EPROM data lines. (This switch could be a cassette recorder spare part.) While reading the EPROM (after programming), the switch is kept in the open position and then $\overline{CS}$ pin goes low. The eight data l.e.d.s use two 7400 gates to drive them. In the program mode, the switch is closed, thus connecting to the keyboard outputs, and then $\overline{CS}$ goes high, as required for programming. The address lines are grouped into A0–A7 and A8–A10.

The A8 to A10 are selected high or low using three 2 way slide switches, which are wired to +5V and ground, so that one can choose a 0 or 1 for these address bits. These bits select the page on the EPROM to be programmed or read. The lines A0–A7 are fed from the outputs of the two 7493 4-bit counter i.c.s, which count the address. Incrementing the address is by the toggle switch 'Addr. Incr.' which gives one pulse at a time, so that one location after another of EPROM can be successively programmed. The 11 address lines are indicated by the 11 l.e.d.s at all times. The programming pulse of 50ms is given by the pulser switch which initiates the 74121 monostable to give the 50ms pulse to the PGM pin 18 of the 2716. The 25V supply needed for programming is also selected by a separate 25V-to-5V changeover switch. This separate switch is safer than incorporating it within the 10 way slide switch.

Programming is done by sequencing the address by the Addr. Incr. switch after initially resetting the Address lines to 00 by the push to open switch 'Zero Addr.'. Data is entered on the keyboard and after checking up by looking at the l.e.d.s, the pulser switch is pressed once and released. That byte would be programmed into the EPROM. The procedure can be repeated for the next address location and so on.

For reading/verifying, the slide switch is opened from the keyboard side and the address is selected by the 'Addr. Inc.' pulser so that the data l.e.d.s indicate the data already in the 2716 at that address.

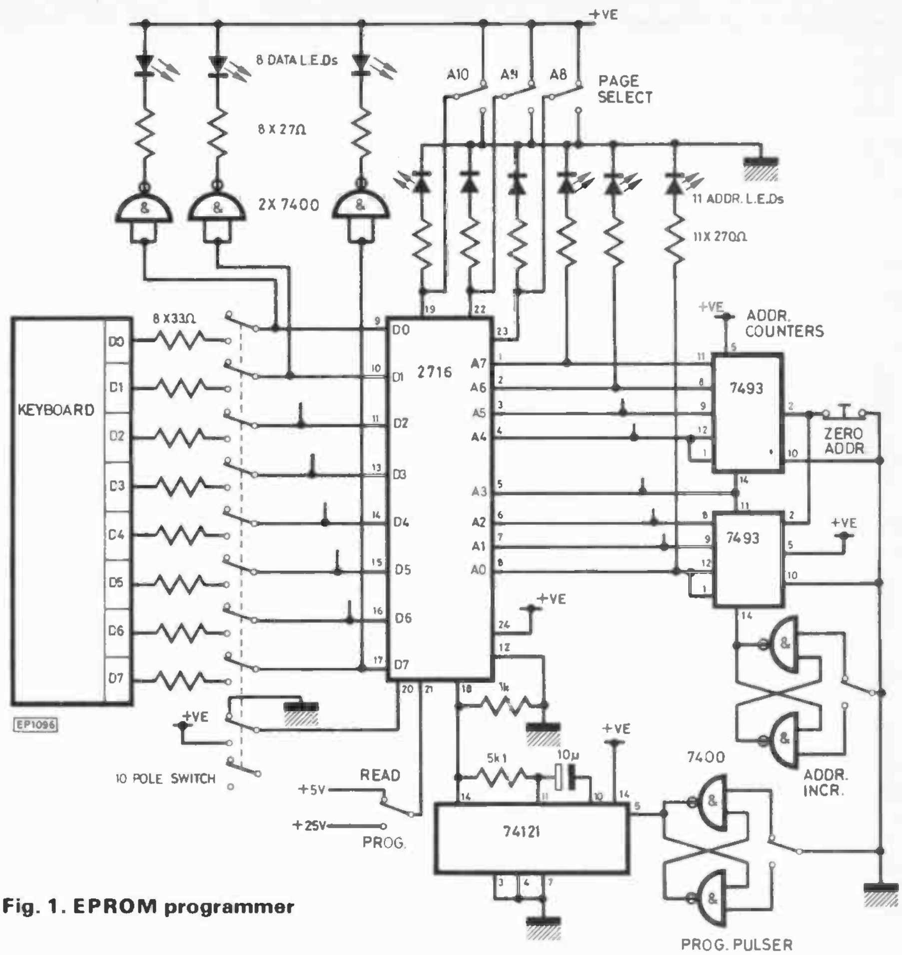

Fig. 1. EPROM programmer

EXMON DISASSEMBLER

The UK101 Extended Monitor contains an excellent disassembler, but it will only list a given number of lines at one time, depending on the contents of location $099D. It would be more convenient when a printed listing is desired, to be able to specify the start and end addresses of the program. This may be achieved by using the short program given here, which occupies locations $07DF to $07FF.

There are two spare letters available within Exmon, namely J and U. One of these may be used to call the routine, and the relevant locations (i.e. for J:$0974, 5) should be loaded with #$DF and #$07. It is then simply a matter of typing J (start), (end *+1) to use.*

L. J. Dolman,
Norwich.

PROGRAM LISTING

```
07DF   20110B   JSR   $0B11
07E2   85D5     STA   $D5
07E4   A5DB     LDA   $DB
07E6   85D6     STA   $D6
07E8   20260B   JSR   $0B26
07EB   A901     LDA   #$01
07ED   85D8     STA   $D8
07EF   A900     LDA   #$00
07F1   209E09   JSR   $099E
07F4   38       SEC
07F5   A5D5     LDA   $D5
07F7   E5DE     SBC   $DE
07F9   A5D6     LDA   $D6
07FB   E5DF     SBC   $DF
07FD   90F0     BCC   $07EF
07FF   60       RTS
:
PUT    #$DF     IN    $0974
PUT    #$07     IN    $0975
TO USE ENTER JXXXX, YYYY
```

BASIC TIDY-UP

Sir—After getting to grips with a UK101 computer I discovered two very annoying features about it. The first was the "Out Of Memory" error on the first immediate instruction after a warm start (caused by a stack error) and the second was the fact that the OK message was output to cassette when saving BASIC programs, thus causing a "Syntax" error on LOADing.

```
10 POKE 1,34 : POKE 2,2
20 POKE 4,38 : POKE 5,2
30 FOR T=546 TO 581
40 READ A : POKE T,A
50 NEXT
60 DATA 162, 252, 154, 76, 116, 162, 169, 13, 32, 105, 255
70 DATA 169, 10, 32, 105, 255, 162, 8, 189, 61, 2, 32, 45
80 DATA 191, 202, 208, 247, 96, 10, 13, 46, 89, 68, 65, 69, 82
```

I include a short BASIC program to load some machine code which will cure both these faults. An added bonus is that the OK message can be changed to anything one wants; I have made it output READY instead but anyone with machine code experience will be able to change this. The machine code resides at 0222 up to 0245 inclusive. The BASIC can be destroyed after the program is run. After a cold start the two vectors have to be reset for the new routine so one must type in the two lines of POKE (lines 10, 20) in immediate mode.

N. J. Young,
Bristol.

CEGMON ERROR MESSAGES

Sir—Since there does not seem to be much information about the UK101/Superboard in the mainline journals I would like to see Micro Prompt monthly.

Although the latest microcomputers have high resolution graphics, many of them do not have an auto-repeat keyboard, a hardware monitor and standard chips, like the UK101.

Here is a quick tip on how to obtain standard error messages with Cegmon.

```
50000 For X=576 TO 580: READ A :
      POKE X,A : NEXT: POKE
      538,64 : POKE 539,2
50010 DATA 41,127,76,155,255
```

M. P. Winter,
South Glamorgan.

PLEASE

Micro Prompt has been devised to provide an exchange point for ideas which apply to *any* P.E. computer project—*it does not have to be related to the UK101!* Any project which is either computerised (uses a microprocessor), or which is intended to be a computer peripheral, may be discussed here. Submitted material may be hints, suggestions, hardware modifications or software, although software should not be lengthy.

It should be emphasised that material presented in Micro Prompt has not necessarily been proved by us. Neither can compatibility with *all generations* of the computer equipment to which it relates be guaranteed.

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	1x015	22+22	0.68	
	1x016	25+25	0.60	
	1x017	30+30	0.50	
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13%	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	
80 VA	3x010	6+6	6.64	**£6.08**
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Regulation	3x013	15+15	2.66	TOTAL £8.91
12%	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	
120 VA	4x010	6+6	10.00	**£6.90**
90 × 40mm	4x011	9+9	6.66	+p/p £1.67
1.2Kg	4x012	12+12	5.00	+VAT £1.29
Regulation	4x013	15+15	4.00	TOTAL £9.86
11%	4x014	18+18	3.33	
	4x015	22+22	2.72	
	4x016	25+25	2.40	
	4x017	30+30	2.00	
	4x018	35+35	1.71	
	4x028	110	1.09	
	4x029	220	0.54	
	4x030	240	0.50	
160 VA	5x011	9+9	8.89	**£7.91**
110 × 40mm	5x012	12+12	6.66	+p/p £1.67
1.8Kg	5x013	15+15	5.33	+VAT £1.44
Regulation	5x014	18+18	4.44	TOTAL £11.02
8%	5x015	22+22	3.63	
	5x016	25+25	3.20	
	5x017	30+30	2.66	
	5x018	35+35	2.28	
	5x026	40+40	2.00	
	5x028	110	1.45	
	5x029	220	0.72	
	5x030	240	0.66	

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
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110 × 45mm	6x013	15+15	7.50	+p/p £2.00
2.2Kg	6x014	18+18	6.25	+VAT £1.68
Regulation	6x015	22+22	5.11	TOTAL £12.88
7%	6x016	25+25	4.50	
	6x017	30+30	3.75	
	6x018	35+35	3.21	
	6x026	40+40	2.81	
	6x025	45+45	2.50	
	6x033	50+50	2.25	
	6x028	110	2.04	
	6x029	220	1.02	
	6x030	240	0.93	
300 VA	7x013	15+15	10.00	**£10.17**
110 × 50mm	7x014	18+18	8.33	+p/p £2.00
2.6Kg	7x015	22+22	6.82	+VAT £1.83
Regulation	7x016	25+25	6.00	TOTAL £14.00
6%	7x017	30+30	5.00	
	7x018	35+35	4.28	
	7x026	40+40	3.75	
	7x025	45+45	3.33	
	7x033	50+50	3.00	
	7x028	110	2.72	
	7x029	220	1.36	
	7x030	240	1.25	
500 VA	8x016	25+25	10.00	**£13.53**
140 × 60mm	8x017	30+30	8.33	+p/p £2.35
4Kg	8x018	35+35	7.14	+VAT £2.38
Regulation	8x026	40+40	6.25	TOTAL £18.26
4%	8x025	45+45	5.55	
	8x033	50+50	5.00	
	8x042	55+55	4.54	
	8x028	110	4.54	
	8x029	220	2.27	
	8x030	240	2.08	
625 VA	9x017	30+30	10.41	**£16.13**
140 × 75mm	9x018	35+35	8.92	+p/p £2.50
5Kg	9x026	40+40	7.81	+VAT £2.79
Regulation	9x025	45+45	6.94	TOTAL £21.42
4%	9x033	50+50	6.25	
	9x042	55+55	5.68	
	9x028	110	5.68	
	9x029	220	2.84	
	9x030	240	2.60	

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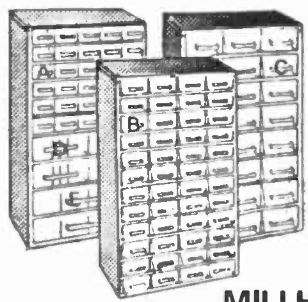

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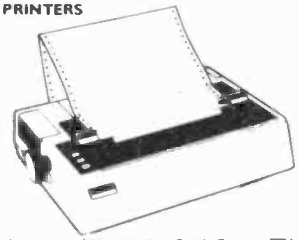

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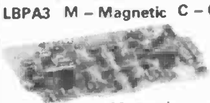

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TELEVISION

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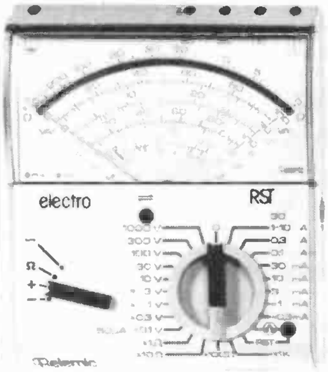

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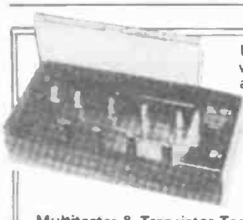

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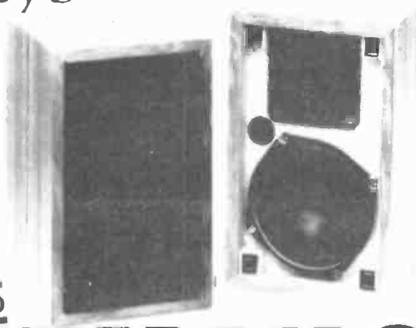

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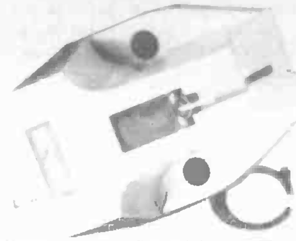

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CONNECTOR SYSTEMS

I.D. CONNECTORS
(Speedblock Type)

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10	90p	85p	200p
20	145p	125p	240p
26	175p	150p	300p
34	200p	160p	380p
40	220p	190p	550p
50	235p	200p	600p

D-CONNECTORS

	9 way	15 way	25 way	37 way
MALE				
Solder	95p	135p	160p	250p
Angled	160p	230p	265p	425p
FEMALE				
Solder	110p	160p	210p	350p
Angled	175p	240p	275p	500p
Hood	100p	100p	100p	130p

36 way Centronix Type Conn. £5.50
25 way 1EEE Type Conn. £5.50

DIL HEADER PLUGS
RS 232 Connectors Available from Stock

	Solder type	IDC type
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16 pin	50p	140p
24 pin	100p	200p
40 pin	200p	225p

RIBBON CABLE (Grey)

10 way	50p
14 way	60p
16 way	70p
20 way	80p
26 way	120p
34 way	180p
40 way	210p
50 way	330p
64 way	370p

JUMPER LEADS
24" Ribbon Cable with headers

	14 pin	16 pin	24 pin	40 pin
1 end	145p	165p	240p	380p
2 ends	210p	230p	345p	540p

24" Ribbon Cable with sockets

	20 pin	26 pin	34 pin	40 pin
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2 ends	290p	385p	490p	540p

24" Ribbon Cable with D Conn.
25 way Male 500p Female 550p.

EURO CONNECTORS
(Indirect Edge Conn.)

DIN STD	Plug	Skt
41617 21 way	180p	180p
41617 31 way	200p	200p
41612 2×32 way	290p	330p
Angled 2×32 way	325p	400p
41612 3×32 way	250p	400p
Angled 3×32 way	—	400p
2×32 way IDC a+c		525p

(for 2×32 way specify a+b or a+c)

EDGE CONNECTORS

	0.1"	0.156"
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2×22 way	200p	250p
2×23 way	200p	—
2×25 way	225p	300p
1×43 way	260p	—
2×43 way	395p	—
2×50 way	—	—
1×77 way	700p	—
S100 Conn	—	600p

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NEW FOR BBC

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EPSON MX80 F/T3 and EPSON MX100 F/T3

MX80 80 cps 80 cols. MX100 100 cps 136 cols. Logic seeking, Bi-directional, bit image printing, 9×9 matrix, Auto Underline. MX80 F/T3 **£320**. MX100 F/T3 **£430** (£8 carr./printer).

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7437	22p
7438	22p
7440	15p
7441	55p
7442A	30p
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7446A	50p
7447A	36p
7448	45p
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74157	30p
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74LS139	27p
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74LS148	75p
74LS151	40p
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74LS157	25p
74LS158	30p
74LS160A	36p
74LS161A	36p
74LS162A	36p
74LS163A	36p
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74LS165A	50p
74LS166A	60p
74LS168	85p
74LS169	85p
74LS170	70p
74LS173A	55p
74LS174	40p
74LS175	40p
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74LS190	36p
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74LS194A	35p
74LS195A	35p
74LS196	45p
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74LS240	55p
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74LS363	140p
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74LS365A	30p
74LS367A	30p
74LS368A	30p
74LS373	55p
74LS374	55p
74LS375	45p
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74LS378	70p
74LS390	45p
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74LS395	90p
74LS399	160p
74LS445	100p
74LS640	100p
74LS641	100p
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74S32	70p
74S37	60p
74S38	70p
74S51	70p
74S74	75p
74S85	450p
74S86	180p
74S112	90p
74S113	90p
74S114	90p
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74S132	110p
74S133	60p
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74C163	90p
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74C175	90p
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74C221	150p
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LM748	35p
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LM1872	300p
LM1886	700p
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LM3909	85p
LM3911	125p
LM3914	200p
LM3915	200p
LM3916	225p
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TA7204	150p
TA7205	90p
TA7222	150p
TA7310	150p
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TBA641BX1	300p
TBA800	80p
TBA810	100p
TBA820	80p
TBA920	200p
TBA950	225p
TC9109	750p
TCA210	350p
TCA220	350p
TCA940	175p
TDA1004A	300p
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18V 1A	7818	•40p	7915	45p
24V 1A	7824	•40p	7918	45p
5V 100mA	78L05	30p	7924	45p
12V 100mA	78L12	30p	79L05	65p
15V 100mA	78L15	30p	79L12	50p
			79L15	50p

OTHER REGULATORS

Type	Price	Type	Price
LM309K 1A 5V	135p	78HGKC	600p
LM317K	325p	78H05KC	550p
LM317T 1A Adj	200p	78MGT2C	140p
LM337T	225p	78GUIC	200p
LM323K 3A 5V	450p	79GUIC	225p
LM723 150mA Adj	37p	79HGKC	700p
TL494	400p	TL497	300p
78S40	300p	LM305H	250p

OPTO-ELECTRONICS

Type	Price	Type	Price	Type	Price
2N5777	45p	ORP12	120p	ORP61	120p
OCP71	180p	ORP60	120p	TIL78	55p

OPTO-ISOLATORS

Type	Price	Type	Price
ILD74	130p	TIL 111	70p
MCT26	100p	TIL 112	70p
MCS2400	190p	TIL 113	70p
ILQ74	240p	TIL 116	70p

LEDS

0.125"		0.2"	
TIL32	55p	TIL220 Red	10p
TIL209 Red	10p	TIL222 Gr	12p
TIL211 Gr	12p	TIL228 Yel	15p
TIL212 Ye	15p	Rectangular LEDs (R, G, Y)	30p
TIL216 Red	18p	NSB5881	670p

DISPLAYS

Type	Price	Type	Price
		TIL311	600p
		TIL312/3	110p
DL704	140p	TIL321/2	130p
DL707 Red	140p	TIL330	140p
FND357	120p	7750/60	200p
FND500	90p		
FND507	90p		
MAN3640	175p		
MAN4640	200p		

DRIVERS

Type	Price
9368	250p
9370	300p
UDN6118	320p
UDN6184	320p

TRANSISTORS

Type	Price
AD161/2	40p
BC107/8	14p
BC108B	15p
BC109C	16p
BC169C	10p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	10p
BC187	30p
BC212/3	10p
BC214	12p
BC237	10p
BC327	16p
BC337	10p
BC338	15p
BC461	30p
BC477/8	30p
BC516/7	36p
BC547B	12p
BC548C	12p
BC549C	12p
BC557B	14p
BC559C	16p
BCY70	20p
BCY71/2	20p
BD131	60p
BD132	40p
BD135	40p
BD136	35p
BD139	40p
BD140	40p
BD189	60p
BD242A	60p
BD379	40p
BD380	40p
BF244B	25p
BF256B	50p
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MPSA13	50p
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MPSA43	50p
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MPSA70	50p
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MPSU45	90p
MPSU65	78p
TIP29A/8	35p
TIP29C	40p
TIP31C	50p
TIP32A	40p
TIP32B	45p
TIP32C	50p
TIP33A	60p
TIP33B	65p
TIP33C	70p
TIP34A	65p
TIP34B	70p
TIP34C	80p
TIP35A	120p
TIP35B	140p
TIP35C	150p
TIP36A	140p
TIP36B	150p
TIP36C	160p
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8156	350p
8205	225p
8212	110p
8216	100p
8224	110p
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8251	250p
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8259	£4
8279	440p
8284	350p
8288	100p
8755A	£15
Z80PIO	250p
Z80APIO	280p
Z80CTC	250p
Z80ACTC	250p
Z80ADART	£7
Z80ADMA	£10
Z80SIO-0/1/2	£9

CRT CONTROLLER

Type	Price
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CRT5027	£18
CRT5037	£18

Type	Price
EF9365	£48
EF9366	£48
MC6845	650p
MC6847	650p
SFF96364	£8
TMS9918	£60
TMS9927	£18
TMS9929	£20

ZIF SKTS (TEXTOOL)

Type	Price
24 pin	£6
28 pin	£8
40 pin	£10

MEMORIES

Type	Price
2101A	400p
2102-3L	120p
21078	500p
2111A	300p
2112-A	300p
2114-2L	100p
2147	450p
4027-3	300p
4116-15	120p
4116-20	100p
4118-3	500p
4118-4	450p
4164-2	500p
4164-15(TI)	£4
4816AP-3	280p
5101	210p
5516	850p
6116P-3	420p
6116LP-3	550p
6514	250p
6810	120p
7489	180p
74S189	150p
74S201	350p
74S289	150p
93415	600p
93425	600p

ROMs/PROMs

Type	Price
74S188	150p
74S225	550p
74S287	225p
74S288	150p
74S387	225p
74S471	650p
74S473	650p
74S474	400p
74S570	650p
74S571	650p
74S573	900p

EPROMs

Type	Price
2516 (+5V)	250p
2532	375p
2564	£12
2708	250p
2716 (+5V)	250p
2732	450p
2716 (350ns)	500p
2732 (300ns)	750p
TMS2716	750p

UARTs

Type	Price
AY-3-1015P	300p
AY-5-1013P	300p
COM8017	300p
IM6402	450p
TR1602	300p

INTERFACE ICs

Type	Price
AD558CJ	775p
AD561J	£20
AD7581	1150p
AM25S10	350p
AM25LS2521	£2
AM26LS31	125p
AM26LS32	125p
DAC80	£28
DM8131	275p
DP8304	250p
DS8830	140p
DS8831	140p
DS8832	250p
DS8833	225p
DS8836	150p
DS8838	225p
LF13201	450p
MC1488	55p
MC1489	55p
MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
MC4024	325p
MC4044	325p
MC14411	675p
MC14412	750p
ULN2003A	75p
75107	90p
75108/9	90p
75110/12	90p
75114/15	160p
75121/22	140p
75150P	120p
75154	140p
75182	90p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75453/4	72p
75491/2	65p
8T26	120p
8T28	120p
8T95/96	90p
8T97/98	90p
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81LS96	80p
81LS97	80p
81LS98	80p
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9637AP	160p
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ZN426E-8	350p
ZN427E-8	650p
ZN428E-8	500p

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Type	Price
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FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
WD1691	£15
WD2143	550p
8271	£36

CHARACTER GENERATORS

Type	Price
RO-3-2513UC	750p
RO-3-2513LC	700p
SN74S262AN	£10
MC66760	750p

CRYSTALS

Frequency	Price
32·768KHz	100p
100KHz	250p
200KHz	280p
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1·008MHz	275p
1·5MHz	450p
1·8432MHz	210p
2·00MHz	225p
2·45760MHz	210p
2·5MHz	250p
2·662MHz	250p
3·276MHz	150p
3·5795MHz	100p
3·686MHz	300p
4·00MHz	150p
4·194MHz	200p
4·43MHz	110p
4·608MHz	250p
4·9152MHz	250p
5·00MHz	175p
6·00MHz	150p
6·144MHz	150p
7·00MHz	150p
7·168MHz	175p
8·00MHz	175p
8·86MHz	175p
10·00MHz	175p
10·50MHz	250p
10·70Hz	150p
12.00MHz	150p
14·318M	175p
14·756MHz	250p
15·00MHz	200p
16·00MHz	200p
17.7MHz	200p
18.00MHz	200p
18.432MHz	150p
19·968MHz	150p
20·000MHz	200p
26·690MHz	150p
27·145MHz	200p
38·6667MHz	175p
48·0MHz	175p
55·5MHz	400p
116MHz	300p
145.80MHz	250p

KEYBOARD ENCODER

Type	Price
AY-5-2376	700p
74C922	420p
74C923	500p

MODULATORS

Type	Price
6MHz UHF	375p
8MHz UHF	450p

BAUD RATE GENERATOR

Type	Price
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COM8116	700p
4702B	750p

TELETEXT DECODER ICs

Type	Price
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SAA5030	£9
SAA5041	£16
SAA5050	£9

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Type	Price
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MCM66760	700p

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14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

DIODES

Type	Price
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OA47	9p
OA90/91	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	5p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

BRIDGE RECTIFIERS

Type	Price
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1A 100V	20p
1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
6A 50V	80p
6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p
40290	260p
40361/2	75p
40408	90p
40409	100p
40410	100p
40411	300p
40594	120p
40595	120p
40673	75p
40871/2	100p

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Type	Price
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1W	15p

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Type	Price
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6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
12A 500V	105p
16A 400V	110p
16A 500V	130p
T2800D	130p

THYRISTORS

Type	Price
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1A 400V	90p
3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	180p
16A 400V	180p
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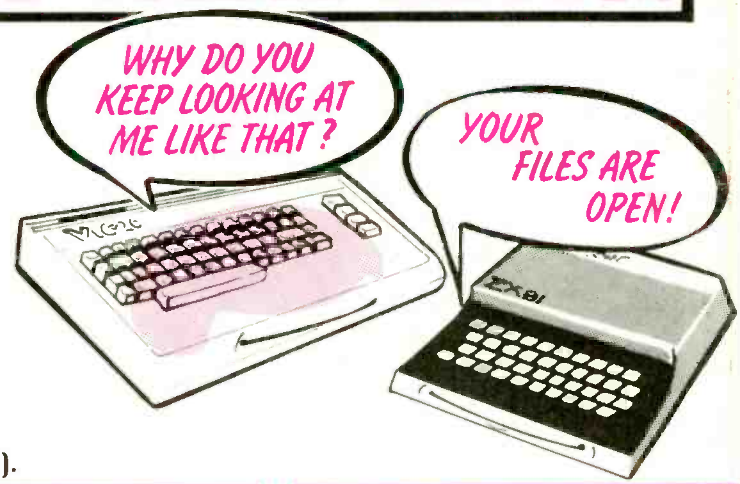
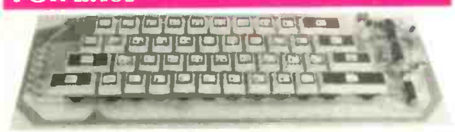


KEYBOARD WITH ELECTRONICS FOR ZX81



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