Australia $1.25 Malaysia $4.95 IR £1.26 (inc. VAT)

PRACTICAL ELECTRONICS

MARCH 1983

85p

Free SCRATCH PAD

CIRCUIT LAYOUT SIMPLIFIED

4½ Digit Frequency Meter

extra! INGENUITY UNLIMITED

Get moving with these new developments in UK Robotics

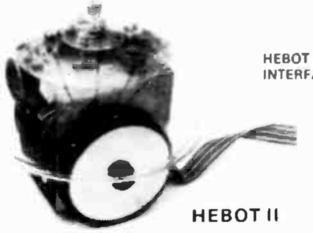
— advanced electrohydraulic designs for education, industry and now available to the home constructor.

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 II

HEBOT KIT £85.00
INTERFACE BOARD KIT £10.00

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

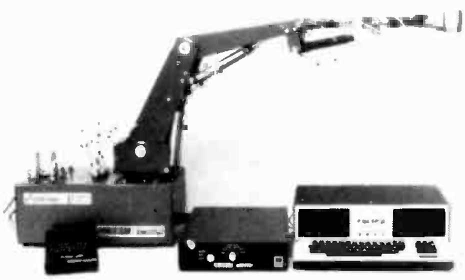
4 axis system in kit form	£681.50
5 axis system in kit form	£737.50
5 axis system Ready Built	£1450

Genesis P101

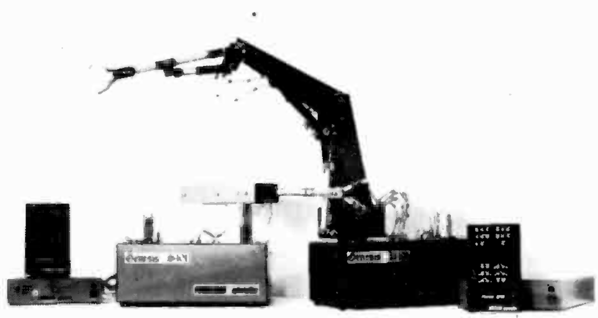
6 axis system in kit form	£945.00
6 axis system Ready Built	£1650

All prices exclusive of VAT

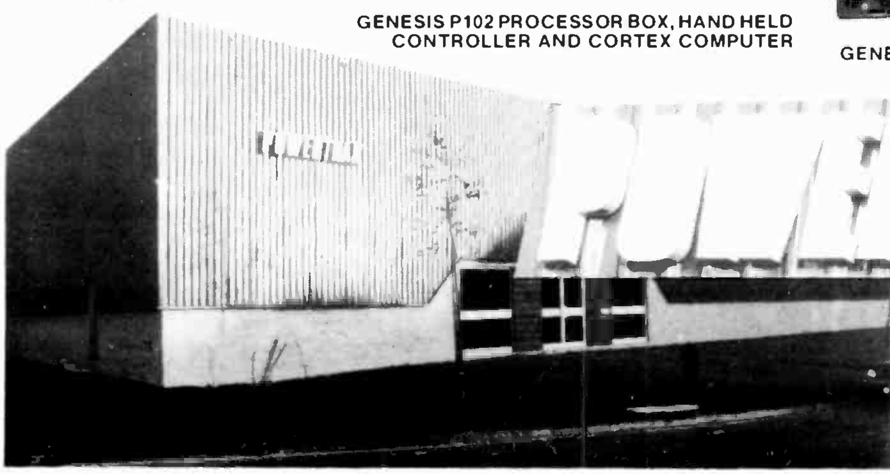
With prices starting below £1,000 the Genesis range of general purpose robots provide a first rate introduction to robotics for both education and industry. Each has a self-contained hydraulic power source, which enables loads of several pounds to be smoothly handled. The system operated from a single 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

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

PRACTICAL
ELECTRONICS

VOLUME 19 No. 3 MARCH 1983

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

SPECIAL SUPPLEMENT

OUR APRIL ISSUE WILL BE ON SALE FRIDAY, MARCH 11th, 1983
(for details of contents see page 5/6 of Micro-file)

WATFORD ELECTRONICS

33, CARDIFF ROAD, WATFORD, HERTS WD1 8ED, ENGLAND
Tel. Watford (0923) 40588. Telex: 8956095 WAELEC

ALL DEVICES BRAND NEW. FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.O.s OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS OFFICIAL ORDERS ACCEPTED (ACCESS ORDERS BY TEL. PHONE 0923 50234). TRADE AND EXPORT INQUIRY WELCOME. P & P ADD 50p TO ALL CASH ORDERS. OVERSEAS POSTAGE AT COST.

VAT Export orders no VAT. U.K. customers please add 15% VAT to total cost incl. p&p. We stock thousands more items. It pays to visit us. We are situated behind Watford Football Ground. Open Monday to Saturday, 9.00 am to 6.00 pm. Ample FREE Car parking

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 CAPACITORS: **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**.

SILVER MICA (pF)
2, 3·3, 4·7, 6·8, 8·2, 10, 1[illegible] 18, 22, 27, 33, 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**; 2µ2 **50p**.

POTENTIOMETERS: Carbon Track, 0·25W Log & Linear Values.
500Ω, 1K & 2K (LIN ONLY) Single **30p**
5KΩ-2MΩ single gang **30p**
5KΩ-2MΩ single gang D/P switch **78p**
5KΩ-2MΩ dual gang stereo **88p**

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm track
5KΩ-500KΩ Single gang **70p**
10KΩ-500KΩ Dual gang **110p**

PRESET POTENTIOMETERS
0·1W 50Ω-2·2M Mini Vert. & Horiz. **7p**
0·25W 100Ω-3·3MΩ Horiz. larger **10p**
0·25W 250Ω-4·7MΩ Vert. **10p**

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

	RANGE	Val.	1-99	100+
0·25W	2Ω2-4·M7	E24	2p	1p
0·5W	2Ω2-4·M7	E12	2p	1p
1W	2Ω2-10M	E12	6p	4p
2% Metal Film	10Ω-1M		6p	4p
1% Metal Film	51Ω-1M		8p	6p

CERAMIC Capacitors: 50V
Range 1pF to 6800pF **4p**; 10nF, 15n, 33n, 47nF **5p**; 100nf/30V **6p**.

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
AC127/8	35
AC141/2	30
AC176	28
AC187/8	32
ACY17/18	70
ACY19/20	75
ACY21/22	75
AD142	120
AD149	79
AD161/2	42
AF118	95
AF139	40
AF239	55
BC107/8	10
BC107B	12
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC117/8	20
BC140/42	30
BC147/8	9
BC147B	10
BC148C	10
BC149	9
BC149C	12
BC153/4	27
BC157/8	10
BC159	11
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171/2	11
BC173	11
BC177/8	16
BC179/81	20
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	26
BC212/3	10
BC212L	10
BC213L	10
BC214	10
BC214L	10
BC237/8	14

BC307B	14
BC308B	16
BC327/8	15
BC337/8	15
BC441	34
BC461	34
BC477/8	40
BC516/7	40
BC547/8	12
BC549C	14
BC556/7	15
BC558/9	15
BCY70	16
BCY71/2	20
BD124	115
BD131/2	48
BD133	60
BD135	45
BD136/7	40
BD138/9	40
BD140	40
BD245	45
BD378	70
BD434	55
BD695A	125
BD696A	125
BDY56	180
BDY60	160
BF167	29
BF177	25
BF178	30
BF179	35
BF180	38
BF194/5	12
BF196/7	12
BF198/9	18
BF200	30
BF224	25
BF244A	28
BF244B	29
BF256B	35
BF257/8	32
BF259	35
BF274	42
BF336	40
BF451	35
BF594/5	30
BFR39/40	23
BFR41/79	23
BFR80/81	25
BFR98	105
BFX29/84	28

BFX85/86	28
BFX87/88	28
BFY50/51	23
BFY52	23
BFY56	32
BFY64	35
BFY81	120
BFY90	80
BRY39	40
BSX20	20
BSX29	34
BSY95A	25
BU105	170
BU205	190
BU206	200
BU208	200
MDB001	250
MJ2955	70
MJE340	54
MJE370	100
MJE371	100
MJE520	95
MJE2955	99
MJE3055	70
MPF102	40
MPF103/4	30
MPF105	30
MPF106	40
MPSA05	25
MPSA06	25
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	30
MPSU02	58
MPSU05	55
MPSU06	55
MPSU52	65
MPSU55	60
MPSU56	60
OC23	170
OC28/36	220
OC41/42	75
OC44	75
OC70	40
OC71/72	40
OC76	50
OC81/82	50
OC83/84	40
OC170/1	50
OC200/2	50
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38

TIP31C	37
TIP32A	38
TIP32C	42
TIP33A	65
TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	110
TIP35C	128
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121	73
TIP141	105
TIP142	105
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44	45
TIS88A	50
TIS90	30
TIS91/93	32
VK1010	80
VN10KM	55
VN46AF	78
VN66AF	80
VN88AF	94
VN89AF	96
ZTX107/8	11
ZTX109	12
ZTX212	28
ZTX300	13
ZTX301/2	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX320/26	30
ZTX451	23
ZTX341	30
ZTX500/1	14
ZTX502/3	18
ZTX504	25
ZTX531	25
ZTX550	25
2N696	30
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N914/5	32

2N918	35
2N930	20
2N1131/2	24
2N1303/4/5	
2N1307/8	65
2N1613	30
2N1671B	160
2N2160	295
2N2219A/20A/	
21A/22A	25
2N2369A	16
2N2646	45
2N2846	80
2N2904A/05A	21
06A/07A	26
2N2926G	10
2N3053	26
2N3054	58
2N3055	48
2N3442	140
2N3614	199
2N3615	199
2N3702/3	10
2N3704/5	10
2N3706/7	10
2N3708/9	10
2N3710	10
2N3771	179
2N3772	195
2N3773	210
2N3819	25
2N3820	38
2N3822/3	45
2N3866	90
2N3903/4	15
2N3906/5	15
2N4037	46
2N4069	45
2N4427	80
2N4859	78
2N4871	55
2N5135/6	20
2N5172	18
2N5179	45
2N5180	45
2N5191	75
2N5194	80
2N5305	24
2N5457	30
2N5458/9	30
2N5485	36
2N5777	45
2N6027	32
2N6109	60
2N6290	70
2SA636	250

2SA671	250
2SA715	60
2SC495/6	70
2SC1061	250
2SC1096	85
2SC1162	30
2SC1172	125
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1679	190
2SC1678	140
2SC1923	50
2SC1945	225
2SC1953	90
2SC1957	90
2SC1969	140
2SC2028	85
2SC2029	210
2SC2078	170
2SC2091	85
2SC2166	165
2SC2314	85
2SC2465	125
2SC2547	30
2SD234	75
2SK45	90
2SK288	225
2SJ83	225
2SJ85	225
3N128	112
3N140	112
40097	120
40100	215
40101	130
40250	95
40251	150
40311	60
40313	130
40315	90
40316	95
40317/20	80
40360	60
40361/62	70
40406/7	75
40408	75
40411	285
40412	90
40467	130
40468	85
40594	105
40595	110
40603	110
40673	70
40871/2	90

LINEAR IC's

555CMOS	80
702	75
709C 8 pin	35
710	48
741	14
747C 14 pin	65
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	350
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	675
AY-3-8910	375
AY-3-8912	450
AY-5-1230	450
AY-5-1317A	630
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	365
CA3046	70
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3086	48
CA3089E	200
CA3090AQ	375
CA3123	165
CA3130	90
CA3140	40
CA3160	95
CA3161E	160
CA3162E	450
CA3189	200
CA3240	110
HA1366	175
HA1388	255
ICL7106	690
ICL7107	975
ICL7611	99
ICL7660	248
ICL8038CC	300
ICL8211	350
ICM7204	550
ICM7205	1150
ICM7207	475
ICM7215	1050
ICM7216A	£22
ICM7216B	£22
ICM7216C	£22
ICM7217A	750
ICM7224	785
ICM7240	300
ICM7555	80
ICM7556	150
LA3350	220
LA4031P	240
LA4032	295
LA4400	295
LA4422	275
LC7120	350
LC7130	340
LC7137	395
LF347	150
LF351	48
LF353	95
LF355	85
LF356	95
LF357	110
LF398	475
LM10	325
LM301A	24
LM307	45
LM308	95

LM311	70
LM318	150
LM319	215
LM324	30
LM334Z	90
LM335	128
LM339	47
LM348	64
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	160
LM386	90
LM387	120
LM389	95
LM392	60
LM393	100
LM394CH	290
LM725CN	325
LM733	70
LM2917	195
LM3302	75
LM3900	50
LM3909	85
LM3911	125
LM3914	200
LM3915	200
LM3916	250
LM13600	110
LS7220	280
M253AA	1150
M51513L	230
M51515L	320
M70681	125
MB3712	220
MB3756	440
MC1303	98
MC1304P	260
MC1310P	150
MC1445	250
MC1455	65
MC1458	35
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	90
MC3340P	120
MC3360P	120
MC3401	65
MC3403	75
MC3405	150
MC3423P	80
MF10	350
MFC6040	75
MK5039B	635
ML924	275
MSM5526	820
NE515	275
NE529	225
NE531	140
NE543	225
NE544	210
NE555	16
NE556DB	45
NE558	140
NE560	325
NE561	395
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567	140
NE570	410
NE571	400
NE5532	145
NE5534	105
OM335	750
RC4136D	60
RC4558	45
S566B	225
SAB3209	425

SAB3210	325
SAB3271	485
SAB4209	595
SG3402	295
SL490	350
SN76003N	350
SN76013N	350
SN76023N	350
SN76033	350
SN76227N	95
SN76477	420
SN76488	480
SN76660	120
SP8629	299
TA7120	125
TA7130	125
TA7204	195
TA7205	175
TA7222	150
TAA661A	190
TAA700	275
TAA900	395
TAD100	159
TBA120S	70
TBA540	275
TBA550O	330
TBA641-A12/BX1	290
TBA651	190
TBA800	80
TBA810S	95
TBA820	80
TBA9200	200
TBA990	350
TCA270	350
TCA280A	220
TCA940	175
TCA965	145
TDA1004	290
TDA1008	310
TDA1010	198
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	350
TDA2002	325
TDA2003	198
TDA2004	495
TDA2006	330
TDA2020	320
TDA2030	295
TDB0791	420
TL061CP	40
TL062CP	60
TL064CN	98
TL071CP	24
TL072CP	45
TL074CN	100
TL081CP	24
TL082CP	45
TL083CP	75
TL084CP	90
TL091CP	55
TL170	50
TL430C	90
UA2240	120
UA78540	230
UAA170	180
UAA180	180
UAA1003-3	935
ULN2003	75
ULN2004	75
ULN2068	290
ULN2802	200
ULN2804	150
ULN2283	100
UPC575	165
UPC1025H	265
UPC1032	95
UPC1182	270
UPC1156H	225
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN419CE	180

ZN423E	130
ZN424E	130
ZN425E-8	345
ZN426E-8	300
ZN427E-8	590
ZN428E	410
ZN429E-8	210
ZN459	570
ZN1034E	200
ZN1040E	665
ZNA234E	850

COMPUTER IC's

1702	350
1802CP	650
2112-2	250
2114L-300n	90
2114L-200n	95
2147-3	425
2532	300
2564	£12
2708	225
2716-5V	225
2732	350
2764	650
3242	590
4027	190
4116-150	85
4116-200	80
4118-250	325
4164-200	425
4334-3 (CMOS 2114)	325
4532-3	350
4816-100ns	215
5101	220
6116-150ns	375
6116L-120ns	550
6117-100n	490
6167-6	795
6502 CPU	325
6503	600
6504-250	550
6520	100
6522 VIA	295
6530 RRIOT	£11
6532 RIOT	570
6545 CRTC	899
6551 ACIA	650
6592 PC	£20
68B54	780
6800	220
6802	250
6803	850
6804	160
6805	670
6808	520
6809	630
6810	115
6820	100
68821	220
6821	100
6840	375
6843	00
6845	650
6847	650
6850	110
6852	250
6854	599
6875	500
68000 New msk	£78
8080A	250
8085A	350
8088	£18
81LS95	80
81LS96	80
81LS97	80
81LS98	85
8118-10	225
8123	125
8155	350
8156	350
8202	£25
8205	225
8212	110
8214	425

8216	100
8224	110
8226	250
8228	220
8243	270
8250	850
8251A	250
8253	400
8255	225
8256A	£35
8257A	400
8259	395
8271	£32
8279	385
8284	350
8288	£10
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95N	90
8T97N	90
9364AP	550
9602	220
AM26LS31C	125
AM26LS32A	125
AM26LS33A	125
AY-3-1015	300
AY-5-1013	300
AY-5-1350	388
AY-5-2376	600
AY-5-3600	750
COM8017	275
COM8116	700
DM8131	275
DP83048N	250
DS3691N	320
DS8820	110
DS8830	110
DS8831	125
DS8832	250
DS88LS120N	275
E9365	£38
E9366	£35
FD1761	£15
FD1771	£15
FD1791	£22
FD1793	£23
FD1795	£28
FD1797	£28
HD26501	75
HMG167-6	795
IM6402	380
INS8060N	1050
INS8154N	£9
MC1488	55
MC1489	55
MC14411	675
MC14412	725
MC3446	250
MC3447P	315
MC3486	175
MC3487	175
MK3886-2M	£7
MM5280D	695
MM5303	635
MM5307	1275
MM5387A	475
MM58174	700
RO-3-2513L	650
RO-3-2513U	600
SFF96364E	800
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
Z80CPU2.5	299
Z80ACPU4M	300

Z80CTC	250
Z80ACTC	260
Z80B	£11
Z80DART	495
Z80ADART	550
Z80ADMA	895
Z80DMA	675
Z80P10	260
Z80AP10	275
Z80S10-1	850
Z80AS10	980

74S Series

74S00	24
74S02	24
74S04	30
74S05	60
74S08	60
74S10	40
74S11	50
74S20	40
74S22	50
74S30	40
74S32	70
74S37	60
74S74	75
74S85	295
74S86	70
74S112	90
74S113	90
74S114	90
74S124	300
74S132	110
74S133	60
74S138	115
74S139	115
74S140	60
74S151	180
74S153	182
74S157	250
74S158	195
74S163	300
74S174	250
74S175	320
74S188	140
74S189	140
74S194	320
74S195	480
74S197	400
74S201	350
74S225	500
74S240	300
74S241	300
74S244	290
74S251	250
74S257	250
74S258	250
74S260	70
74S262	850
74S287	225
74S288	150
74S289	290
74S299	540
74S301	000
74S365	000
74S373	400
74S374	365
74S470	325
74S471	620
74S472	1150
74S474	400
74S475	800
74S571	620
74S573	950

75 Series

75107/B	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
7401	11
7402	11
7403	12
7404	13
74L04	85
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	20
7416	20
7417	20
7420	15
7421	20
7422	20
7423	20
7425	18
7426	18
7427	18
7428	25
7430	14
7432	20
7433	22
7437	25
7438	22
7440	15
7441	55
7442	32
7443	90
7444	90
7445	56
7446	60
7447	35
7448	40
7450	16
7451	16
7453	16
7454	16
7460	16
7470	30
7472	24
7473	24
7474	20
7475	25
7476	25
7480	40
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	170
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	35
7497	90
74100	80
74104	50
74105	55
74107	20
74109	25
74110	35
74111	55
74112	170
74116	50
74118	55
74119	60
74120	60
74121	25
74122	35
74123	35
74125	35
74126	35
74128	35
74132	28
74136	28

74141	55
74142	175
74143	210
74144	210
74145	50
74147	75
74148	60
74150	50
74151	40
74153	40
74154	55
74155	40
74156	40
74157	30
74159	80
74160	60
74161	48
74162	40
74163	40
74164	40
74165	48
74166	48
74167	150
74170	125
74172	250
74173	60
74174	54
74175	19
74176	40
74177	45
74178	80
74179	80
74180	40
74181	115
74182	60
74184	90
74185	95
74186	470
74188	250
74190	48
74191	46
74192	46
74193	45
74194	40
74195	40
74196	46
74197	40
74198	80
74199	84
74221	54
74246	120
74247	120
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

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

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	13
LS08	12
LS09	12
LS10	13
LS11	13
LS12	12
LS13	20
LS14	26
LS15	13
LS20	13
LS21	12
LS22	12
LS26	14
LS27	12
LS28	14
LS30	12
LS32	13
LS33	14
LS37	14
LS38	15
LS40	13
LS42	28
LS47	35
LS48	45
LS49	50
LS51	14
LS54	14
LS55	14
LS63	120
LS73	18
LS74	18
LS75	20
LS76	18
LS78	18
LS83	36
LS85	42
LS86	16
LS90	24
LS91	60
LS92	32
LS93	23
LS95	40
LS96	95
LS107	40
LS109	23
LS112	22
LS113	16
LS114	22
LS122	36
LS123	38
LS124	90
LS125	24
LS126	25
LS132	35
LS133	30
LS136	24
LS138	25
LS139	28
LS145	70
LS147	100
LS148	70
LS151	40
LS153	40
LS154	80
LS155	30
LS156	36
LS157	27
LS158	30
LS160	32
LS161	37
LS162	37
LS163	37
LS164	43
LS165	50
LS166	52
LS168	85
LS170	70
LS173	55
LS174	50
LS175	40
LS181	90
LS183	180
LS190	36

LS191	36
LS192	36
LS193	37
LS194	33
LS195	33
LS196	45
LS197	45
LS221	55
LS240	55
LS241	55
LS242	55
LS243	55
LS244	55
LS245	70
LS247	50
LS248	55
LS249	55
LS251	32
LS253	32
LS257	30
LS258	35
LS259	55
LS260	22
LS261	100
LS266	18
LS273	54
LS275	125
LS279	30
LS280	90
LS283	40
LS290	53
LS293	40
LS295	75
LS298	80
LS299	150
LS320	200
LS323	160
LS324	168
LS325	295
LS326	240
LS327	240
LS347	95
LS348	90
LS352	62
LS353	62
LS362	750
LS363	140
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	650

CMOS

4000	10
4001	10
4002	12
4006	50
4007	14
4008	32
4009	24
4010	24
4011	10
4012	16
4013	20

4014	46
4015	40
4016	20
4017	32
4018	45
4019	25
4020	42
4021	40
4022	40
4023	13
4024	32
4025	13
4026	80
4027	20
4028	39
4029	45
4030	15
4031	125
4032	80
4033	125
4034	140
4035	45
4036	275
4037	115
4038	110
4039	290
4040	40
4041	40
4042	40
4043	40
4044	40
4045	105
4046	46
4047	40
4048	40
4049	25
4050	25
4051	45
4052	60
4053	50
4054	85
4055	85
4056	85
4057	1915
4059	435
4060	45
4061	1195
4062	995
4063	85
4066	24
4067	245
4068	14
4069	13
4070	13
4071	13
4072	13
4073	15
4075	13
4076	50
4077	13
4078	16
4081	13
4082	13
4085	50
4086	60
4089	125
4093	20
4094	70
4095	95
4096	70
4097	190
4098	75
4099	75
4160	95
4161	99
4162	99
4163	99
4174	99
4175	105
4194	105
4408	790
4409	790
4410	725
4411	690
4412	790
4415	480
4419	280
4422	770
4433	770
4435	850

4440	999
4450	350
4451	350
4490	350
4500	675
4501	28
4502	60
4503	35
4504	75
4505	185
4506	35
4507	35
4508	130
4510	46
4511	46
4512	42
4513	199
4514	125
4515	125
4516	65
4517	275
4518	40
4519	30
4520	70
4521	130
4522	125
4526	60
4527	50
4528	50
4529	150
4530	90
4531	130
4532	50
4534	455
4536	275
4538	70
4539	90
4541	140
4543	70
4544	150
4548	40
4549	375
4553	245
4554	190
4555	35
4556	35
4557	320
4558	120
4559	395
4560	160
4561	104
4562	495
4566	165
4568	250
4569	175
4572	36
4580	460
4581	250
4582	99
4583	99
4584	48
4585	99
4597	330
4599	290
40097	45
40098	42
40100	215
40101	130
40102	140
40103	175
40104	95
40105	115
40106	75
40107	60
40108	450
40109	100
40110	300
40114	240
40163	50
40174	45
40175	50
40192	95
40193	95
40194	90
40195	80
40244	195
40245	195
40373	240
40374	245
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
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

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

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	55
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	59
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	54
TIL38 45 TIL81 82	
TIL100	90

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

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

ALUM. BOXES

4x2¼x2"	85
4x2¼x2¾"	103
4x4x2½"	120
5x4x2	105
5x2½x1½"	90
5x2½x2½"	130
5x4x1½"	99
5x4x2½"	120
6x4x2"	120
6x4x3"	150
7x5x3"	180
8x6x3"	210
10x4½x3"	240
10x7x3"	275
12x5x3"	260
12x8x3"	295

COPPER CLAD BOARDS

	Fibre Glass Single-sided	Double-sided	SRBP 9.5"x8.5"
6"x6"	90p	110p	95p
6"x12"	150p	195p	

VEROBOARDS 0.1"

	Clad	Plain
2½x3¾"	80p	—
2½x5"	91p	—
3¾x3¾"	91p	—
3¾x5"	105p	87p
3¾x17"	360p	232p
4¾x18"	470p	—
Pkt. of 100 pins	50p	
Spot Face Cutter	135p	
Pin Insertion Tool	178p	

'VO' 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
78H05 5V/5A	550	LM317K	320
78H12 12V/5A	580	LM317P	99
78HG+5 to +24V 5A	599	LM323K	500
		LM337T	175
79HG −2.25V to −24V 5A	685	LM723	35
		T8A625B	75

SWITCHES

SLIDE 250V

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

TOGGLE 2A 250V

SPST	33
DPDT	44
4 pole on off	54

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

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

OIL 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	12p	22p
16	25p	40p
20	25p	40p
26	35p	52p
34	48p	60p
40	55p	70p
60	75p	115p

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 PLUG with latch Strt. Pins	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	236p	169p	340p
40 way	220p	250p	190p	420p
50 way	235p	270p	200p	470p

EURO CONNECTORS

	FEMALE SOCKETS Strt.	Angle	MALE PLUGS Strt.	Angle
DIN 41617 31 way	170p	—	—	175p
DIN 41612 2x32 way	275p	320p	220p	285p
DIN 41612 2-3x32 way	295p	340p	240p	300p
DIN 41612 3x32 way	360p	385p	260p	395p

'D' CONNECTORS:

Pins	9 way	15 way	25 way	37 way
MALE				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	355p
Strait	170p	160p	220p	310p
FEMALE				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p
COVERS	90p	80p	80p	90p

IOC 25 way Plg. 385p, Skt. 450p

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: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-2A; 2x30V-0.8A 465p (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x30V-1.5A; 2x40V-1.25A; 2x50V-1A 920p (60p p&p)

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

EDGE CONNECTORS

	1"	.156"
2x10 way	—	135p
2x15 way	—	140p
2x18 way	180p	145p
2x22 way	199p	200p
2x23 way	170p	190p
2x25 way	225p	220p
2x28 way	185p	—
2x30 way	245p	—
2x36 way	295p	—
2x40 way	315p	—
2x43 way	395p	—
2x75 way	550p	—

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

COMPUTER CORNER

- **SEIKOSHA GP100A** – Unihammer Printer, normal & double width characters, dot resolution graphics 10" Tractor feed, parallel interface standard. FREE 500 Sheets £175
- **SEIKOSHA GP 250X.** Printer £230
- **DRAGON** Microcomputer. £173
- **JUPITER ACE** Microcomputer £78
- **SOFTY–2.** The complete Microprocessor development system. New powerful instructions. Accepts any 24 pin 5V single rail EPROM. Supplied fully built & tested. £169
- **WEMON.** Watford's 4K Ultimate Monitor IC for Superboard & UK101. £10
- **VIDEO MONITORS.** Fully cased. Smoked anti-glare display filter. Bandwidth 12MHz. Res. 750 lines. I/P 75Ω or high. 240V/50Hz. 9" – B&W **£89;** Green **£95;** Amber **£98.** 12" – Green **£114;** Amber **£118.**
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- **C12 COMPUTER Grade BASF Cassettes** in Library Cases 40p
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- **Teleprinter Roll** (no VAT) £3.50

(P&P on some of the above items is extra)
Call in at our shop for demonstration of any of the above items. Be satisfied before you buy.

WE-ROM for Acorn ATOM
A highly sophisticated Acorn Atom Utility ROM. Plugs straight into floating point Atom's Utility socket. Gives many unique BASIC Extensions: Hi-speed tape Interface; 2 key rollover keyboard; full disassembler, Memory dump modify; Machine code breakpoints; BASIC error trapping; READ, DATA & RESTORE; Full BASIC keyboard scanner (BBC like); Find line & delete; Auto line numbering; Plus: Chain, Cursor movement, Loop aborting; Easily extendible further. Manual Supplied.
INTRODUCTORY OFFER: ONLY £9.95

★ PRINTERS ★
- **MX80FT/3** 10" Tractor and Friction Feed. 9x9 matrix, 80 column, 80 CPS, Bi-directional, Centronix Interf., BR110-9600 Hi-res, bit image graphics, subscript & superscript, Italics, Underlining plus **FREE** 500 Sheets paper. **£324** (carr. £7)
- **NEC PC-8023BE-C,** 100CPS bi-directional, logic seeking, 80 column, 7x9 Dot matrix, super/subscript, underlining, true decenders Tractor/Friction, Hi-Res, 2K Buffer, Proportional Spacing, at a Special Price. Plus **FREE** 500 sheets paper. **ONLY £320** (carr. £7)

ANTEX Soldering Irons

C15W	450
CX17W	475
CCN15W	490
X25W	500
Spare bits	65
Elements	210
Iron stands	165
Heat Shunt	30

Access
Just phone your order through, we do the rest. 0923-50234

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
2.5625OM	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	150
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 280p
8MHz Wideband 475p

BBC MICRO UPGRADE KITS
- BBC Microcomputer Model B **£399**
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- COLOUR MONITOR - MICROVITEC 1431. 14" RGB Input. For BBC. Lead included. **£249**
- Complete range of Connectors, Cables, Quality Software, Accessories, Books, etc. for BBC available. Send SAE for detail list.

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- TEAC FD-50E 5¼" 80 track S/S in cabinet with own PSU 200K (BBC compatible) **£250**
- TEAC FD-50E Two 5¼ S/S 80 track Drives, cased with PSU. 400K (BBC compatible) **£475**
- SIEMENS FDD100-5 Fully cased drive for APPLE (incl. Cable) **£235**
- APPLE II DOS Int. Card for above drive. Gold plated Edge connection **£42**
- DRIVE Connecting Cable. Single **£8;** Dble **£12.**
- 10 Verbatim 5¼" Diskettes S.D. **£20;** DD **£30**

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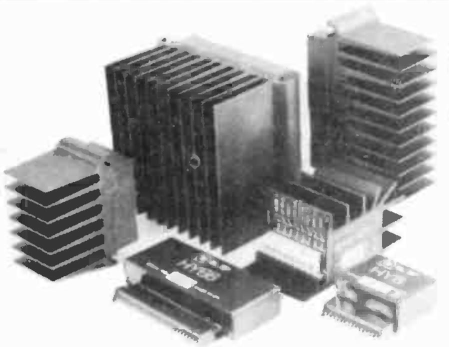
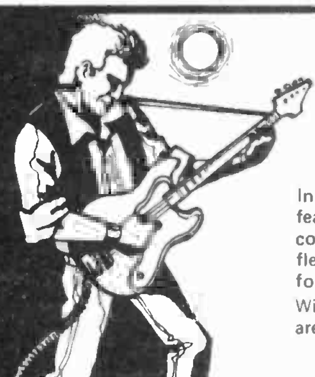
GET BIG POWER



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.



WE'RE INSTRUMENTAL IN MAKING A LOT OF POWER

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 Impedence Ω	DISTORTION T.H.D. Typ at 1KHz	DISTORTION 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 Impedence Ω	DISTORTION T.H.D. Typ at 1KHz	DISTORTION 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	420	£30.41
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	£46.[illegible]

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.

'NEW to ILP' In Car Entertainments

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 15KΩ 3V rms into 8Ω
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

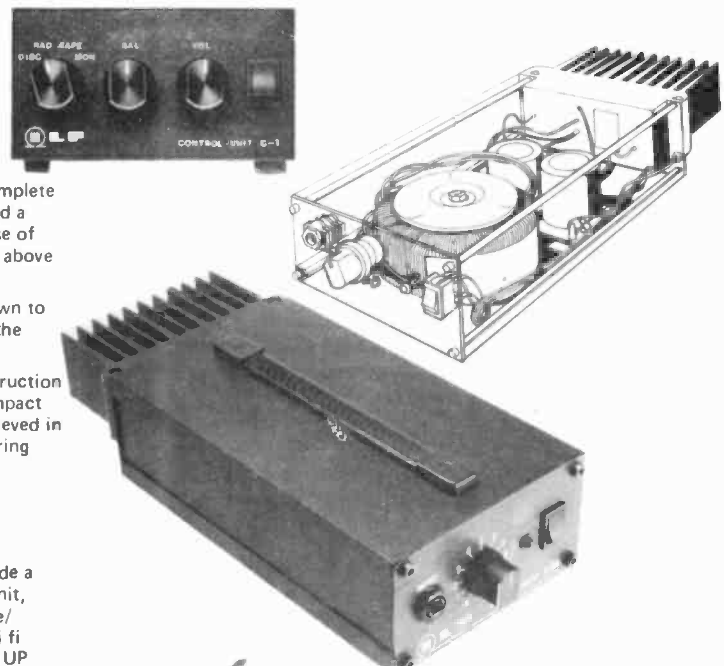
Model Number	For Use With	Price inc. VAT
PSU 52X	2 × HY124	£17.07
PSU 53X	2 × MOS128	£17.86
PSU 54X	1 × HY248	£17.86
PSU 55X	1 × MOS248	£19.52
PSU 71X	2 × HY244	£21.75

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.

WITH A LOT OF HELP FROM ILP ELECTRONICS LTD

PROFESSIONAL HI-FI THAT EVERY ENTHUSIAST CAN HANDLE...



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 'O' 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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Fill in the coupon as shown, or write details on a separate sheet of paper, quoting the name and date of this journal. By sending your order to our address as shown at the bottom of the page opposite, with FREEPOST clearly shown on the envelope, you need not stamp it. We pay postage for you. Cheques and money orders must be crossed and made payable to I.L.P. Electronics Ltd. if sending cash, It must be by registered post. To pay C.O.D. please add £1 to TOTAL value of order.

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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

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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
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SX66 5 x 22k Log	SX70 5 x 1 meg Lin

SX40 250 Silicon Diodes—Switching like IN4148 DO-35 All good—uncoded Worth double our price 45v 75mA £1.25

SX41 250 Silicon Diodes—General Purpose, like OA200/202 BAX13/16 Uncoded 30 100v 200mA DO-7 £1.25

SX44 10 5A SCR's T064 3 x 50v, 3 x 100v, 2 x 200v, 2 x 400v Super value less than ½ price £1

SX45 10 5A SCR's T066 2 x 50v, 2 x 100v, 4 x 200v, 2 x 400v All coded Brand new, a give away at £1

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

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Miniature snipe nose pliers with side cutter and serrated jaws — insulated handles 5inch length Order No:Y042.

ALL AT 1.25 each

All with insulated handles

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A flexible shaft screwdriver for those awkward to get at screws. Overall length 8½inch Order No FS-1 Flat blade 4mm FS-2 Cross point no 1 £1.75 each

GRIP-DRIVER

6inch long screwdriver with spring loaded grip on end to hold screws in position while reaching into those difficult places Order No SD-1 Flat blade 4mm SD 2 Cross point no 0 95p each

INEXPENSIVE TOOLS OF IMMENSE VALUE

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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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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

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ALUMINIUM BOXES

Made with Bright Aluminium folded construction with deep lid and screws

SIZE "L	W	H	Order No.	Price
5¼	2¼	1½	159	83p
4	2¼	1½	161	83p
4	2½	2	163	83p
3	2	1	164	67p
8	6	3	166	£1.66
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
4	2	1	141	£1.00
4¾	2½	1½	143	£1.30
6	3¼	2	144	£1.60
Plastic as above but with aluminium top panel				
4	2¾	1	146	£1.40
Plastic sloping front				
5½	4¼	2¼ slope to 1½	148	£2.14

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

IC SOCKETS

The lowest price ever.

The more you buy the cheaper they come!

Pin	10 off	50 off	100 off
8 pin	85p	£3.50	£6.00
14 pin	90p	£3.75	£6.50
16 pin	95p	£4.00	£7.00

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 SX574

Valued Normal Retail £12.00

Our Price **£5.00**

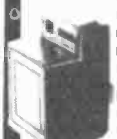
SEMICONDUCTORS FROM AROUND THE WORLD

100 A Collection of Transistors, Diodes, Rectifiers, Bridges, SCR's, Triacs, IC's both Logic and Linear plus Opto's all of which are current everyday usable devices

Guaranteed Value over £10 at Normal Retail Price

yours for only **£4·00** Data etc in every pak. Order No SX56

MW398 NI-CAD CHARGER



Universal Ni-Cad battery charger All plastic case with lift up lid Charge/Test switch LED indicators at each of the five charging points

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

POWER SUPPLY OUR PRICE £3.25

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

Glass Type similar IN4000 SERIES IN4001-IN4004 50 — 500v — uncoded — you select for VLTS ALL perfect devices — NO duds Min 50v 50 for £1.00 — worth double ORDER NO SX76

Silicon General Purpose NPN Transistors TO-18 Case Lock fit leads — coded CV7644 Similar to BC147 — BC107 — ZT89 ALL NEW! VCE 70v IC500mA Hfe 75-250

	50 off	100 off	500 off	1000 off
PRICE	£2.00	£3.80	£17.50	£30.00

Order as CV7644

Silicon General Purpose PNP Transistors TO-5 Case Lock fit leads coded CV9507 similar 2N2905A to BFX30 VC 60 IC 600mA Min Hfe 50 ALL NEW!

	50 off	100 off	500 off	1000 off
PRICE	£2.50	£4.00	£19.00	£35.00

Order as CV9507

Silicon NPN 'L' Type Transitors

TO-92 Plastic centre collector Like BC182L — 183L — 184L VCBO 45 VCEO 30 IC200mA Hfe 100-400

ALL perfect devices — uncoded ORDER AS SX183L

50 off	100 off	500 off	1000 off
£1.50	£2.50	£10.00	£17.00

PNP SILICON TRANSISTORS:

Similar ZTX500 — ZTX214 — E-Line VCEO 40 VCBO 35 Ic 300mA Hfe 50-400

Brand New — Uncoded — Pefect Devices

50 off	100 off	500 off	1000 off
£2.00	£3.50	£15.00	£25.00

Order as ZTXPNP

DIGITAL VOLT METER MODULE

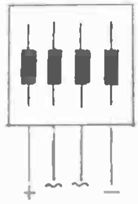
3 x 7 segment displays Basic Circuit 0-2V± instructions provided to extend voltage & current ranges. Operating voltage 9/12v. Typ. Power Consumption 50mA O/NO:SX99 Once only price **£9.95**

ELECTRONIC SIREN 12v DC

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 12 v DC

Our Price:- **£5.50**

SILICON BRIDGE RECTIFIERS



Comprising 4 × 1½ amp rectifiers mounted on PCB.

VRM — 150 vlts

IFM — 1.5 Amps

Size: 1 inch square

10 off **£1.00**

50 off **£4.50**

100 off **£7.50**

Order No. As:4RI BRect.

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

30,000 opv Including test leads and case

AC volts:- 0-2.5-10-25-100-250-500-1,000

DC volts:- 0-0.25-1-2.5-10-25-100-250-1,000

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

O/No. 1315. OUR PRICE ONLY £24.75

DOME TWEETER

Dome Tweeter for systems up to 50w. Impedence 8 ohms. Frequency Response 2000-20000Hz. Dims 98mm dia × 31mm deep.

OUR PRICE £2.95. O/No. DMT200

SPECIAL OFFER OF STEREO AUDIO MODULES

Fully built and tested in our factory

A COMPLETE SET TO GIVE YOU **70** WATTS **TOTAL**

35 WATTS (rms) **PER CHANNEL** 55v POWER SUPPLY

Kit comprises:

- 2 × AL80 Power Amplifiers
- 1 × SPM120/55 Power Supply
- 1 × PA200 Stereo Pre-Amplifier
- 1 × Transformer 55v
- 1 × Front Panel – Black with White lettering
- 4 × Black Knobs with White Pointers
- 2 × Coupling Capacitors & 1 Reservoir Capacitor. Full hook-up chart

NORMAL RETAIL PRICE £52. COMPLETE **SAVING £14**

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MICRO

BEST PRICES ANYWHERE!

2114L-2	75	Z80A CPU	290	81LS96	85
2716	205	Z80A P10	260	81LS97	85
2532	340	Z80A CTC	260	1488	55
2732	340	Z80A S10	900	1489	55
4116 P20	70	Z80A DMA	1150	Epson Printers and D Connectors now available at low low prices.	
6116-P3 150nS	365	Z80A DART	500		
4164	440	81LS95	85		

CRYSTALS

100KHz	235	4.43M	100
1MHz	275	6.0M	140
1.8432M	200	7.0M	150
2.0M	225	8.0M	140
2.4576M	200	10.0M	170
3.579M	95	12M	170
4.0M	140	16M	200

CMOS

		4016	20	4034	140	4054	78	4081	12	40193	65	4528	45
		4017	30	4036	249	4055	80	4082	12	4502	60	4529	150
		4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
4000	10	4019	25	4040	40	4060	42	4086	50	4507	35	4534	400
4001	10	4020	42	4041	40	4063	80	4089	125	4508	110	4538	60
4002	12	4021	40	4042	38	4066	22	4093	18	4510	45	4543	50
4006	50	4022	45	4043	40	4067	225	4094	68	4511	40	4549	360
4007	14	4023	16	4044	40	4068	14	4095	65	4512	40	4553	215
4008	36	4024	33	4046	40	4069	13	4097	290	4514	115	4555	35
4009	24	4025	12	4047	35	4070	13	4098	70	4515	115	4556	35
4010	24	4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
4011	10	4027	20	4049	21	4072	13	40106	40	4518	40	4560	140
4012	15	4028	40	4050	21	4073	13	40109	110	4520	50	4584	35
4013	20	4029	45	4051	42	4075	13	40163	60	4521	130	4585	60
4014	45	4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
4015	40	4031	125	4053	48	4077	14	40175	75	4527	50		

LS TTL

		LS20	12	LS75	20	LS123	34	LS160	35	LS197	45	LS353	60
		LS21	12	LS76	17	LS126	24	LS161	35	LS221	50	LS365	28
		LS22	12	LS78	17	LS126	25	LS162	35	LS240	60	LS366	28
LS00	11	LS26	14	LS83	35	LS132	35	LS163	35	LS241	55	LS367	28
LS01	11	LS27	12	LS85	48	LS136	26	LS164	40	LS242	55	LS368	29
LS02	11	LS30	12	LS86	16	LS138	30	LS165	55	LS243	55	LS373	58
LS03	12	LS32	13	LS90	24	LS139	30	LS166	60	LS244	55	LS374	60
LS04	12	LS37	14	LS92	25	LS145	70	LS170	75	LS245	70	LS375	43
LS05	12	LS38	15	LS93	24	LS147	150	LS173	60	LS247	48	LS377	60
LS08	12	LS40	13	LS95	38	LS148	75	LS174	45	LS251	28	LS378	57
LS09	12	LS42	28	LS96	95	LS151	38	LS175	45	LS257	32	LS390	45
LS10	12	LS47	35	LS107	40	LS153	38	LS190	35	LS258	32	LS393	40
LS11	12	LS48	45	LS109	21	LS154	75	LS191	35	LS259	55	LS399	156
LS12	12	LS51	14	LS112	21	LS155	33	LS192	35	LS266	20	LS541	78
LS13	19	LS55	14	LS113	21	LS156	36	LS193	36	LS273	58	LS670	135
LS14	30	LS73	18	LS114	22	LS157	26	LS195	32	LS279	30		
LS15	12	LS74	17	LS122	35	LS158	29	LS196	45	LS283	38		

TTL

		7413	17	7444	85	7483	30	74122	38	74161	46	74190	40
		7414	23	7446	58	7485	60	74123	38	74162	46	74191	40
		7416	19	7447	36	7486	19	74125	33	74163	46	74192	40
7400	11	7417	19	7448	43	7489	180	74126	33	74164	46	74193	40
7401	11	7420	14	7450	14	7490	19	74132	30	74165	46	74194	40
7402	11	7421	19	7451	14	7491	34	74141	54	74167	150	74195	40
7403	12	7422	19	7453	14	7492	24	74145	48	74170	115	74196	40
7404	12	7427	18	7454	14	7493	24	74147	75	74173	58	74197	40
7405	14	7428	25	7460	14	7494	33	74148	60	74174	53	74198	80
7406	19	7430	13	7472	22	7495	33	74150	48	74175	45	74199	80
7407	19	7432	20	7473	24	7496	38	74153	38	74176	35		
7408	13	7433	20	7474	19	7497	86	74154	47	74177	42		
7409	13	7437	23	7475	26	74100	78	74155	36	74179	75		
7410	13	7438	24	7476	25	74107	22	74156	36	74180	36		
7411	15	7440	14	7480	45	74109	24	74157	28	74181	100		
7412	17	7442	30	7482	65	74121	24	74160	55	74182	55		

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 12p.
Push to make 12p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each.
DIL switches:
4SPST 80p 6 SPST 80p. 8SPST 100p.

TRANSFORMERS

Please add carriage charges to our normal post charges.

Miniature mains:
606V, 909V, 12012V all @ 100mA 100p each.
PCB mounting. Miniature:
3VA 0-6, 0-6 @ 0.25A; 0-9, 0-9 @ 0.15A; 0-12, 0-12 @ 0.12A 200p each.
6VA 0-6, 0-6 @ 0.5A; 0 9, 0-9 @ 0.3A; 0-12, 0.12 @ 0.25A 270p each.
High quality. Split bobbin construction
6VA 0-6, 0 6 @ 0.5A; 0-9, 0-9 @ 0.4A; 0-12, 0-12V @ 0.3A 220p each.
12VA 0-6, 0-6 @ 1A, 0-9, 0-9 @ 0.8A, 0-12, 0-12 @ 0.5A; 0-15, 0-15 @ 0.4A 295p (plus 40p carriage).
25VA 0-6, 0-6 @ 1.5A; 0-9, 0-9 @ 1.2A, 0-12, 0-12 @ 1A; 0 15, 0-15 @ 0.8A 330p each (plus 60p carriage)
50VA 0-12, 0-12 @ 2A, 0-15, 0 15 @ 1.5A. 440p each (plus 75p carriage)

VERO

VEROBLOC ◀	350
Size 0 1 matrix:	
2.5 x 1	22
2.5 x 3.75	75
2.5 x 5	85
3.75 x 5	95
VQ board	160
Veropins per 100:	
Single sided	50
Double sided	60
Spot face cutter	105
Pin insertion tool	162
Wiring pen and spool	310
Spare spool 75p Combs	6

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	350
▶6V Electronic buzzer	60
▶12V Electronic buzzer	65
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2.5mm	10p	10p
3 pin	12p	10p	3.5mm	9p	9p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB) Connectors:
PL259 Plug 40p. Reducer 14p.
SO239 square chassis skt 38p.
SO239S round chassis skt 40p.
IEC 3 pin 250V/6A.
Plug chassis mounting 38p
Socket free hanging 60p
Socket with 2m lead 120p

BOXES

Plastic with lid + screws		Aluminium	
3x2x1"	55	3x2x1"	70
4½x3x1½"	88	4x3x1½"	85
7x4x2	160	4x3x2"	100
		6x4x2"	120
		6x4x3"	150

MULTIMETERS

HT-120 4,000 opv
A smart looking 11 range pocket sized multimeter with an impressive spec. Complete with battery, etc. 650p each.
HT-320 20,000 opv.
Highly sensitive 19 range multimeter including transistor tester. Overload protection. DC volts - 1000, AC volts - 1000; DC current 0.25A. 4 resistance ranges. Complete with batteries, leads, etc. 1395p

DIODES

BY127	12	▶1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	12
OA202	8	1N5404	16
1N914	4	1N5406	17
▶1N4148	2	400mW zen	6

SCRs

▶C106D	30
400V 8A	70
400V 12A	95

BRIDGE RECTIFIERS

		2A 200V	40
		2A 400V	45
		6A 100V	80
		6A 400V	95
1A 50V	20	VM18 DIL 0.9A	
1A 400V	35	200V	50

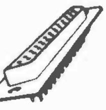
CABLES

20 metre pack single core connecting cable ten different colours. 65p

Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	65p/m
20 way rainbow ribbon	120p/m

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs				
Solder lugs	75p	110p	150p	240p
Right angle pcb mount	150p	200p	240p	350p
Sockets				
Solder lugs	105p	200p	240p	350p
Right angle pcb mount	160p	210p	290p	440p
Covers	100p	90p	100p	110p



CAPACITORS

Polyester, radial leads. 250v. C280 type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p.
Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 470/25V - 22p; 1000/25V - 30p; 2200/25V - 50p.
Tag end power supply electrolytics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p
Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p; 470n 26p; 680n, 29p; 1u 33p; 2u2, 50p.
Tantalum bead:
0.1, 0.22, 0.33, 0.47, 1.0 @ 35V - 12p. 2.2, 4.7, 10 @ 25V - 20p; 15/16V - 30p; 22/16V - 27p; 33/16V - 45p; 47/6V - 27p; 47/16V - 70p; 68/6V - 40p; 100/10V - 90p.
Car. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate: 1.8pF to 100pF 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p.
Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p

RESISTORS

¼W 5% Carbon film E12 series 4.7 ohm - 1M. 1p each.
½W 5% Carbon film E12 series 4.7 ohm to 4M7 2p each.
¼W 1% metal film E24 series 10 ohm - 1M 6p each.

SOCKETS

	Low profile	Wire-wrap
8 pin	6p	25p
14 pin	8p	35p
16 pin	9p	42p
18 pin	12p	52p
20 pin	13p	60p
22 pin	16p	70p
24 pin	18p	70p
28 pin	23p	80p
40 pin	25p	98p

Soldercon pins 60P/100

POTENTIOMETERS

Rotary. Carbon track Log or Lin 1K - 2M2. Single 32p. Stereo 85p. Single switched 80p. Slide 60mm travel single Log or Lin 5K 500K 63p each.
Preset submin. hor. 100 ohms -1M 7p each.
Cermet precision multiturn, 0.75W ⅜" 100 ohms to 100K - 88p each.

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	LM338K	475
LM317T	120	78H05 5A	
LM323K	350	▶5V	550

SOLDERING IRONS

Antex CS 17W Soldering iron	460
2.3 and 4.7mm bits to suit	65
CS 17W iron: 450, element:	210
Antex XS 25W	480
3.3 and 4.7mm bits to suit	65
Solder pump desoldering tool.	480
Spare nozzle for above	70
10 metres 22swg solder	100

PCB MATERIALS

Alfac transfer sheets — please state type (e.g. DIL pads etc.)	45
Dalo etch resist pen	100
Fibre glass board 3.75"x8"	80
Ferric chloride 250ml bottle.	100

TOOLS

Small trimming tool	22
Small pocket screwdriver	16
Large pocket screwdriver	13
6 piece precision screwdriver set In plastic case	170
Low cost side cutters	160
High quality side cutters	650
Low cost pliers	160
High quality pliers	650
Wire strippers	120
Expo reliant drill	695
Expo Titan drill	1025
Drill stand	1200
Reduced shank drill bits for above 0.8mm, 1mm, 1.4mm	60

OPTO

▶3mm red	7	▶5mm red	7
▶3mm green	10	▶5mm green	10
▶3mm yellow	10	▶5mm yellow	10

Clips to suit - 3p each.

Rectangular		TIL32	40
▶red	12	TIL78	40
green	17	▶TIL111	60
yellow	17	ORP12	85
▶TIL38	40	TIL100	90
2N5777	45	Dual colour	60

Seven segment displays:

Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
▶FND500 0.5"	100	FND507 0.5"	100
TIL313 0.3"	115	TIL312 0.3"	115
TIL322 0.5"	116	TIL321 0.5"	115

LCD: 3½ digit 580p. 4 digit 620p.

TRIACS

		400V 8A	65
		400V 16A	95
400V 4A	50	BR100	25

LINEAR

				LM339	45	LM3911	120	NE566	140	TL064	96
				LM348	60	LM3914	175	▶NE567	100	TL071	30
				LM358	50	LM3915	195	▶NE570	370	TL072	50
556CMOS	80	ICL7106	790	LM377	170	LM13600	105	NE571	370	TL074	95
556CMOS	150	ICL7611	95	▶LM380	65	MC1496	68	▶RC4136	55	▶TL081	25
709	25	ICL7621	180	▶LM381	120	MC3340	135	▶RC4558	60	TL082	45
▶741	14	ICL7622	180	LM382	120	▶MF10CN	350	SL480	170	TL084	95
748	35	ICL8038	295	LM384	130	ML922	400	SL490	250	TL170	50
9400CJ	350	ICL8211A	200	LM386	65	ML924	195	SL76018	150	UA2240	120
AY-3-1270	720	ICM7224	785	LM387	120	ML925	210	▶SN76477	380	ULN2003	85
AY-3-8910	370	ICM7555	80	LM393	100	ML926	140	SP8629	250	ULN2004	90
AY-3-8912	540	▶LF351	45	LM709	25	ML927	140	TBA120S	70	XR2206	290
CA3046	80	LF353	85	LM711	60	ML928	140	TBA800	75	ZN414	100
▶CA3080	65	LF356	90	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3089	190	LM10	360	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3090AQ	375	LM301A	25	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3130E	85	LM311	70	LM747	60	NE531	150	TDA1008	320	ZN426E	330
▶CA3140E	36	LM318	170	LM1458	40	NE544	205	▶TDA1022	490	ZN427E	650
CA3161E	100	LM324	40	LM2917	200	▶NE555	16	TDA1024	125	ZN428E	480
CA3189	290	LM334Z	100	LM3900	45	▶NE556	45	TL061	40	ZN459	285
▶CA3240E	110	LM335Z	125	▶LM3909	70	NE565	110	TL062	60	ZN1034E	200

TRANSISTORS

				BC517	40	BF337	40	MPSU56	60	ZTX108	8	2N3055	50
				BC547	[illegible]	BFR40	23	TIP29A	30	ZTX109	12	2N3442	120
				BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶2N3702	6
AC125	35	BC149	9	BC549	10	▶BFR81	20	TIP29C	37	ZTX301	16	2N3703	9
AC126	25	BC157	8	BC558	10	BFX29	25	TIP30A	35	ZTX302	15	▶2N3704	6
AC127	25	BC158	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17	2N3705	9
▶AC128	20	BC159	8	BCY71	18	BFX85	25	TIP30C	37	ZTX341	30	2N3706	9
AC176	25	BC160	45	BCY72	18	BFX86	28	TIP31A	35	ZTX500	15	2N3707	10
AC187	22	BC168C	10	BD115	55	BFX87	25	TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	BD131	35	BFX88	25	TIP32A	35	ZTX502	15	2N3709	10
AD142	120	BC170	8	BD132	35	BFY50	23	TIP32C	37	ZTX503	18	2N3772	170
AD149	80	BC171	10	BD133	50	BFY51	20	TIP33A	50	ZTX504	25	▶2N3773	195
AD161	40	BC172	8	BD135	40	BFY52	23	TIP33C	75	2N697	20	▶2N3819	18
AD162	40	BC177	18	BD136	30	BFY53	32	TIP34A	60	2N698	40	2N3820	40
AF124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	BD138	30	BFY56	32	TIP35A	105	2N708	20	2N3866	90
AF139	40	BC182	10	▶BD139	35	BRY39	40	TIP35C	125	2N918	35	2N3903	10
AF186	70	▶BC182L	8	▶BD140	35	BSX20	20	TIP36A	125	2N1132	22	2N3904	10
AF239	75	BC183	10	BD204	110	BSX29	35	TIP36C	135	2N1613	30	2N3905	6
BC107	10	BC183L	10	BD206	110	BSY95A	25	TIP41A	45	2N2218A	45	2N3906	10
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	45	2N2219A	25	2N4037	45
▶BC108	9	BC184L	7	BF180	35	BU206	180	TIP120	90	2N2221A	25	2N4058	10
BC108B	12	BC212	10	BF182	35	BU208	170	TIP121	90	2N2222A	20	2N4060	10
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	2N2368	25	2N4061	10
▶BC109	9	BC213	10	BF185	25	MJE340	50	TIP141	98	2N2369	18	2N4062	10
BC109C	12	BC213L	10	BF194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC114	18	BC214	10	BF195	12	MJE521	95	TIP147	110	2N2646	45	2N5458	36
BC115	22	▶BC214L	8	BF196	12	MJE3055	70	TIP2955	60	2N2904	20	2N5459	30
BC117	18	BC237	8	BF197	12	MPF102	40	TIP3055	55	2N2904A	20	2N5485	36
BC119	35	BC238	14	BF198	10	MPF104	40	TIC43	40	2N2905	22	2N5777	45
BC137	40	BC308	12	BF199	18	MPSA05	22	TIS44	45	2N2905A	22	2N6027	30
BC139	40	BC327	14	BF200	30	MPSA06	25	TIS90	30	2N2906	25	40360	40
BC140	28	BC328	14	▶BF244B	22	MPSA12	30	TIS91	30	2N2906A	25	40361	50
BC141	30	BC337	14	BF245	30	MPSA55	30	VN10KM	45	2N2907	25	40362	50
BC142	25	BC338	14	BF256B	45	MPSA56	30	VN46AF	75	2N2907A	25	40408	70
BC143	25	BC477	30	BF257	32	MPSU05	55	VN66AF	85	2N2926	9		
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23		
BC148	8	BC479	30	BF259	35	MPSU55	60	ZTX107	8	2N3054	55		

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) 480
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) 575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets 425
Nut and Bolt kit (total 300 items): 180p

25 6BA ¼" bolts	50 6BA washers	50 6BA nuts
25 6BA ½" bolts	25 4BA ¼" bolts	50 6BA washers
50 6BA nuts	25 6BA ½" bolts	

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ORDERING INFO. All components brand new and full specification. All prices exclude VAT. Please add to total order. Please add 50p carriage to all orders under £15 in value. Send cheque/P.O. or Access/Visa number with order. Our detailed catalogue costs 45p (free with orders over £10). Callers most welcome. Telephone orders welcome with Access or Visa. Official orders accepted from colleges, Schools, etc. . . Callers most welcome, we are open Monday to Saturday.

PE VOLUME 19 No. 3 MARCH 1983

PE—THE FUTURE

THE free Scratch Pad on the cover of this issue will be the last of a line, at least for the foreseeable future. Right from the first issue of PE (November 1964) it has been our policy to give readers a "free gift" roughly twice a year. For some time now we have been doubtful of the value of this idea. While we have always tried to ensure our free gifts are worthwhile—and from readers' response to some of them there can be no doubt of that—we have felt that improved value for money on a monthly basis might be a better policy, after all if you are a regular reader you buy the magazine for its content, not what you get free with it. So from now on we will be giving you more content every month instead of any free gifts. In short, the money we would normally spend each six months or so on gifts has been redirected to pay for about 8 extra editorial pages, per month from the May issue onwards. We hope you will like the idea.

We will be starting a new regular feature in May—see next month's issue for details—and also expanding the range of our other articles. So instead of the free board, book, tool or component etc. every so often, which you may or may not want or use, you will get more info., more circuits and more reading each and every month.

PE COVERS

Next month you will also notice an immediate change when you buy your issue or when it drops on your doormat. We are changing the style of our covers. In line with our future contents we are also putting more on the front cover, so if you are just browsing at the bookstall it should give you a better idea of just what is inside to interest you. We believe the new style looks more modern, exciting and colourful; your impressions would be interesting.

FEEDBACK

As we have said before we are pleased to hear your criticisms, likes and dislikes as this feedback helps us to produce a magazine which is just what you want. Feedback in the form of IUs and material for *Microbus* and *Microprompt* is always interesting and keeps the whole area of "hobby designs" alive.

In recent months the number of contributions to IU have tended to fall. They are always welcome and we should have more room for them from May onwards. So keep the ideas coming; we do pay for each one published at the rate of £40 per magazine page—enough to buy some more components anyway!

In line with our policy we are continually striving to meet the needs of our readers and, with your help, will continue to produce what we believe is the best magazine of its type available anywhere.

Mike Kenward

Technical *and* Editorial *queries and letters (see note below to):*
Practical Electronics Editorial,
Westover House,
West Quay Road, Poole,
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:*
Practical Electronics Advertisements,
King's Reach Tower,
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.

Items mentioned are available through normal retail outlets, unless otherwise specified. Prices correct at time of going to press.

Computer Literacy Advances

It was on a wet Thursday back in January that the press responded to an invitation by the BBC to attend a preview and mini exhibition at the World Trade Centre, in London. The preview was of 1983's "The Computer Programme" Series Two, which by now is well under way. The mini exhibition featured the BBC microcomputer and its various peripheral and software options.

A number of exciting pipeline stage developments were in evidence. What was claimed to be the first public demonstration of telesoftware took place, during which a BBC micro was downloaded with a program from a CEEFAX page. The acquisition worked with simplicity and speed, a condensed format program being transferred. The BBC has committed itself to the transmission of reliable and worthwhile software, the broadcasting of which commences this spring. Acorn Computers are to manufacture the telesoftware adaptors for use with any teletext adapted TV set. At the preview, the idea of a telesoftware club was mooted.

Among the many impressive extensions to the Acorn computer which were demonstrated, was the BBC Buggy, manufactured by Economatics of Sheffield. The Buggy demonstrates the principles of intelligent machine control and robotics, and is delivered in kit form, requiring only a screwdriver to assemble it. This training tool is a small, skeletal unit capable of propelling itself around using two drive wheels, and which has on-the-spot turning capability. The Buggy's party tricks include following a black or white line, seeking out a light source in a maze, exploring miscellaneous objects whilst mapping them on the VDU, drawing its own lines, and a repertoire of bar code stunts, one of which involves composing music. The thirteen well thought out programs are completely modular, enabling the user to call upon them as if a subroutine library. Students following the National Extension College computer course will also be able to use the BBC Buggy.

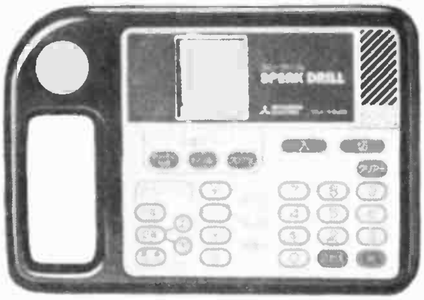
Econet, Acorn's LAN (Local Area Network) offers a cost effective link-up for the educational establishment, allowing communication by way of a four wire bus between, for example, the physics lab' computer and the school data base, and the mathematics class processor etc. Up to 254 stations may share expensive peripherals like printers and disc drives, thus creating every opportunity to save cash.

Among the BBC microcomputer interfaces are a digitizer pad, a teletext adaptor (CEEFAX and ORACLE), voice synthesiser (taken from the tones of newsreader Kenneth Kendal), disc storage system (up to 800Kbytes), and a second processor unit. This last addition doubles the processing speed by circumventing the need to interrupt calculations whilst outputting data. Data is transferred across "the Tube®". A 6502 or Z80 second processor may be chosen, the latter allowing CP/M operation. At the exhibition, a BBC micro with second processor busied itself designing ULA layouts!

Readers may like to know of the Information Referral service which is run in association with the BBC Computer Literacy Project. This is intended to put viewers in touch with local sources of advice, and provide information about the project. A large S.A.E. should be addressed to: BBC Computer Literacy Project, Broadcasting Support Services, PO Box 7, London W3 6XJ.

MATHEMATICS EXPRESSED?

In their first step into the educational field Mitsubishi Electric have developed the 'Sansu Meki-Meki', a basic maths teaching aid aimed at pre-schoolers and primary school children. The unit has an LCD display which shows the questions and the child's answers to them. The questions dealing with addition, subtraction, multiplication and division are shown in groups of ten. When the child



answers correctly a tiny steam locomotive toots and chugs down a track and a voice synthesiser tells the operator that the answer is correct. If the wrong answer is given the locomotive crashes and a wrong answer is announced. A test score is given at the end of each group of ten questions, a three minute speed drill can also be incorporated. The unit can also be programmed to concentrate on weak points, or similarly add more difficult problems. The company plan further similar products for teaching language, as well as for other subjects for upper grade students, the unit is supplied with batteries and a mains adapter, the price is expected to be under £50.

SYSTEMA CHESS COMPUTERS

Following the launch of the CG1 chess computer Systema have now introduced two additional models into their range both with extra features. The CG1 unit had a built in sensory board and eight levels of difficulty for a retail price of under £30.

First of the new chess computers is model CG2 which has a full-sized sensory chess board and pieces. The CG2 has all the features of model CG1 plus a 'save' switch to 'freeze' the game at any stage and retain the chess position in its memory until the player is ready to resume the challenge. Other features include keys for under promotion, taking back moves and to set-up or verify positions.

Also introduced is the CG3 travel chess computer. It combines the compact design of the original CG1 with the extra features of the full-size model CG2. The lid snaps into position to keep out dust and a special compartment is provided for the chess pieces. A soft carrying case is available as an optional extra.

The retail price of full-sized model CG2 will be around £50 and the CG3 travel model will be under £40.

Other features of all three models include changeable levels during play, changing sides during play, en passant capatures, castling and pawn promotion.

Systema (UK) Ltd., 74/76 South Street, Reading, RG1 4LG. (0734 586429).

● ● ● ●

Government approval of British Rail's plans to invest £21 million in new ticket issuing machines will soon bring BR's ticket offices firmly into the microchip age. £17 million of the investment is for a new all purpose ticket issuing system, APTIS and the remainder, £4 million is for PORTIS a portable version of the main system for use by guards on pay trains. Subject to satisfactory evaluation of the prototypes the new machines should come into operation in mid-1984 and be fully established by the middle of 1986.

MARKET PLACE

Disc Film! Square Eyes?

Kodak's innovative disc camera has been described by the Consumers' Association (Which? report Nov. '82) as foolproof but unimpressive in its photographic picture quality. It was summarized as being ideal for the average person wanting straightforward trouble-free snap shots. Eight million disc cameras, however, were estimated to have been sold at the close of 1982. Eight million people who prefer to have no knobs to twiddle before taking a photograph!

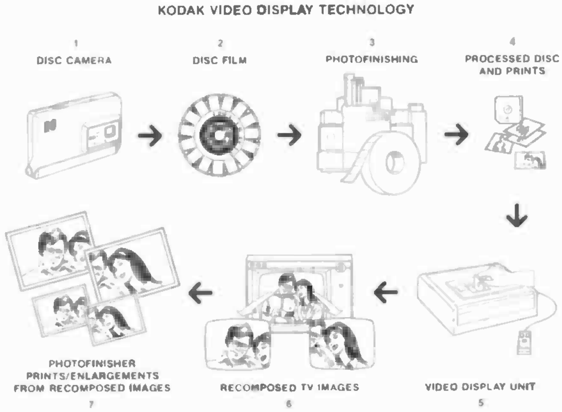
Kodak's eye is still firmly on the future of popular photography. In Cologne, last October, the company demonstrated a possible future option in the shape of a video display unit which allows disc film images to be reproduced on a television screen. The demonstrator scanned a 15-image disc negative, enlarging them and cropping them, and showing the results on a 21 inch TV screen.

A remote control unit allows quick sequencing through 15 disc images under personal control, and facilitates zooming in on a section of image, or recomposing that image for a better view of one of its aspects. Scientists at Kodak say that this system would enable consumers to order prints of their own home-culled pictures.

The heart of the prototype system is an extremely high resolution charge-coupled image sensor which converts and enhances the optical data ready for television display. A colour array of more than 350,000 elements produces a very detailed TV picture from each whole, or portion of the disc exposure. With a luminance signal bandwidth of greater than 3·5MHz, the potential for picture quality exceeds that of most television receivers.

The video display system is exploratory, with no commitment by Kodak as yet, to manufacture and sell the equipment.

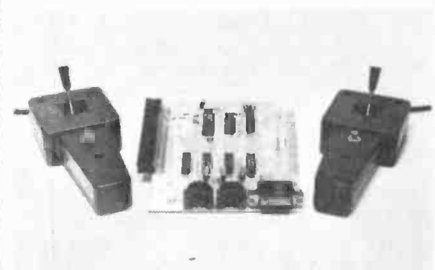
KODAK VIDEO DISPLAY TECHNOLOGY



The Kodak colour-corrected enhanced image system promises a kind of editing of photographs, in the home. Encoding of the film disc core would allow recomposed prints to be ordered by the consumer.

JOYSTICKS

A new range of joysticks has been introduced by Midwich, made of high-quality injection moulded materials, these ergonomic designs fit comfortably into the hand. Each joystick or pair of joysticks is fitted with the appropriate connector for the machine in question, the range is aimed at the BBC micro, Dragon 32 and the Spectrum/ZX81. Since the ZX81 and Spectrum do not have a built-in A to D converter, Midwich have also designed a high-speed, 4 channel controller board, which plugs into the expansion slot. An edge connector is provided for RAM pack, disc drives, etc. Prices as follows: ZX81, Spectrum and Dragon 32 £15·98 per pair, and for the BBC micro £13·00 per pair, the controllers being £22·95 each. All prices include VAT. All units available from Midwich Computers, Rickinghall House, Hinderclay Road, Rickinghall, Suffolk IP22 1HH (0379 898751).



HIS MASTER'S VOICE

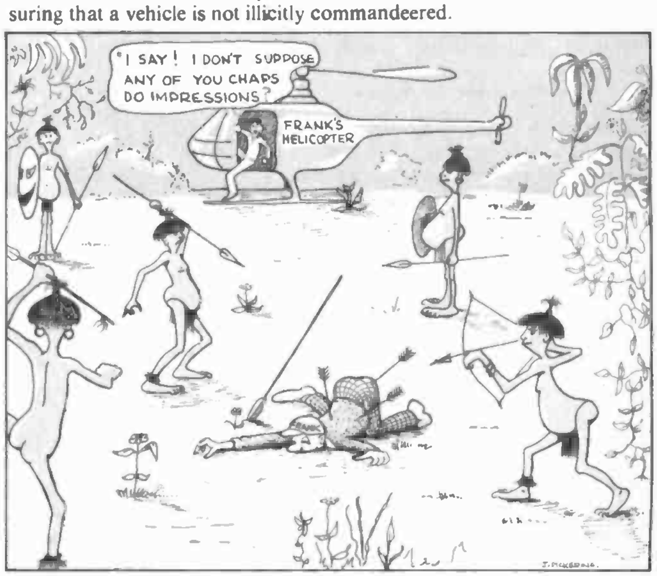
The science of electronic speech *synthesis* is gaining ground rapidly, but speech *recognition* is hampered by a lack of precision in human articulation. We humans frequently experience difficulty in understanding one another, so how might an inflexible machine cope with the various dialects, or emotional undulations of an individual's voice?

Marconi Space and Defence Systems have developed, with financial help from the DoI, a speech recogniser with a capacity of 240 words and/*or phrases,* costing £10,000. It is called the SR–128, and it uses dynamic programming to match voice input with pre-recorded voice commands, or templates as they are called.

The voice matching pattern for each user can be prepared in minutes by way of a learning routine in which the operator repeats his or her personal rendition of the control words, prompted by a 40 character plasma display. Data profiles of the user's oration are then stored on minicassette. When in use, the SR-128 recognises quite normal "connected" speech by dynamically pattern matching the content of its solid state memory. It is claimed that the number of *active* templates may be restricted by applying syntax rules. The system can recognise utterances of up to eight seconds duration, with a response time of 50ms.

There are both military and civilian applications, many of which would be airborne. An SR–128 is installed at the Royal Aircraft Establishment, Bedford, for map display and waypoint identification. Such systems will not only free pilots from physical switch manipulation when using *peripheral* equipment, but may one day completely outspan the flyer. The potential of machines like the SR–128 to ease the four-limbed juggling act of flying a helicopter is axiomatic.

Other applications include security, where response only to an authorised voice is necessary, be it for access to a restricted area, or ensuring that a vehicle is not illicitly commandeered.



...NEWS & MARKET PLACE

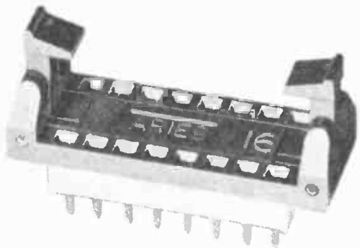
IC SOCKET

A low-profile i.c. socket, which locks the chip into position and also provides an ejecting action when the chip has to be withdrawn, is now available from Aries Electronics. The EJECT-A-DIP socket can be in 14, 16 and 24 pin configurations.

The socket incorporates a pivoting arm at each end. In one position, these arms lock the device into the socket and the arms are available in three heights to cover the various standard thicknesses of i.c.s. When the arms are pushed outward to release the device they also provide a lever action which ejects the i.c. from the socket without damaging the legs.

The socket itself has gold or tin-plated, spring-tempered, phosphor-bronze bifurcated contacts, designed to take both round or flat pins.

Aries Electronics, Unit E, Metrostore House, Eastways Industrial Estate, Witham, Essex. (0376 519318).



Briefly...

The president of National Semiconductor is often quoted as having said that if the progress of microelectronics over the past two decades was applied to the motor industry, a Rolls Royce would cost $2·75, do three million miles per gallon and deliver enough power to drive the QE2. By the look of things, Mr. Sporck's Rolls Royce will soon have to fly to keep that parallel up to date, for the bioelectronic device is here—in the laboratory at least!

In the United States, a molecule that can exist in two states, and therefore represent a binary bit, has been successfully synthesised. Mississippi University would seem to be a mere heartbeat away from the birth of the molecular diode. A memory capacity of 1K using this technology would theoretically fit into a line only one micron long, it is reported. This breakthrough brings closer the day of implanted electronics, and its interface to living tissue.

●●●●

Coals to Newcastle, fridges to the Eskimos, fair enough, but British electronic equipment to Japan? Well its true, and we have the Thandar Electronics company to thank for this encouraging reversal in the waves of electronics from the East. The equipment in this initial order, worth £100,000, was a quantity of logic analysers and were purchased by a "major" Japanese instrument manufacturer. The model ordered, the TA 2080, was favoured because of its ability to offer a combination of performance, reliability, quality and most importantly price which was, to quote Thandar Chairman Mr Taylor, "unbeatable even in Japan". The company based in St Ives, Huntingdon, export over 50% of their output.

●●●●

As if by magic, forecast figures are regularly conjured up which naturally find their way into the electronics press. Appearing in Electronics Times (2/9 Dec.), these figures are attributed to International Resources Development, whose study revealed the following: Sales of personal computers will rise from the current level of $1·3bn a year to $3·5bn, and then plunge to $480m by 1992. Sales of the personal computer's rival, the "multifunction workstation" will rocket from zero to $650m in 1984, to $3·76bn in 1987, and on to $14bn in 1992.

Evidently computers are not so prone to misting over as tall, dark strangers.

POINTS ARISING...

STYLOCHORD (Dec. '82)

The 5024 Top Octave Generator may be replaced directly with the M083 device available from Maplin Electronics (order code YY81C).

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.

Microsystems Feb 23–25. West Cntr. Hotel, Fulham, London. **Z1**
CAD North Mar. 1–3. Belle Vue Ex. Cntr., Manchester **Z1**
Mailing Efficiency Mar. 1–3. Bloomsbury Cntr. Hotel, London. **Z**
Local Networks Mar. 8–10. Royal Lancaster Hotel, London. **O**
Component Fair (Pontefract & District Amateur Radio Society) Mar. 13. Carlton Grange Community Centre, Carlton, Pontefract. **F2**
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**
Biotech May 4–6. Wembley. **O**
Micro City May 10–12, Bristol Exhibition Complex. **F3**
The Business Computer Show May 10–12. Wembley. **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 Wood Processing May 24–27. Wembley Conf. Cntr. **Z**
Laboratory Edinburgh July 18–20, Appleton Tower, Univ. **E**

A7 Institute Of Acoustics ✆ 031 225 2143
A8 Holographic Exhibitions ✆ 01-836 6423
C Reg. Rowles ✆ Cardiff 565656
E Evan Steadman ✆ 0799 22612
F2 Pontefract & District Am. Rad. Soc. ✆ 0977 791071
F3 Tomorrow's World Exhibitions, Bristol
I Industrial Trade Fairs ✆ 021 705 6707
K Douglas Temple Studios ✆ 0202 20533
L1 World Trade Cntr., Europe Ho., London E1
N Institute Electrical & Electronic Engineers
O Online ✆ 09274 28211
T Trident ✆ 0822 4671
V1 Jack Tootill, Ipswich Radio Club
Z BETA Exhibitions ✆ 01-405 6233
Z1 IPC Exhibitions ✆ 01-643 8040

Space Watch...

MISSILE FROM MARS

Headlines were generated when a meteorite was discovered recently in Antarctica because it is the opinion of most of those who have examined it, that it is from Mars. At the Johnson Space Centre considerable excitement was demonstrated when the piece of rock weighing about 17·5lb was displayed. The characteristics are different from any previous bodies of meteoritic origin. Naturally it now raises the problem that there must be more of this material on the surface of the Earth. This sample was found by a team funded by the National Science Foundation, the Smithsonian Institution and the National Aeronautical and Space Administration.

At the moment the main problem being studied is the manner of this piece of another planet arriving and impacting the Earth. There are some dissenters that it is in fact from Mars but Laurence E. Nyquist, who has identified it, has shown that such an event is possible. He is head of the Planetary and Sciences Division at the Johnson Space Centre where his latest work was undertaken. His conclusions are based on the study of the Viking orbiter photographs. A number of the craters on Mars have a configuration which would indicate that they were made by the impact of bodies arriving at an oblique angle. It has been calculated that bodies of the size to have caused the craters observed, would need to have a velocity of about 9·98km/sec. This would make it likely that parts ejected could have a velocity of the order of 7·88km/sec. This is greater than the escape velocity from Mars which is 4·89km/sec. Debris from the impact would be scattered across the Martian orbit. The dynamics of the relative orbits of Mars and the Earth would certainly make it possible for material to fall as meteorites. The real question is how often would that final condition arise. This can only be stated as 'It could happen'. However there is another way of looking at the probability. The age of the Martian material at the crater is reasonably well established and is about 1,300 million years old. It is also reasonably likely that Mars was volcanically active then. The age of the meteorite is given as 180 million years or thereabouts. Since all other finds so far have on average been assessed at 4,500 million years the argument is reasonable. This could be a talking point for renewed proposals to bring back again the original plan for a manned landing on Mars. However the immediate active plans are to re-examine earlier finds made by a Japanese expedition. They found that many objects were lying about on the surface of the ice and easily detected. An American expedition in 1976 found large numbers of meteorites on the surface easily identified. On the latest expedition there were two other bodies which may be Martian. They are still undergoing tests. One of them may well be from the Moon and its origin similar to the Martian bodies in the mode of transmission to Earth. In this case there are a number of samples of Moon rock collected by astronauts from the Apollo landings. The suspect sample found in Antarctica weighs 32 grammes and was from the same Elephant Morraine area where the Martian samples were found. A section of the sample appears to be identical with the original Moon samples. The Martian sample on examination would show some indication of how long it might have been in space. This is regarded as not longer than 2 million years. In that case it must have come from a large body nearby. The sample is large enough to support years of study. There are a number of areas of glass like appearance which may have been part of the original material. One crucial task will be to penetrate these areas for they may have trapped in them the atmosphere of the time. This will add much to our knowledge of the early conditions on the Planet.

SPACE MOTION SICKNESS

Much has been made of the small incidence of space sickness particularly on Shuttle Mission 5. It seems that there is always someone to exaggerate small incidents for which they have little evidence. The practice of shock headlines is increasing for the purpose of creating adverse opinions and boosting sales in certain parts of the media. It labels the writers who follow this policy as the backward looking cranks akin to those 'experts' who earlier in the century were forever prattling about the inability of the humans to withstand speeds of 20 miles per hour. A little thought about the effects of statements that are entirely without attested foundation, have repercussions on the families and serve to spread needless alarm. As a first example the fact that the Russian cosmonauts have set a new record for time spent in space should make people hesitate about a journey of a few days involved in this so-called motion sickness.

A number of critical issues have been raised which have repercussions both in the personal lives of the astronauts and in the various legal aspects. There arise the questions of confidentiality between doctor and patient. There is the psychological effect on the individual astronaut who may feel that continued work in the field may be jeopardised, the legal difficulties due to various existing codes of practice and the Federal Privacy Act.

The entire situation has been built up into unnecessary proportions. There is a very important point at issue here for it so happens that there has been an increasing number of the same symptoms in the general populations who live in cities. There are a number of things which could assist the explanation of this trend. Indeed a great deal is going on in the areas of the changing eating habits of the communities. So much indeed that within a very short time it will be found that many projects will be set up and grants applied for the proliferation of useless knowledge. Perhaps a little exposure of some of the so-called research in the area of man and his environment would sort the valid from the invalid. As the Year 2000 approaches perhaps it will be possible to get feet set on a useful path which deals with the true reality.

NEW MINERAL FINDINGS

Some of the findings using the instruments of the second shuttle mission have now been published. It was possible to detect other clay minerals where in the previous observations from space only Limonite was readily identified. Using the multispectral infrared radiometer in an area between Kharga and Aswan in Egypt, it was possible to identify exactly kaolinite a hydrous aluminium silicate clay mineral and another of the same group, montmorilionite. These are important finds because they are useful guides to the finding of ore deposits of iron. This new facility means that both topographical data and minerological data can be acquired simultaneously over wide areas. A first saving is then to halve the costs and time compared with previous geological surveys.

JOINT VENUS MISSION

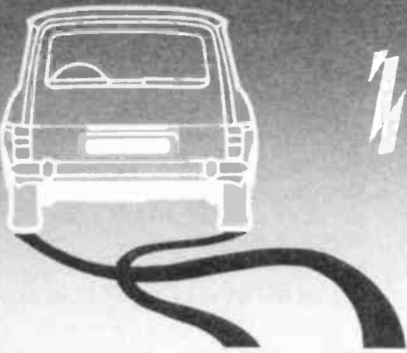
Cooperation between Russia and France has been working very well and now the most ambitious project is being discussed regarding what might be called a massive assault on the problem planet Venus. The target date for this mission is 1989. A French statement indicates that there will be probes, landers and balloons used in this attempt. It is not deemed practical to land a moving vehicle at this time, mainly because more certain knowledge of the terrain is needed.

Leading up to the 1989 mission will be two others. The first will involve the Soviet Vega – Venus/Halley Comet mission. Originally the French were to supply two large balloons with meteorological instruments which would be released into the Venusian atmosphere. Because of the modifications for the Halley Comet part of the mission the large balloons were later deleted. In place of them the Soviets are preparing two small balloons and the French are designing suitable meteorological instruments for attachment to the balloons.

A new project has been agreed and this will involve the launching of polar and equatorial satellites for the study of the Earth's atmosphere and ionosphere. This mission will be called Interball.

Initial studies have begun on another project called Satellite d'Astonomie Gamma, (SAGA) to study gamma ray sources. This was a mission offered to France by Russia when for financial reasons they had to abandon it earlier in the year. The instruments already developed can be incorporated in the new satellite. It would seem that the Soviets are anxious to push this project, perhaps to beat the American mission for a Gamma ray observatory. The final decision on this project will be made at the next space reunion between the French and the Russians this year.

Frank W. Hyde



ICE WARNING & LIGHTS REMINDER

P.J. McFARLANE

The brow of a hill; the dip in a country lane—each can cause surprise local freezing. With no change in lustre, a road can turn from being just plain wet to *iced over.* Building this device is a worthwhile project, for it will discreetly arm the driver with a piece of information which could save his life.

MANY motorists have tales of skidding on so called "black ice", most of these, fortunately, without unhappy endings. It is possible to drive perfectly safely on ice, providing of course, that you know you are doing so. Cocooned in a car with the heater going, a driver can often fail to realise just how cold it is outside, and get caught by surprise when he tries to go in one direction and the car goes off in another.

The PE Ice and Lights Alarm can be put together for a few pounds, and as well as providing a visual and audible warning that the temperature outside is freezing, it also provides an audible warning that the car lights have been left on. The device can save you from both a flat battery *and a flat car!*

OPERATION

The unit operates as follows: If the ignition is switched on whilst the temperature outside is freezing, or the car is driven into a region where the temperature is freezing, then the unit will emit a bleep for about a second. A l.e.d. illuminates all the time the ignition is on and the outside temperature is freezing.

Also, if the ignition is switched off and the car lights are still on, the unit will emit a pulsed bleep for about two seconds. This is long enough to remind that the lights are still on, but not so long as to be annoying if this is intentional.

CIRCUIT

The circuit diagram is shown in full in Fig. 1. The temperature sensor is the base-emitter junction of a BC182L transistor. A silicon p-n junction has a temperature coefficient of about 2·2mV per degree centigrade.

A 78L05 voltage regulator i.c. supplies a stable reference voltage to the base of the sensor transistor, TR1, via a potential divider chain. When the sensor temperature is higher than zero, the threshold voltage of the transistor is low enough for the voltage on its base to turn it on. This removes the current from the base of TR2, so this is off, and so is TR3.

Should the temperature of the sensor drop, the base-emitter threshold voltage will rise, and there will not be enough voltage at the base to turn the transistor on. When this transistor is off, TR2 is turned on via R1. This turns on TR3 via R6, and hence the l.e.d. Resistor R5, and D1 provide a small amount of hysteresis, by reducing the base voltage of TR1.

When the car lights are off, the l.e.d. current passes through both R10, and R9 through the lights, and the l.e.d. glows brightly. When the lights are on, the end of R9 is at +12V, hence the l.e.d. is dimmed, to prevent dazzle at night. Diode D2 prevents the l.e.d. from being excessively reverse biased when the lights are on.

Resistor R13, C4, IC1a and IC2a form a positive edge-to-pulse converter. Pin 11 of IC2 has a positive going pulse of about one second duration following a 0 to 1 transition on pin 1 of IC1. This circuit is used in preference to the usual series capacitor one, as the latter puts a reverse voltage on the capacitor.

Fig. 2 shows the essence of the circuit, and Fig. 3 the associated waveforms. The input to the gate can be considered to be a logic '0' if the input is below the threshold voltage (approximately half the supply voltage). The output of a NOR gate is low if either of its inputs is high.

When this pulse output is high, this causes the output of IC2c to be low. This enables the oscillator IC2d and IC1d. IC1e and IC1f provide a bridge output drive to the ceramic sounder X1, giving 24 volts peak to peak signal here, producing a very adequate sound.

The remainder of the circuit is concerned with the *lights left on* alarm. D3 and D4 are included so that the circuit is powered from either the lighting, or the ignition circuit.

The circuit has another edge-to-pulse converter, this time a falling edge is converted to a negative going pulse of about 2 seconds duration at the junction of R15 and D5. These two components give the equivalent of an OR function. The pulse occurs when the ignition input becomes low. If the lights are still on, then there is power to operate the rest of the circuit.

The pulse enables the oscillator IC2b and IC1c which operates at about 10Hz, and this gates the output oscillator on and off via IC2c.

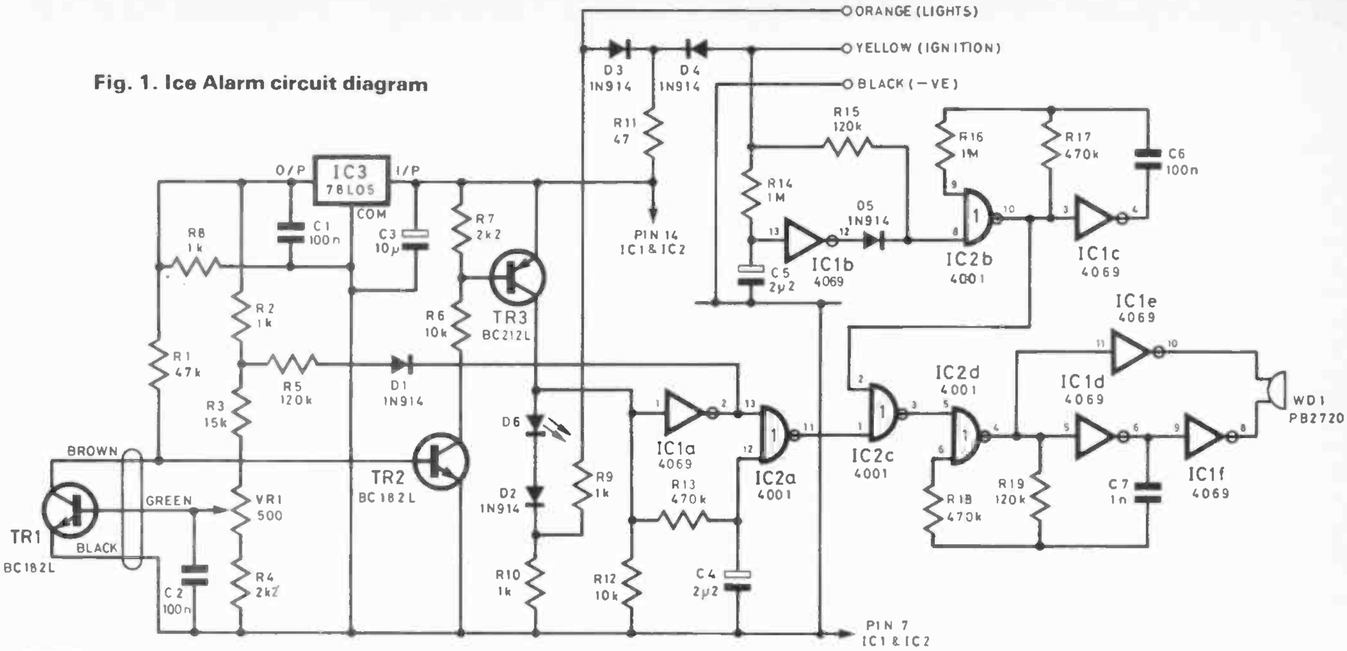


Fig. 1. Ice Alarm circuit diagram

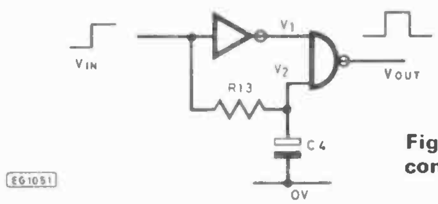


Fig. 2. Edge-to-pulse converter

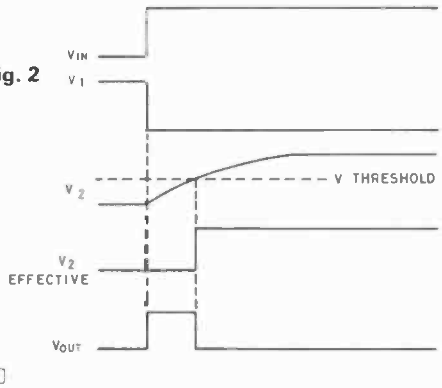


Fig. 3. Waveforms of Fig. 2

CONSTRUCTION

Fig. 4 shows the p.c. layout for the P.E. Ice Alarm, and Fig. 5 the component locations. Leave the l.e.d. wires long if it is to be mounted in the box.

The sensor transistor, TR1, is fitted at the end of about two metres of wire, as this obviously has to be outside the car. Cut the transistor legs to about 6mm in length. Strip about 3mm from the connecting wire insulation and slide about 10mm of 1mm bore rubber sleeving over the wires. Carefully solder the black wire to the emitter of the transistor and pull the sleeving over the join. Repeat with the green wire for the base and the brown wire for the collector. Fig. 6 shows the transistor base connections.

Twist the three transistor wires together and thread them into 2 metres of 5mm bore PVC sleeving. Glue the transistor into the sleeving with the end of the transistor level with the end of the sleeving, and make sure that the end is water tight.

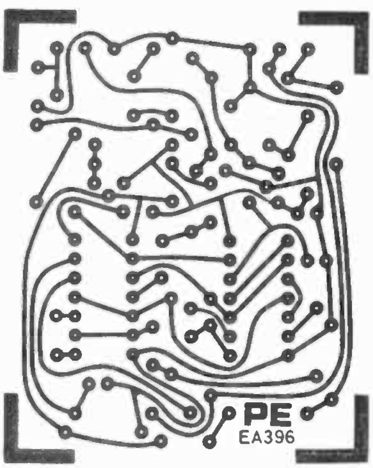


Fig. 4. Printed circuit layout (actual size)

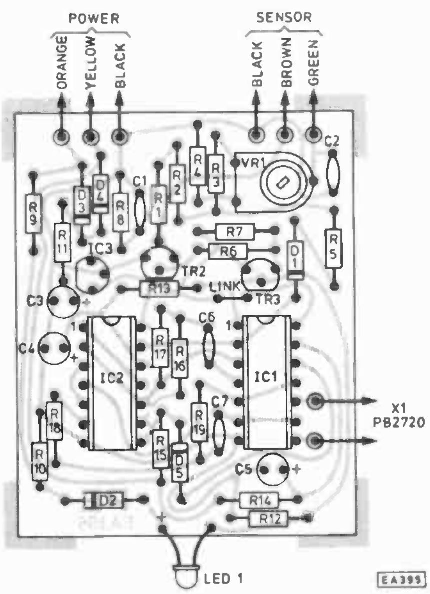


Fig. 5. Component layout

COMPONENTS...

Integrated Circuits

IC1	4069
IC2	4001
IC3	78L05

Transistors & Diodes

TR1, TR2	BC182L (2 off)
TR3	BC212L
D1–D5	1N914 (5 off)
D6	3mm Red l.e.d.

Capacitors

C1, C2, C6	100n 25V. Ceramic disc (3 off)
C3	10μ 16V. Electrolytic
C4, C5	2μ2 63V. Electrolytic (2 off)
C7	1n 50V. Ceramic disc

Resistors

R1	47k
R2, R8, R9, R10	1k (4 off)
R3	15k
R4, R7	2k2 (2 off)
R5, R15, R19	120k (3 off)
R6, R12	10k (2 off)
R11	47
R13, R17, R18	470k (3 off)
R14, R16	1M (2 off)

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

Potentiometers

VR1	500 preset

Miscellaneous

Verobox type 21024
Wire
Sleeving
Cable ties
P.c.b.
Adhesive pads
X1 PB2720 Ceramic sounder

Constructor's Note

A complete kit of parts is available from: **PIMAC Systems Ltd.**, 20 Bloomfield. Road, Birmingham B13 9BY. Price £6·95 includes VAT and postage.

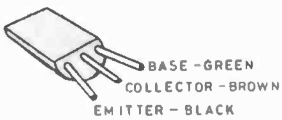


Fig. 6. BC182L connections

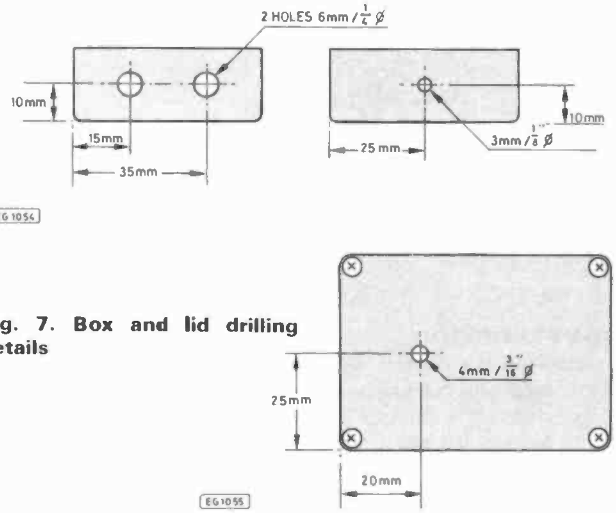


Fig. 7. Box and lid drilling details

Drill the box base and the lid according to Fig. 7. Use a paper hole punch to make a hole in the centre of a 25mm square of double sided adhesive pad, stick the pad to the front of the sounder, with the holes concentric, then stick this to the inside of the lid of the box over the hole drilled.

Prepare another cable using 600mm of black, orange and yellow wires in 500mm of 5mm PVC sleeving. Thread this and the temperature sensor cables through the holes drilled in the box.

The p.c.b. will be held in the bottom of the box using more double sided adhesive pad, and the l.e.d. pushed through the small hole in the box. Do not fix it yet, though, until the unit has been tested. Connect up the sensor and power wires, and the wires to the sounder.

TESTING

Connect a source of power between the black wire (negative) and orange wire (positive)—a 9 volt battery will do for testing. Touch the yellow wire to the positive terminal for a few seconds, then to the negative terminal. If all is well, the unit will emit a pulsed bleep for about 2 seconds—this is the *lights left on* alarm.

Mix up some crushed ice and water, and stir it with the sensor for a minute or two. This will cause the sensor to be at 0 degrees centigrade. Leave the sensor in the water and slowly rotate the calibration pot clockwise until the l.e.d. just comes on. When this happens the sounder should operate for about a second.

If all is well, fit cable ties over the ends of the two cables to prevent them being pulled through the box, and stick the unit into the box. Pass the l.e.d. through the hole in the side of the box, and screw on the lid.

INSTALLATION

Fit the box to a suitable place on or under the car dashboard using more adhesive pad. Thread the wires under the dashboard, this can often be done through the windscreen demisting vents.

Connect up the power cables as follows:
Black Chassis
Orange Side lights or panel lights
Yellow Ignition power

Thread the sensor cable through into the engine compartment, then into a position under the car, where it will *not* be in the air stream from the radiator, for example. Fix it securely in place. Keep the cable away from hot parts of the engine and the ignition wiring. Use cable ties to hold the cable in place.

POSITIVE EARTH VEHICLES

The circuit is designed for use with vehicles having a negative earth system. The easiest way to adapt the circuit for positive earth is to reverse everything. Thus, fit all the diodes and electrolytic capacitors the other way about. Use a 79L05 in place of the 78L05 (but be aware, the pin-out is different), and use a 4011 i.c. in place of the 4001 for IC2. In addition, cut the p.c. tracks to pins 7 and 14 of the i.c.s, and reverse them. Use BC212L transistors for TR1 and TR2, and BC182L for TR3. ★

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74LS30	12
74LS32	13
74LS37	14
74LS38	14
74LS42	28
74LS47	36
74LS51	14
74LS73	18
74LS74	16
74LS75	18
74LS76	15
74LS85	40
74LS86	16
74LS90	22
74LS92	30
74LS93	22
74LS107	20
74LS112	20
74LS123	34
74LS125	24
74LS126	25
74LS132	34
74LS136	23
74LS137	90
74LS138	25
74LS139	27
74LS145	70
74LS148	75
74LS151	40
74LS153	40
74LS153	40
74LS155	30
74LS156	36
74LS157	27
74LS161	36
74LS163	36
74LS164	30
74LS165	50
74LS166	60
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74LS244	55
74LS245	70
74LS251	30
74LS253	30
74LS257	30
74LS259	55
74LS266	20
74LS273	55
74LS279	30
74LS299	150
74LS367	30
74LS368	28
74LS373	60
74LS374	55
74LS378	60
74LS393	45

7400

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7401	11
7402	11
7403	12
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7472	24
7473	26
7474	30
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7485	60
7486	18
7489	159
7490	20
7491	35
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7493	25
7494	35
7495	35
7496	34
74100	80
74104	45
74107	20
74121	24
74123	34
74125	34
74126	33
74141	51
74151	40
74154	60
74155	39
74156	40
74157	30
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4007	14
4008	32
4009	24
4010	24
4011	11
4012	16
4013	20
4014	46
4015	40
4016	20
4017	32
4018	45
4019	25
4020	42
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4026	80
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4072	13
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748C8	35
741S	56
1458C5	62
1458C14	40
7106	450
7107	500N
555	10N
7555	80N
556	45
CA3046	70N
CA3080E	80N
CA3130E	90N
CA3140E	45N
LM301AN	25N
LM308N	60
LM317K	295N
LM324N	32
LM348N	65
LM380N	65
LM380N8	80
LM381N	145
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SAB3271	329
SAB4209	497
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SAD1024	9.00N
SAJ131	238
SAJ141	278
SAJ205	810
SAS231W	261
SAS251	142
SAS580	198
SAS590	196
SDA5680A	15.55
TAA761	104
TAA761A	49
TAA765A	62
TAA861	103
TAA865A	59
TAA2761A	72
TAA4761A	113
TAA4765A	120
TAB1041K	187
TBA120AS	62
TBA120U	72
TBA800	75
TBA810S	75
TBA820	75
TBB1458	62
TBB1458B	40
TCA105	120
TCA105B	108
TCA105G	140
TCA250A	185
TCA205K	200
TCA335A	66
TCA345A	109
TCA345W	177
TCA671	131
TCA780	211
TCA871	114
TCA955	228
TCA965	136
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TCA991K	100
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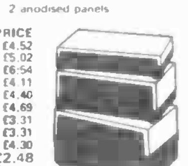

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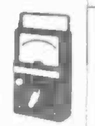

SEMICONDUCTORS

1N914	03
1N914B	10
1N916	52N
1N4007	06
1N4148	03
1N5402	14
1N5407	18
2N697	23
2N706	18
2N930	20
2N1132	23
2N1302	110
2N1303	58
2N1304	62
2N1305	62
2N1306	90
2N1307	67
2N1308	147
2N1309	99
2N1599	100
2N1613	25
2N1711	25
2N1893	32
2N2218A	31
2N2219A	25
2N2222A	25
2N2369A	21
2N2484	25
2N2646	46
2N2904	26
2N2904A	25
2N2905A	25
2N3053	23
2N3054	56
2N3055	48
2N3405	64
2N3663	15
3702-11	09
2N3771	180
2N3794	21
2N3819	22
2N3820	40
3823	60
2N3904	15
2N3906	15
2N4036	46
2N4058 62	09
2N4124	25
2N4126	25
2N4284	30
2N4286	18
2N4289	23
2N4291	24
2N4292	21
2N4991	62
2N5062	32
2N5192	110
2N5195	106
2N5457	32
2N5458	32
2N5459	36
2N6050	380
2N6057	375
6F40	152
16F40	165
40HF40	225
40361DIS	
40362	65
40406	71
40408	95
40412	108
40430	100
40594	123
40595	123
40636	147
40673	146
A9903	16
AA113	13
AA116	9
AA117	13
AA118	14
AA119	13
AC126	25
AC127	25
AC128	25
AC151R	55
AC153K	20
AC176	25
ACY17	155
ACY18	120
ACY19	99
ACY20	90
ACY21	85
ACY39	170
ACY41	10
AD136	530
AD142	90
AD149	88
AD161	95
AD162	36
AF114	37
AF115	37
AF116	57
AF117	110
AF124 AF125	37
AF126	37
AF127	37
AF200	10
AF239	114
AF279	30
AFY12	204N
AFY16	327N
AFY180	310N
AFY18E	615N
AFY42	461N
AU106	240
AU111	fuse
AU116)	
AUY22	10.95
BO140	25N
BO146	30N
BO226	45N
B1906	38
BA379	25
BAS40 03	36
BAS70 03	41
BAT14 036	11.75
BB409	33
BC107A,B	16
BC108A,B,C	16
BC109B,C	18
BC121W	30N
BC122Y	100
BC125	20
BC125	20
BC140	25
BC141	30
BC147A	10
BC149	10
BC154	25
BC160	25
BC161	30
BC167A	09
BC167B	09
BC168A	09
BC168B	09
BC169B	09
BC169C	09
BC177B	16
BC178B	16
BC179B	18
BC182	09
BC182L	09
BC183	09
BC183L	09
BC184	09
BC184L	09
BC202Y	120
BC212	09
BC212L	09
BC213	09
BC213L	09
BC214	09
BC214L	09
BC238C	09
BC239C	09
BC258B	09
BC267B	16
BC300	32
BC301	24
BC303	30
BC327	16
BC328	11
BC337	14
BC338	11
BC413	09
BC414	09
BC477	24
BC546	10
BC547	09
BC548	09
BC549	09
BC550	10
BC556	10
BC557	09
BC558	09
BC559	09
BC560	10
BC879	38
BC880	43
BCY31A	157
BCY58	18
BCY70	18
BCY71	18
BCY72	18
BD130	45N
BD131	43
BD132	48
BD135	27
BD136	27
BD139	30
BD140	32
BD644	42N
BD679	62
BD680	64
BF115	35
BF167	25
BF173	25
BF177	25
BF178	25
BF244B	40
BF254	14
BF255	14
BF420	31
BF421	34
BF457	35
BF458	35
BF459	35
BF597	12N
BFR34A	84
BFR39-41	23
BFR79-81	23
BFT65	119
BFT66	192
BFX29	24
BFX84	24
BFX85	24
BFX87	28
BFX88	26
BFY50	24
BFY51	24
BFY52	24
BFY90	143
BR34	70
BR64	110
BRY39	45
BSX20	22
BSX26	22
BSX63	769N
BT106	147
BT108	136
BU105	170
BU124	85
BU208	180
BUX26	350N
BUX28	545
BUX81	744
BUX85	249
BUZ10A	478
BUZ15	12 27
BUZ20	523
BUZ23	787
BUZ24	12.50
BUZ32	625
BUZ33	844
BUZ41A	637
BUZ44A	9.67
BUZ45	12.76
BUZ48	18.94
BUZ50A	763
BUZ54A	21.43
BUZ80	739
BUZ83	11.29
BUZ83A	11.95
BUZ84A	12.75
BY164	48
C106D1	45
C0326	460N4
C0340	490N4
C407	17
C0546	126N1
C762	40
C1406	77
D4 clip	for
C1406	and
E2506	10
D1046	88
E1110	76
E1210	76
E2506	154
EB383	20
MJ2955	90
MJE340	55
MJE2955	95
MJE3055	70
MPF102	40
MPS6531	40
MPS6534	42
MPSA12	36
MPSA63	38
NAS206S5	81
OA47	12
OA90	10
OA91	10
OA95	DIS
OA202	14
OC28	75
OC29	75
OC35	75
OC36	90
OC84	25
PM7A2	373
PN7C	10
PN72	05
Q4006LT	104
Q4010LT	115
Q4025H	450
T2700D	189
T2800D	104
TAG3 400	100
TAG209 400	86
TAG209 600	30
TIC106D	48
TIC106M	55
TIC126D	54
TIC206M	54
TIC226D	61
TIC236D	96
TIC246D	105
TIP31A	36
TIP32A	36
TIP41A	45
TIP41C	60
TIP42A	45
TIP42C	60
TIP150	75
TIP2955	55
TIP3055	56
TIS43	50
U763	50
VN10KM	55
VN46AF	93
VN66AF	105
VN88AF	123
W02	25

CRYSTALS

(in MHz)

0.032768	102	4 433	128
0 100000	453	4 915	157
1 000	453	5 000	157
1 8432	320	5 025	128
2 000	268	5 000	157
2 4576	268	6 144	157
3 2768	188	6 5536	128
3 579	128	8 000	1.88
4 000	102	8 867	128
4 194	128	10.000	157
		18 432	188

ZENER DIODES

400mW/2 7-30V	7p
1 3W/3.3-100V	15p
20W/7.5-75V	£1.98

CONNECTORS

DIN AUDIO

Pins	plug	skt
2	8p	8p
3	14p	8p
4	17p	14p
5 180	17p	11p
5 240	20p	8p
6	18p	20p
7	19p	30p

JACK PLUGS SKTS

MONO

chrome	P1	53p	34p	42p
plastic	P2	32p	14p	20p

STEREO

chrome	P3	81p		52p
plastic	P4	60p	15p	20p

MONO

3.5mm	14p	14p
2.5mm	23p	42p

D SERIES

	Plug	skt	hood
9	78p	104p	92p
15	106p	140p	96p
25	147p	205p	110p
37	199p	298p	122p

IDC Connectors

DIL

14 way	103p
16 way	117p
24 way	170p
40 way	265p

PARALLEL TYPE

	plug	skt
16 way	1 10	1.30
20 way	1.25	1 45
26 way	1 50	1 70
34 way	1.65	1 95
40 way	1 85	2 10

Plugs have retainers. Sockets have strain relief.

IC SOCKETS

Pins	Each	25 for
8	6	120N
14	8	160N
16	9	180N
18	11	220N
20	12	240N
22	14	280N
24	15	300N
28	18	360N
40	25	500N

REGULATORS

				7818	40	7918	50
7805	40	7905	50	7824	40	7924	50
7806	40	7906	50	78L05	32	79L05	50
7808	40	7908	50	78L12	32	79L12	50
7812	40	7912	50	78L15	32	79L15	50
7815	40	7915	50	78L24	32	79L24	50

CAPACITORS

Polystyrene, Siemens
5% Tolerance 160V
5, 7, 10, 12, 15, 18, 22, 27, 33, 39pF **15p**; 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330, 390, 470, 560, 680, 820pF, 1n, 1n2, 1n5, 1n8, 2n2, 2n7, 3n3, 3n9, 4n7, **10p**; 5n6, 6n8, 8n2, 10n, **13p**
Ceramic Very small 1 8, 2.2, 2 7 etc, up to 1n **5p each** 1n5, 2n2, 3n3, 4n7, 6n8 **5p**; 10n, 22n, **6p**; 33n, 47 **7p**; 100n **8p**
Polyester, Siemens Layer Type 7 5mm lead spacing 100V
1n, 1n5, 2n2, 3n3m **6p**; 4n7, 6n8, 8n2, 10n, 12n, 15n, 18n, 22n, 33n, 47n, **7p** 56n, 68n, **7p**, 82n, 100n, **9p** 120n, 150n **15p**; 180n, 220n, **12p**, 270n, 330n, 330n, 390n, 470n, **15p**; 560n, 680n, **24p**, 10mm spacing 1uF **25p**; 15mm spacing 2u2 **35p**, 22 5mm spacing 1uF 400V **50p**, 3 33uF 100V **69p**; in depth stocks

ELECTROLYTICS

1/63	9	1000/10	19
2.2/25	13	1000/16	26
2.2/63	9	1000/25	36
4.7/63	9	1000/40	44
4.7/100	14	1000/63	76
6.8/40	9	2200/6	9
10/6	13	2200/16	44
10/25	10	2200/25	60
10/40	11	2200/40	73
10/63	12	4700/16	72
10/100	15	4700/25	90
22/10	10		
22/25	11	**TANTALUM BEADS**	
22/40	14		
22/63	15	0 1/35	13
22/100	16	0 22/35	13
47/3	3	0.47/35	13
47/10	11	1.0/35	13
47/25	10	2.2/16	13
47/40	15	2.2/35	16
47/63	15	4 7/16	16
47/100	18	4 7/35	18
100/3	3	6.8/16	16
100/10	12	6.8/25	24
100/16	12	10/6.3	16
100/25	12	10/16	18
100/40	15	10/25	18
100/63	20	22/6.3	18
100/100	27	22/16	30
220/10	16	22/25	30
220/16	16	33/6.3	24
220/25	16	33/10	30
220/40	20	47/6.3	30
220/28	28	100/10	66
220/100	42		
470/10	19		
470/16	19		
470/25	19		
470/40	27		
470/63	45		
470/100	73		

For full ranges of very many other types please see Cat 82 and/or current price list.

RF CHOKES

1, 1.5, 2.2 etc to 33μH ea. 30p
47, 68, 100 etc to 680μH ea. 33p
1000, 1500 etc to 4700μH ea. 35p

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LED chrome, red **54**
LED yellow or green **70** (high efficiency)
Filament in red amber green or clear
6V 60 mA **48**
14V 40 mA **54**

LED's
5mm red **10**
yellow **19**
green **16**
Mountings 865 **3**

DISPLAYS
7 segment
Common anode
MAN72A red **75**
MAN82A yellow **110**
MAN52A green **110**
Common cathode
MAN74A red **85**
MAN84A yellow **110**
MAN54A green **110**
5V filament
3015F 8 mA **256**
3015F 15 mA **256**

SWITCHES

Type CK 1P 12 way, 2P 6 way, 3P 4 way, 4P 3 way **48p**; Min Toggles S7101 SPDT **57p**; S7201 DPDT **80p**; S7301 3PDT **£1.64**; S7203 DPDT **96p**, Push Button min 8531 make/8533 break **62p**; 8225 DPDT **£1.34**.
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K1 skirted with spot 16
K2 as K1, 35mm 21
K3 pointer 15
K7 19mm knurled 23
K8 as K7 + skirt 23

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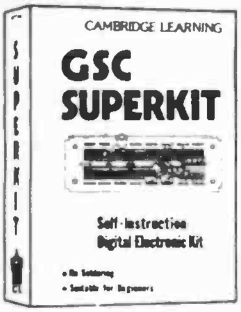

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Parts:
Stereo power amp PCB with all components, £3.50 + 75p p&p. Power supply unit £1.95 + £1.50 p&p. Pair of eliptical speakers, £1.50 the pair + £1 p&p. Input & output sockets and plugs, £1.50. Recommended case (for the power supply and amp only),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

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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.

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BUILT **£14.25** +£1.15 p&p.

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PE MICROCONTROLLER: DATA SHEET 2

PROGRAMMABLE FUNCTIONS

THE Microcontroller keyboard has two keys labelled "PF1" and "PF2" whose use has not so far been discussed. These keys can be configured to provide two user-definable function keys, instead of the dummy functions which are pre-defined by DISBUG at start-up. After power-up, or restart, pressing PF1 or PF2 causes a display with a prompt of "1" or "2", respectively, with the next key depression causing a return to the ". . . dIS . . ." prompt.

The map of the DISBUG RAM region shown in the first datasheet indicates that there are two two-byte stores labelled PF1SRA and PF2SRA which start at locations 03F2 and 03F0, respectively. These are used by DISBUG to hold the start addresses of two subroutines which will be called by the command processor to service the PF1 and PF2 keys. The initialisation values in these two stores are the same (F964), and point to a default service routine within the monitor. Each pointer may, however, be changed using the memory editor to point to an alternative routine (usually in RAM) to perform a special function. As a demonstration of this facility, changing the contents of PF1SRA from F964 to F98F will redefine PF1 to behave exactly the same as the RESTART key. It should be remembered, however, that PF1SRA and PF2SRA will both be restored to their initial values following a power interruption or a restart.

DEFINING USER FUNCTIONS

Fig. 1 shows how a user function routine must be structured. When PF1 or PF2 is recognised by the command processor, the "1" or "2" prompt will be displayed, and the key code will be passed to the defined routine in register A. The routine may choose to over-write the prompt (see datasheet 3), depending

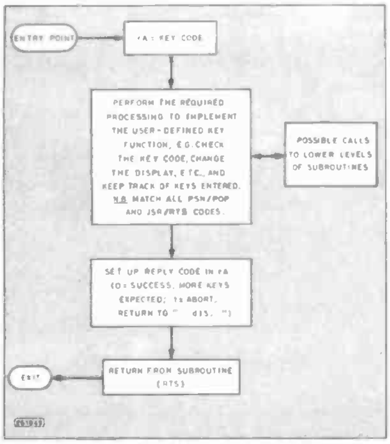


Fig. 1. Structure of a user-defined key function

on the required function and/or available space for code. At the end of the user function, a reply code must be placed in rA before calling the final RTS. This code should be a zero if more keys are expected (e.g. at least four more keys will be required, plus ENTER, if an address is to be specified), or a one if the defined function is finished and a return to the ". . . dIS . . ." prompt is required.

The main routines within DISBUG will only call the defined function routine once for each keystroke, so the number of calls may usefully be counted to keep track of where the function has reached. DISBUG uses the CSW store to hold such a value, and calls an appropriate lower level processing routine (using a look-up table) to process each key entry in turn. Other functions which are performed by DISBUG, and hence are not required within the user routine, are keyboard scanning, decoding, code conversion, latching (looking for new key depressions) and display driving. The user-defined function routines will use the DISBUG stack by default, and may assume that there are eight bytes free on entry; real time clock interrupts and further subroutine levels may, however, extend stack usage into the user stack area. If necessary, therefore, the user stack should be redefined to start at 0390 (rather than 03A0) at the start of the user program by coding LDS#0390 (8E 03 90) as the first instruction.

REAL TIME CLOCK FUNCTION

The routine listed below is one which can be used to redefine PF1 to provide a display of the current value of the real time clock. DISBUG maintains a count of seconds since power-up or restart in RAM location called TICK; the count is two-byte, and can thus indicate up to approximately 18 hours. Pressing the PF1 key will cause the seconds count to be displayed as four hex digits, and the display will be updated with the new value every time the "*" key is pressed. The CANCEL key will return to the ". . . dIS . . ." prompt. To use the function, enter the routine in RAM using the memory editor; the routine is relocatable and so may be placed in any convenient memory space. Then, use the memory editor again to set PF1SRA to point to the start of the routine. The new function is now ready for use.

INSTRUCTION	CODE	COMMENT
PFI: CMP A #*	81 1D	; Key=*?
BEQ STAR	27 10	; Yes
CMP A #PF1	81 14	; Key=PF1?
BNE IGNORE	26 1B	; No—ignore it
CLR DATADIS	7F 03 F8	; Clear all . . .
CLR DATADIS+1	7F 03 F9	; except the . .
CLR SEPDIS	7F 03 FA	; 4 address . . .
CLR STATDIS	7F 03 FF	; digit display
STAR: LDA A TICK+1	B6 03 E3	; Seconds LS byte
LDX #ADDDIS	CE 03 FB	; Output 2 LS . . .
JSR TWODIG	BD F8 F7	; display digits
LDA A TICK	B6 03 E2	; Seconds MS b
JSR TWODIG	BD F8 F7	; O/P 2MS digits
IGNORE: CLR A	4F	; Set reply code
RTS	39	; Return

Real time clock display routine

Readers may wish to experiment further with this example by using PF2 to allow the seconds count to be reset to zero or, more difficult, allow the count to be set to pre-defined value. It should be remembered that power-up and restart will reset the values of TICK, PF1SRA and PF2SRA, but that any code written in RAM should be preserved and thus may be reactivated by re-writing the pointers in PF1SRA and PF2SRA.

M. Tooley BA and D. Whitfield MA, MSc

4½ DIGIT FREQUENCY METER

STEPHEN IBBS

THE frequency meter published in Practical Electronics in May '82 was designed to measure radio frequencies up to 600MHz, and for the necessary resolution, 8 digits were needed. However, there are many occasions when much lower frequencies need to be measured, and only $4\frac{1}{2}$ digits would be perfectly adequate, this project aims to cater for these needs. Intersil produce a series of $4\frac{1}{2}$ digit counters: 7224, for l.c.d.; 7225, for l.e.d.; (and 7236 for vacuum flourescent), and details will be given as to how to use either of these. Complicated logic could be designed to provide the necessary store, reset and inhibit pulses, but a much neater and more convenient solution is to use another Intersil device, the 7207A, designed specifically for this function. The chip requires a crystal frequency of 5·24288MHz, and will give 0·1, and 1 second gates, as well as the necessary pulses to control the main counter. Fig. 1 shows the block diagram of the meter.

HOW IT WORKS

The complete circuit diagram of the meter is shown in Fig. 2. The input frequency is fed via blocking capacitor C1 to the input of IC1, a CMOS op-amp connected as a comparator with hysteresis. The other input pin is d.c. biased with R2 and R3, whilst R5 and R6 provide a Schmitt trigger with approx. 0·1V hysteresis, changing state at 2·45V and 2·55V (assuming a 5V supply), to give some protection against noisy input signals. The output from the op-amp consists of square waves at the same frequency as the input, and these go via S2a (explained later) into the input (pin 32) of the counter IC2, that will drive the l.c.d. display direct. This has count inhibit, reset, and store pins on 31, 33 and 34 respectively, and these all require a pulse to 0V to operate, but in a specific sequence.

First the count inhibit must go high so that the counter is enabled. At the end of the gate time (0·1 or 1 sec) this must go low as the store pin goes low to update the output latches, then the reset pin must go low to finish the sequence ready for the next count. The 7207A produces all the necessary pulses in the right order, with the exception of the count inhibit pulse which needs to be inverted. This is performed by one gate of IC5. The 7207A has its own built-in oscillator, requiring a crystal between pins 5 and 6, and two capacitors, which allows trimming to 5·24288MHz. There is also a multiplex frequency output of 1·6kHz but this is not used. The count inhibit pin is also used to control a pnp transistor that activates an l.e.d. to show when a count is in progress.

The outputs from the 7224 are connected direct to the display segments, with the backplane pin of the display connected to pin 5 of the 7224. Whilst the meter was intended primarily for the audio range, 0–20kHz, it is very easy to insert a switch and a 4017 to divide the incoming square waves by 10, enabling much higher frequencies to be measured, with a 10Hz resolution. S2 is a double pole switch, and the second pole is used to enable another gate of the 4070 to invert the backplane frequency and activate

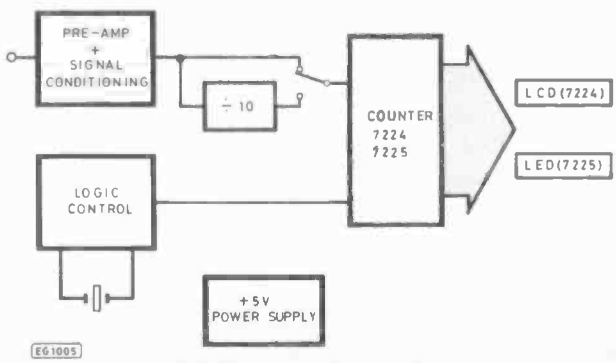
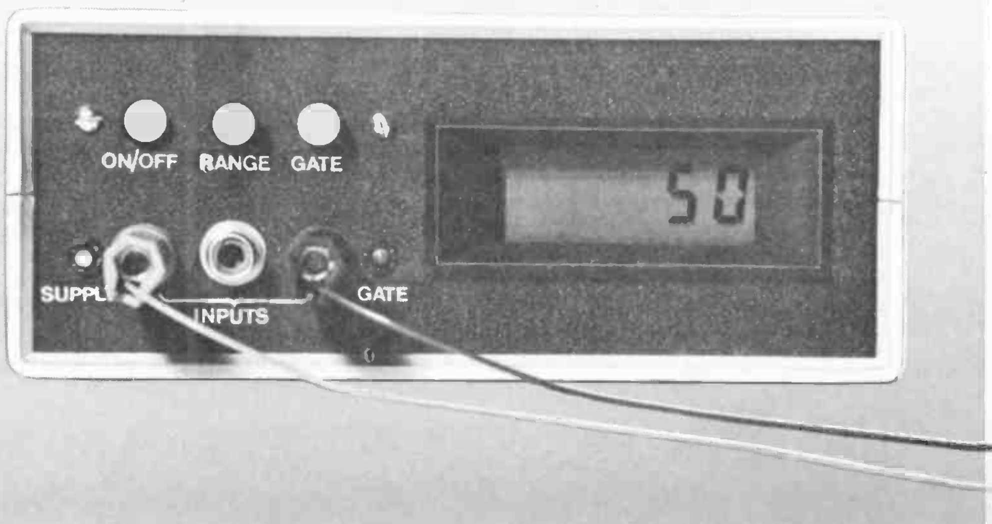


Fig. 1. Block diagram

AN AUDIO RANGE FREQUENCY METER FOR MEASURING 0 TO 20kHz



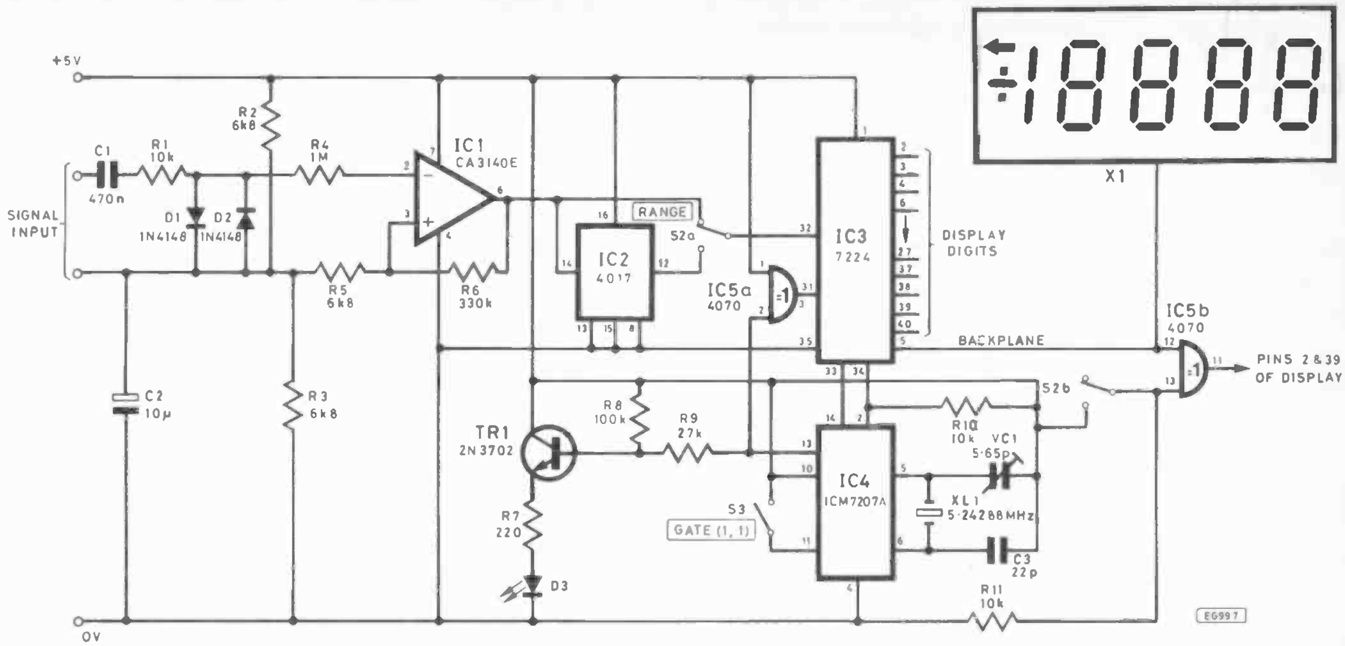


Fig. 2. Complete circuit diagram of the Frequency Meter

one of the 'flags' incorporated in the display to show that the prescaler is activated. Fig. 3 shows what pin is connected to each 'flag', and the author chose to use pins 2 and 39 to give a divide (÷) sign, but this is simply a matter of preference.

The power supply, if included, consists of a 0–6V 250mA p.c.b. transformer, smoothing capacitor and 5V regulator, with C6 and C7 included to aid stability (Fig. 4). The current consumption of the unit is very low, using all CMOS devices, and battery power is a realistic possibility . . . e.g. a PP3 9V battery connected to the input of the regulator. BE WARNED . . . the maximum supply voltage for the counter is 6V. When a battery is used R12 and D4 can be ignored to conserve battery power. If readers would prefer an l.e.d. display (non-multiplexed), the 7225 can be used with exactly the same circuit and p.c.b., except that pin 36 must be grounded (via the pads provided on the p.c.b. for a link), and pin 5 changes from being the backplane pin to a brightness pin (+V for max, 0V for min). A variable brightness control can be provided if a 100k pot is connected across the supply, with the wiper to pin 5. Otherwise, display segment pins are the same. The second pole of S2 can then be used to switch on an l.e.d as an indication of which range is in use.

For those readers who would like to use a vacuum fluorescent display, the 7236 can be employed, with minor changes to the p.c.b., however, the power supply requirements are more complicated, and constructors are advised to consult the Intersil data before selecting this option.

CONSTRUCTION

Constructors are advised to use a p.c.b. for ease of construction, and a suggested design is given in Fig. 6 with the component layout shown in Fig. 7. Mount the components,

COMPONENTS...

Resistors

R1, R10, R11	10k (3 off)
R2, R3, R5	6k8 (3 off)
R4	1M
R6	330k
R7, R12	220 (2 off)
R8	100k
R9	27k

Capacitors

C1	470n polyester
C2	10µ 16V elect
C3	22p
C4	1000µ 16V elect
C5	220n polyester
C6	22µ 16V elect
VC1	5–65p trimmer

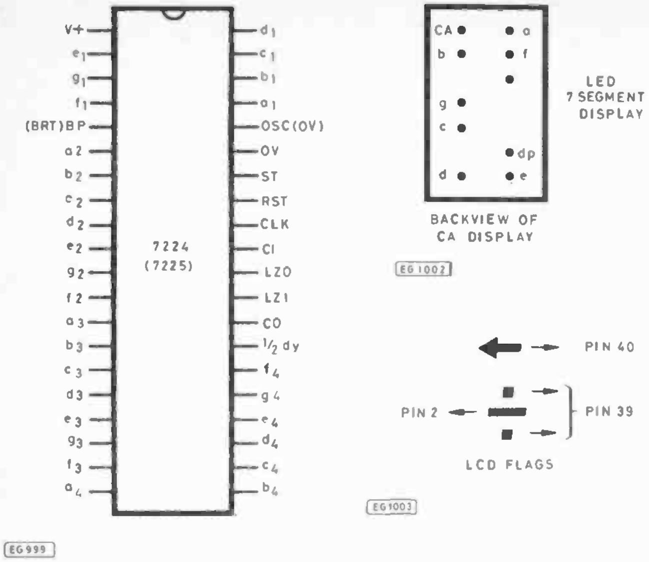
Semiconductors

D1, D2	1N4148 (2 off)
TR1	2N3702
IC1	CA 3140E
IC2	4017
IC3	ICM 7224 (7225 see text)
IC4	ICM 7207A
IC5	4070
IC6	7805

Miscellaneous

X1	4½ digit l.c.d. (RS 587–311)
XL1	Crystal 5·24288 MHz
Display bezel	RS587–282
Case	RS508–649
Transformer	6–0–6V at ·25A (RS207–829)
REC1	1A rectifier
FS1	100mA fuse
Fuse clips	
2 pole push-push latching switches (3 off)	SUE series Ambit
'A' type knobs red (3 off)	SUE series Ambit
3 way 15mm bracket	SUE series Ambit
*Phono socket	
*4mm socket (2 off)	
Strain relief bush	
l.e.d. (red)	
l.e.d. (green)	

*See text



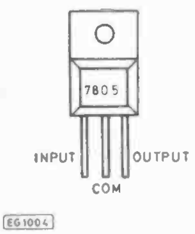


Fig. 3. Pin layout for the 7224 and 7225, rear view of the display, LCD flags and the pin orientation of the 7805

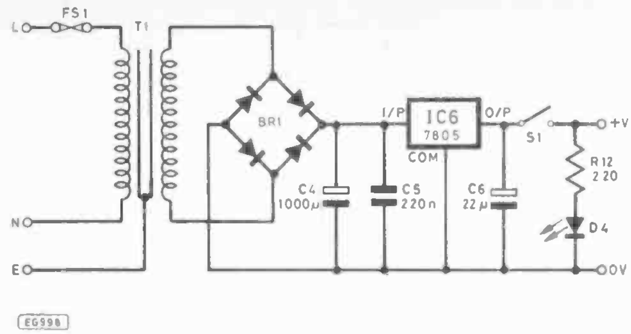


Fig. 4. Circuit diagram for the p.s.u.

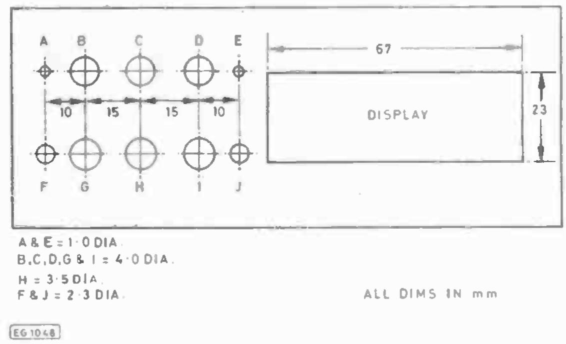


Fig. 5. Front panel drilling details

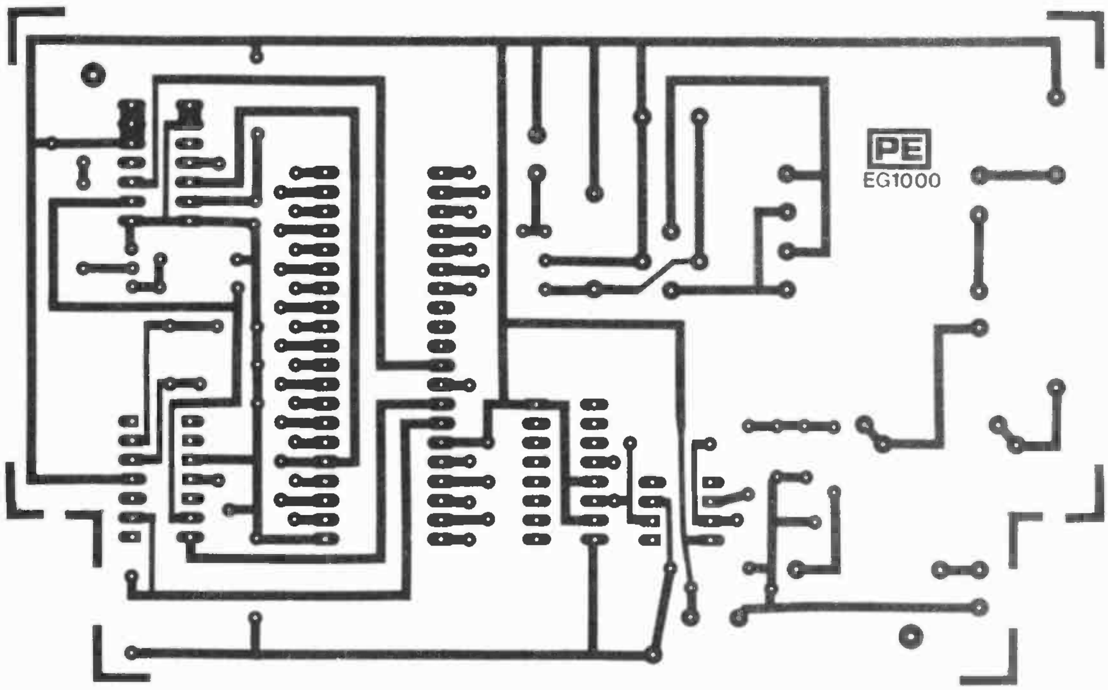


Fig. 6. P.c.b. design

ensuring correct polarity where necessary, and then check the board before mounting it in the case using two bolts and spacers. The interconnections were made using ribbon cable and Veropins and if done carefully there should be no problems. A SUE series switch bank from Ambit was used and the front panel was drilled and cut according to Fig. 5 and the bezel, l.e.d.s etc were mounted. In the prototype, two types of input sockets were included: a phono, and two 4mm sockets, but this is of course dependent on individual requirements. The rear panel was drilled to accept the mains lead strain-relief bush, and then all the necessary connections were made according to Fig. 8. After a final check the

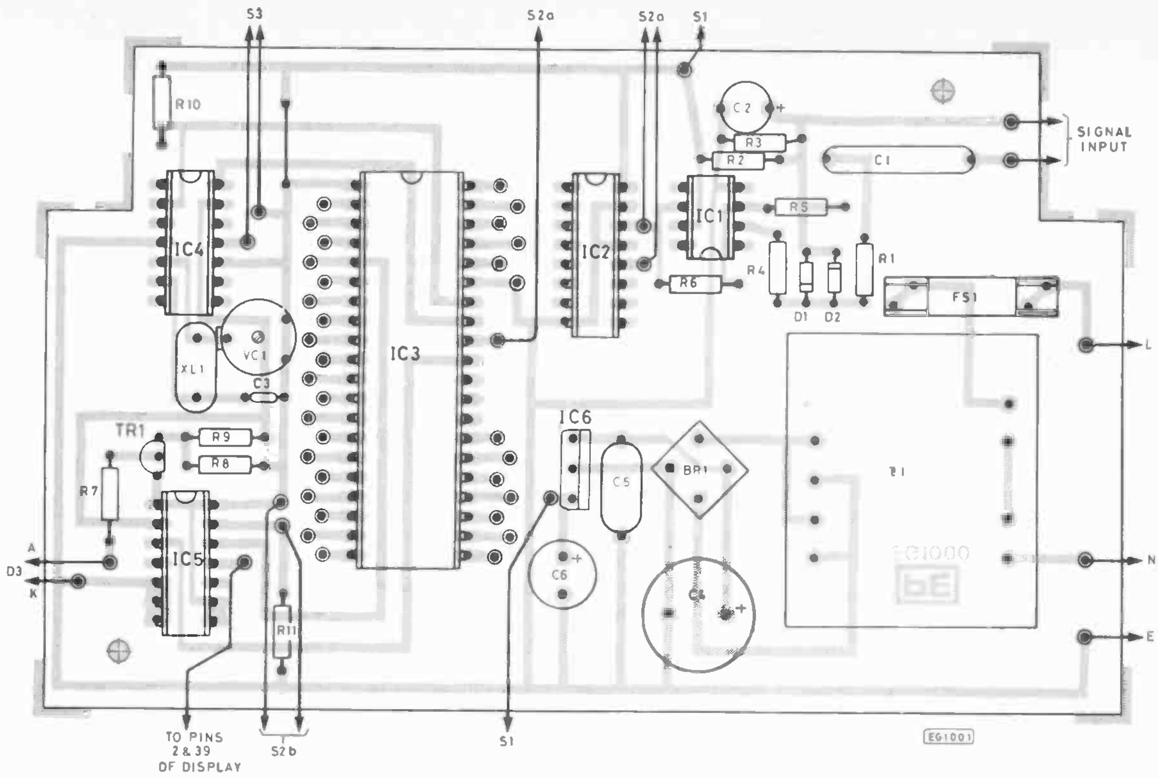


Fig. 7. Component layout

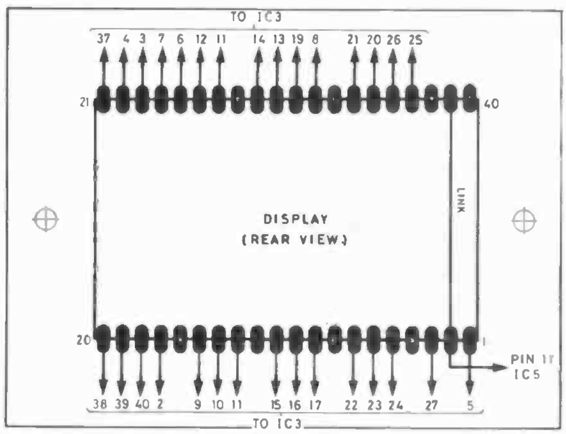


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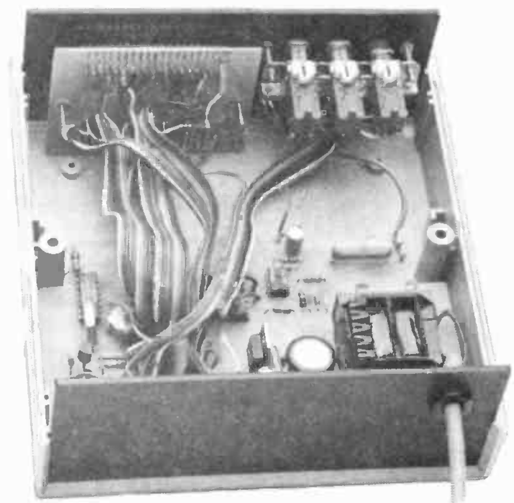
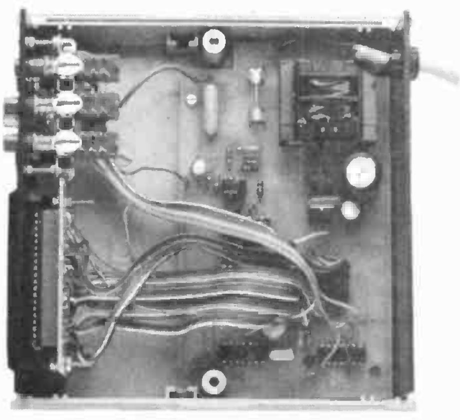
Fig. 8. Display wiring





unit can be switched on, calibrated against a known frequency, and then the case can be bolted together.

CONCLUSION

With no incoming signal, the unit will probably read 50 (mains pick-up), but this will disappear as soon as a signal is applied. Please note that the 'low' input of IC1 is not at earth potential and so should be isolated if an earthed metal case is used. The unit will easily read up to 100kHz, depending on amplitude, above which it is suggested that readers build the 8 digit meter. On the 0–20kHz range, if a frequency above 20kHz is applied, the $\frac{1}{2}$ digit will remain lit, and misleading results will be displayed. To avoid confusion, it is suggested that readings always be made on the high range to start with, and then switched down if necessary. ★

SEMICONDUCTOR UPDATE

R.W. Coles

FEATURING MAA 2000 7114 BU215

DIGITAL TV

If anyone out there is still convinced that the current craze for microprocessors and digital circuits is nothing but a passing fad, I may have some bad news for them, because yet another analogue circuit bastion is about to come under siege, and this time battle will be joined right under our noses in the living-room TV set.

Of course, we have already seen some peripheral skirmishing and some easy victories for the digital cavalry in the form of the first teletext and remote control irregulars, but the latest onslaught will strike right to the very heartland of analogue circuitry, where defences were once thought to be impregnable.

The strike force now being assembled by ITT comprises six divisions of battle hardened VLSI digital chips armed to the teeth with gates, flip-flops, and registers, all determined to rid the living room of those simple but harmless residents of the analogue i.c.s, who themselves once ousted the valves and transistors of yesteryear.

Masterminding the attack will be the MAA2000 8-bit microprocessor which will strike terror into the defenders with infra-red remote control, phase-locked-loop tuning, l.e.d. displays, and a serial bus to control the supporting forces. Next in the order of battle comes the MAA2100 Codec battalion which has some awesome heavy equipment including analogue-to-digital and digital-to-analogue converters, an RGB matrix, a beam current limiter, black level white balance and brightness controls, plus inputs for the dreaded teletext.

In charge of psychological warfare is the MA2200 which handles real-time video signal processing including chroma taping, filtering, and contrast, colour, and hue control. Heavy artillery support will be provided by the MAA2500 deflection controller which can muster video clamping, horizontal and vertical sync, east-west correction and signal standard detection from its comprehensive armoury.

Two digital infantry divisions will also be in support. The MA2400 provides stereo audio processing and the MA2300 contains two 14-bit analogue to digital convertors for the sound channels.

The assault forces make an imposing sight in their 24 and 40 pin landing craft, and their promise of automatic compatibility with NTSC PAL and SECAM standards, dual channel stereo or bilingual sound, and the option of pictures within pictures so that two channels can be viewed at once, is expected to endear them to the local populace.

The result of course, is a foregone conclusion, but isolated guerilla activity from local defence volunteers is expected to continue for some years in such hostile areas as the horizontal and vertical deflection amplifiers.

Personally, I am already dug in behind my favourite armchair, beam-tetrode at the ready, determined to take a few of the blighters with me at least!

BIG BUBBLE

Imagine your pet microcomputer shorn of that troublesome cassette recorder and running a full blown disc operating system with half a megabyte of available storage to hold your compiler, word processor, and space-invader software. Nice thought, but a double-density mini-floppy disc drive is likely to result in a second mortgage or a divorce, and then there are all those motors and heads and drive belts to go wrong, so maybe cassettes aren't so bad after all.

But wait! Now there is an alternative way to that CP/M Utopia you have long dreamed of, in the form of a big new bubble chip from Intel. Hot off the press, their monster new bubble memory, the 7114, offers 4 million bits of non-volatile storage capacity on a chip about half an inch square living in a small 20 pin package.

Bubble memories don't use capacitors or flip-flops to store data like other semiconductor read/write memories. Instead they store data bits as microscopic magnetic domains which can be propagated around loops formed on a magnetic substrate manufactured using a similar fabrication technology to that developed for more conventional devices. Although they operate in a mainly serial mode, more like a floppy disc than a RAM chip, the time to reach a random data item is much shorter than anything that can be achieved with an electromechanical device such as a disc drive, with the 7114 achieving an average access time of only 40 milliseconds.

Perhaps the two most important advantages of bubble memories are their high storage density and their ability to store data without power for long periods, and these features make devices like the 7114 an attractive proposition for disc replacement. The big disadvantage of bubbles is that each chip is expensive, so it is usually uneconomical to make them removable like discs. This could be overcome by loading data into the bubble initially from say, a cassette, a process which would only be necessary occasionally when system software needs to be changed or expanded.

In the 7114, data is stored in 8 octants, each of which has 80 minor loops of 8,192 bits for a total of 4,194,304 bits of storage capacity. Also on the chip are some spare storage loops and a "boot-loop" which is programmed by the manufacturer with information on any faulty loops which testing shows up. During system initialisation, the contents of that boot-loop are read by the 7224 bubble memory controller chip (also available from Intel) which subsequently patches in spare loops to make good any deficiencies.

It is too early to find a 7114 based bubble-disc system available for general use on home computers, but I think we can expect to see one before too long!

LOSS LEADER

Power transistors using MOS rather than bipolar technology have been around for several years now, and their high input impedance and fast switching capability has enabled them to replace bipolar devices like the famous 2N3055 for many applications.

One problem that these MOS devices have always had however, is that when used as a switch, their "ON" resistance has been rather too high for comfort, and certainly a lot higher than that of comparable bipolar transistors. A high "ON" resistance can impose unacceptable losses in some applications, so MOS device manufacturers have been trying hard to improve matters.

A new device in the Siemens SIPMOS power family, the BUZ15, seems to have the measure of the problem since it sports an RDS_{on} of only 30 milliohms. This new capability will undoubtedly open up many new applications areas for MOS devices, especially where power has to be switched with the minimum of resistive loss. The BUZ 15 is a low voltage device for use in 50 volt systems, but in the SIPMOS range there are about 60 different devices, with some operating up to 1kV. One application worth considering is the remote digital control of car lighting systems to reduce the wiring costs, but no doubt there are many others.

AVAILABILITY

Devices featured in Semiconductor Update should, under normal circumstances, be available from good component retailers, but bear in mind that retailers will often not receive stocks of a device until some time after it has been featured in Update.

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6116 P3 150ns	3.85
6116 LP3 150ns	5.75

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7660	2.58
LF398N	5.56
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ZN423 1.26V	1.00
ZN458B 2.45V	1.08
ZN Ref 025 2.49V	1.60
ZNRef 040 4.10V	1.60
ZNRef 062 6.17V	1.60
ZN Ref 100 1.96V	2.56
DVM CHIPS	
ZN450E	7.61
ZN450 KIT	17.35
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LM301AN	0.25
LM308N	0.89
LM311N	0.69
LM319N	2.14
LM324N	0.30
LM348N	0.59
LM555N	0.16
LM556CN	0.45
LM741 (8 PIN)	0.14
LM474CN	0.64
LM748 (8 PIN)	0.34
LM725CN	3.20
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7805	0.39
7812	0.39
7815	0.39
78L05	0.29
78L12	0.29
78L15	0.29
7905	0.55
7912	0.55
7915	0.55
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LM317K	3.20
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8MHZ(UM1233)	4.40
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1.8432MHZ	2.20
2.4576MHZ	2.45
3.6864MHZ	2.95
4MHZ	1.45
6MHZ	1.45
8MHZ	1.70
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CMOS 4000 'B' SERIES	
4001	0.10
4002	0.12
4006	0.65
4007	0.15
4008	0.60
4009	0.34
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

Device	Price
4023	0.15
4024	0.31
4025	0.16
4026	1.29
4027	0.23
4028	0.49
4031	1.69
4033	1.64
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	0.49
4521	1.09
4522	1.24
4526	0.69
4527	0.64
4528	0.69
4532	0.69
4541	0.99
4543	0.79
4553	2.44
4555	0.50
4556	0.50
4585	0.78

NB. Other devices available

74LS SERIES	
00	0.10
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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33	0.14
37	0.12
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	0.18
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	0.36
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

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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24 PIN	5.95
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25 WAY 'D' CONNECTORS

MALE-MALE (36" CABLE)	10.15
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MALE S ENDED (18" CABLE)	5.83
FEMALE S Ended (18" CABLE)	6.25

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10 PIN	0.86
14 PIN	1.22
16 PIN	1.34
20 PIN	1.46
26 PIN	1.76
34 PIN	2.06
40 PIN	2.32
50 PIN	2.70
60 PIN	3.20

IDC Sockets inc 36" Ribbon Cable

10 PIN	1.40
14 PIN	1.82
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20 PIN	2.46
26 PIN	3.24
34 PIN	3.80
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Z80 CPU	0.80
Z80CTC	0.90
Z80ADART	0.80
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Z80PIO	0.90
Z80ASIO	2.00
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6500 FAMILY DATA	
6502	1.80
6520	0.65
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
6800 FAMILY DATA	
6800	4.50
6802	2.80
6803C	1.00
6809	3.50
6810	0.65
6821	1.50
6840	2.00
6845	2.80
6850	1.10
68488	1.50
UHF MODULATORS DATA	
UM1111	0.40
UM1233	0.40
FLOPPY DISC CONTROLLERS DATA	
FD1771	2.60
FD179X	3.00
WD2143	1.00
WD1691	1.10
WD Kits	5.10
MISC. SUPPORT CHIPS DATA	
MC1488	0.90
MC1489	0.90
MC3446	0.60
MC3448A	0.90
MC3480	2.20
MC3487	0.65
MC14411	0.65
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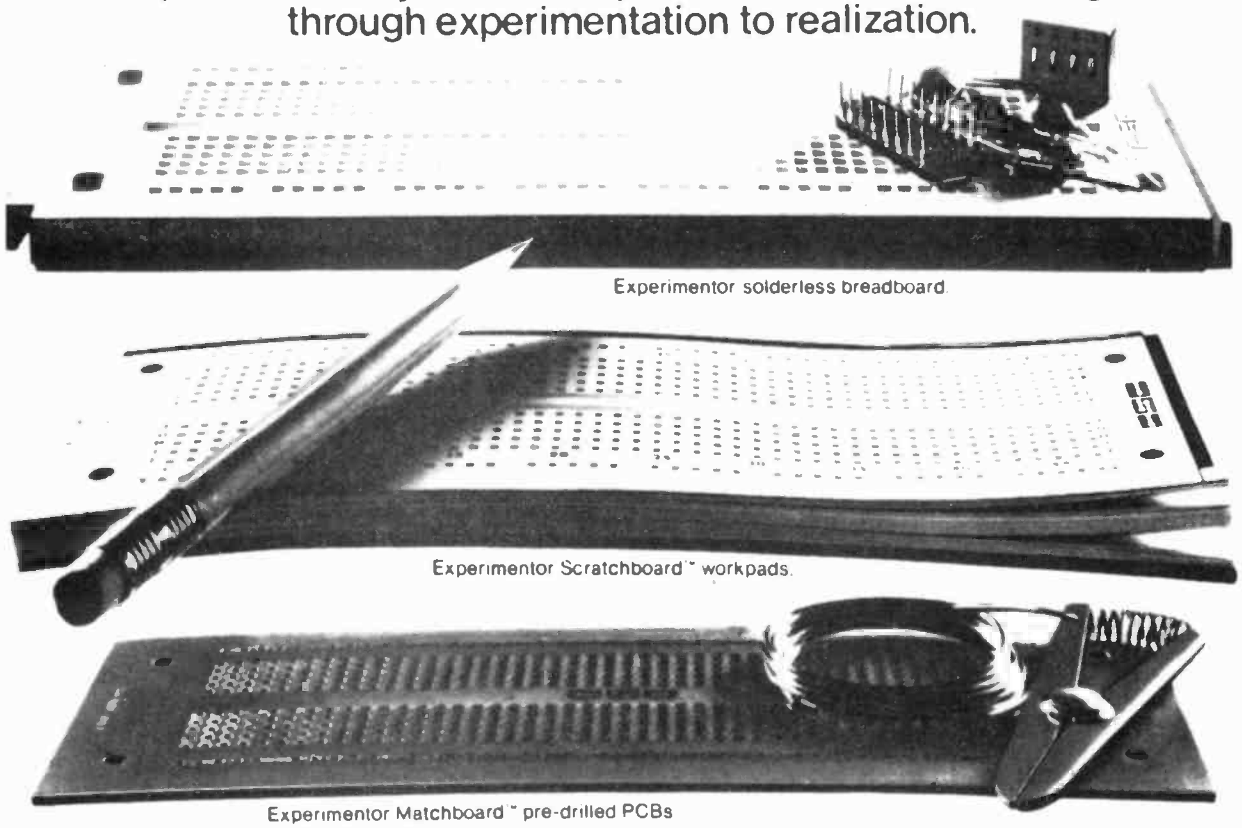
The Experimentor System™—a quicker transition from imagination through experimentation to realization.



Experimentor solderless breadboard

Experimentor Scratchboard™ workpads

Experimentor Matchboard™ pre-drilled PCBs

When you have a circuit idea that you want to make happen, we have a system to make it happen quicker and easier than ever before: The Experimentor System.

You already know how big a help our Experimentor solderless breadboards can be. Now we've taken our good idea two steps further.

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INDUSTRY NOTEBOOK

By Nexus

Getting it Wrong

Sixty years ago when Henry Ford's mass-produced, cheap, universal car (the Model T) was rolling off the production line he saw it as a tool of liberation for the common man. He went even further, forecasting that when the automobile became as numerous in Europe and Asia as in the United States there would be no more war. The automobile, he proclaimed, was the product of peace.

In the event the internal combustion engine became the prime mover in modern warfare and a prime cause of violent death in peacetime, some 8,000 killed on the roads in the UK last year.

Industrialists, of course, tend to be engrossed in the quality of their products, their marketing, and profit. Ford made a fortune through knowing his job. A clever man but not perhaps in the first rank of great thinkers.

Let's then switch to an acknowledged great thinker, an economist who had little interest in money except in its redistribution. Although Karl Marx was buried 100 years ago his name lives on, respected, reverenced or reviled according to political taste. He developed a political and economic theory from social conditions prevailing in Western Europe and more specifically from observation of industrial activities in England, in his day the great centre of the 19th century industrial revolution.

Marx held the conviction that a communist revolution could come only from an industrial society, spearheaded by workers. In fact the revolution came in pre-industrial Russia, subsequently in peasant China and other non-industrial countries. Apart from inspiring a diluted form of socialism, communism has had little impact on industrial Western Europe and, in the UK, which Marx imagined to be fertile revolutionary ground, the impact has been least of all.

Henry Ford got it wrong because the great massacre in the trenches of the 1914-18 war was still fresh in the mind and, in 1923, nobody anticipated the appearance of Adolf Hitler. Similarly, Karl Marx was a creature of his own time seeing only the then long hours and drudgery of factory life. He can be excused for not seeing that in an enlightened capitalist society a production line worker at Dagenham or Detroit would enjoy in years to come a far higher standard of living that he himself enjoyed or even dreamed about. And, moreover, a standard superior to that achieved by ordinary people in what Marx had conceived as a worker's paradise.

Guessing

It is possible for us, in the late decades of this century, to be more percipient? We now have the benefit of instant world-wide communications plus advanced electronic data processing of statistics gathered yearly, weekly, daily, even hourly. Economists, social scientists, defence experts have constructed computer models to handle their respective data to predict the outcome of events. Yet with all this elaborate apparatus, as an end result we only have general trends, feeble guides easily distorted by disturbances that can and do happen almost anywhere.

Looking back to only three years ago I find I was not reporting unemployment. The great topic then was the oil crisis and how alternative energy was needed for salvation. Today the world is awash with oil. There is rationing at the wells in an effort to maintain prices instead of rationing of use at the filling station. Nobody with or without computing aid foresaw such a complete reversal. Equally, nobody predicted the Iranian revolution, the invasion of Afghanistan, the Iran/Iraq war, the Falklands war, the Israeli thrust into the Lebanon, Solidarity and martial law in Poland, or East/West warmish detente degenerating to an approximation of cold war. All these affected international trade and continue to do so.

Who, three years ago, predicted 10 million unemployed in Western Europe, or 10 million jobless in the United States? Or that oil-rich Mexico would become virtually bankrupt, not to mention most of South America, large parts of Africa and the whole of Eastern Europe?

Such is the fragility of society that modern economic forecasting with all its electronic aids is little more than guessing, the computer today's equivalent of the crystal ball, an aid to concentration. A recent comparison of Treasury forecasts for 1983 with those of three respected independant teams, all using computers and economic modelling, revealed none of the leading economic indicators in agreement although thay had a common trend. None were sufficiently up-to-date to reflect an unforeseen fall of five percent in the value of sterling.

Productivity

In the ocean of uncertainty that has afflicted us in the past three years the only consistent current has been the good overall performance of the electronics industry, predicted throughout in these columns without aid of computer but with little fear of being proved wrong. A pity that the NEB-backed electronic office company Nexos foundered with a write-off of £34 million of taxpayers' cash, but heartening to see ICL pulling back into profit. But, viewed as a whole, electronics has been and is the only major growth sector in manufacturing industry.

The snag is that all the expansion in turnover, profits and order books does not lead to a corresponding increase in employment in the industry itself. At shop floor level the old hand-wired products have disappeared and with increasing use of LSI and VLSI the labour content ever decreases.

Even worse from the national and political viewpoint, a substantial proportion of the output is skilfully designed to put people in other industries out of work in the interests of productivity gains.

It is interesting to note that even now, after massive shedding of labour in the older industries, Britain is only 13th in the world league table for competitiveness, actually slipping back a place on the previous year. It is little comfort to learn that France slipped worse, from 8th to 15th, or that New Zealand slumped from 10th to 20th place.

Leaders are Japan, Switzerland, USA, West Germany, Canada and Australia in that order according to the European Management Forum which uses a complicated formula reported to consist of 245 criteria to arrive at their conclusions. When crowing about productivity gains we too often overlook the probability that all our competitors are making similar progress. We have to run to stand still in relative terms. We need to run even faster to gain on the leaders.

On the employment front the one heartening aspect is the apparently insatiable demand for graduate electronics engineers and applied physicists, particularly those with expertise in microprocessor hardware and software, and in telecommunications.

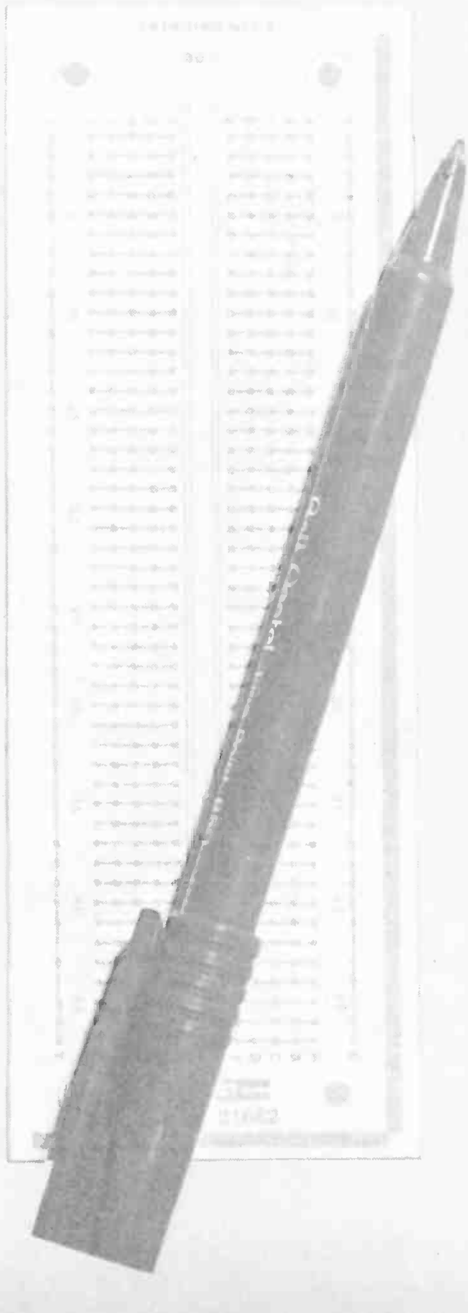
Offshore

Electronics has done well for North Sea oil and had done well out of it in exploration, monitoring, control and communications equipment. A typical oil platform can have as many as 20,000 information points to provide an operational overview and malfunction alarm system, with input data constantly scanned and analysed by computer. The experience gained in the hostile environment of the North Sea has snowballed into export orders from other parts of the world.

A general misconception is that Britain has now an oil-based economy. True we are self-sufficient, even a nett exporter. True we are listed in the top ten producers in the world. But offshore oil and gas together represent only some five percent of our Gross National Product, less than the construction industry and a mere fraction of that of manufacturing industry. In fact, despite present difficulties, we remain relatively a rich country with a well-diversified economic base.

CIRCUIT LAYOUT SIMPLIFIED...

Demonstrating the 'Experimentor' breadboard system from GSC with a combination protected two tone case alarm by R. A. Penfold



IF you have never built projects before and particularly if you have never tried a solderless breadboard this is for you. For qualification, a breadboard is a basic framework on which electronic components can be mounted and wired for preliminary circuit tests, so called because the foundation units were actually wooden breadboards. However, with the 'Experimentor' System from GSC featured here we have moved far from this rudimentary description.

The most fascinating aspect of solderless breadboarding is that designs can be conceived or copied and their applications explored with the promise of total component retrieval at the end. This means that the suitability of a published circuit for a particular role can be explored or rejigged before hard-wiring.

The key feature of the 'Experimentor' breadboard is the basic connector. This is slotted to form five independent pairs of sprung fingers which are placed behind a row of holes in an insulating carrier. The five contacts are electrically common, that is, any leads plugged into the same group are connected together.

Beside the groups of common contacts run the two supply lines made up of parallel strips of connector.

The hole spacing on the board makes up a 0·1in. grid which is compatible with virtually all electronic component mounting arrangements. A 0·6in. centre channel allows the mounting of integrated circuits and other devices with wide spaced leads.

THE SYSTEM

The Experimentor System (Model Exp-304) consists of the breadboard, two pre-etched pre-drilled p.c.b.s and a 50 sheet Scratchpad with each sheet printed with a full sized layout of the hole and connection pattern of the breadboard on which design layouts can be recorded. This means that the p.c.b.s can be loaded from the breadboard and soldered once a design has been finalised.

A simple circuit is now presented to demonstrate the system. To gain familiarity you should try to relay the design to the free Scratchpad with the intention of cutting back on link wires and board space used. It can then be built on a breadboard and tested.

This unit is designed for use in a brief-case, shopping bag, etc., and an audible alarm is activated if someone opens the case or bag in which it is placed. It could also be used in a cupboard or drawer in which valuables are stored. The alarm is triggered by a transition from darkness to relatively bright conditions, and modifications to the case (or whatever) in which the alarm is used are therefore unnecessary.

The circuit has both switch-on and switch-off delays so that there is time to place the unit in the case and close the case before the alarm becomes active, and there is a short delay before it sounds once the unit has been triggered. This gives the user time to switch it off before the alarm operates. The switch is a simple combination type so that there is no easy way for anyone who is unfamiliar with the combination to quickly switch the unit off.

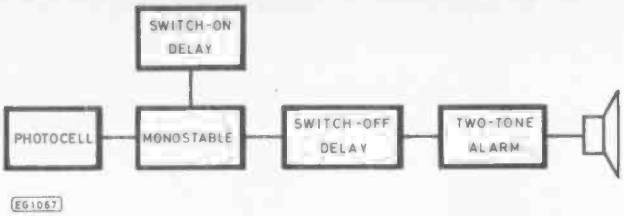


Fig. 1. Block diagram of Case Alarm

THE CIRCUIT

Fig. 1 shows the block diagram of the Case Alarm.

A photocell is used to monitor the light level and it triggers a monostable multivibrator when a suitable increase is detected. However, a delay circuit is coupled to the monostable and prevents it from operating until a few seconds after switch-on so that the delay is obtained. The two-tone audible alarm is operated from the output of the monostable, but another delay circuit is connected between these two stages so that the switch-off delay is produced.

The alarm would normally be switched off soon after it has sounded, but it will anyway after about one minute since this is the length of the output pulse from the monostable.

The full circuit diagram is shown in Fig. 2.

IC1 is used as the basis of the monostable, and the 7555 is used in preference to the standard 555 because of its lower current requirement. This gives the circuit a current consumption of only about 90 microamps and enables the circuit to be powered economically from a small (PP3 size) 9 volt battery.

At switch-on C3 is uncharged and zero volts is supplied to pin 4 of IC1, thus preventing the monostable from functioning since an input potential of about 0·5 volts or more is needed at pin 4 of IC1 in order to permit normal operation of the monostable. C3 charges by way of R5 though, and after about ten seconds the potential fed to IC1 pin 4 from C3 (via the potential divider formed by R6 and R8) is sufficient to give normal operation of the monostable.

R1 and photocell PCC1 form a potential divider connected across the supply lines, and with the cell subjected to dark conditions there is virtually the full supply potential at their junction due to the consequent high resistance of the latter. If PCC1 is subjected to a transition from dark to light conditions a negative signal is produced due to the large fall in its resistance. This signal is coupled to the trigger input of IC1 by C1 and the monostable is activated. R2 and R4 bias IC1's trigger input above the trigger threshold voltage under stand-by conditions.

R2 and C2 set the nominal output pulse duration at a little

COMPONENTS

Resistors

R1	22k
R2, 3, 4	1M8 (3 off)
R5, 8	1M (2 off)
R6	8M2
R7	150k
R9	5k6
R10	4k7
R11	2M7
R12	15k
R13	100k
All 1/3W 5%	

Capacitors

C1, 5	100n polyester (2 off)
C2	33µ 10V tantalum
C3	10µ 25V axial elect.
C4	4µ7 63V axial elect.
C6	10n polyester
C7	1µ 63V axial elect.

Semiconductors

IC1	ICM7555
IC2	4001BE
TR1	BC109C
TR2	BC179
D1, 2	1N4148 (2 off)
D3	BZY88C6V2 Zener

Miscellaneous

LS1	PB2720 ceramic resonator
S1, 2	6 way 2 pole rotary switches (2 off)
PPC1	ORP12 cadmium sulphide photocell
B1	9V PP3 size
Case type PB1 (Maplin)	
Printed circuit board	
Battery connector	
Control knobs	

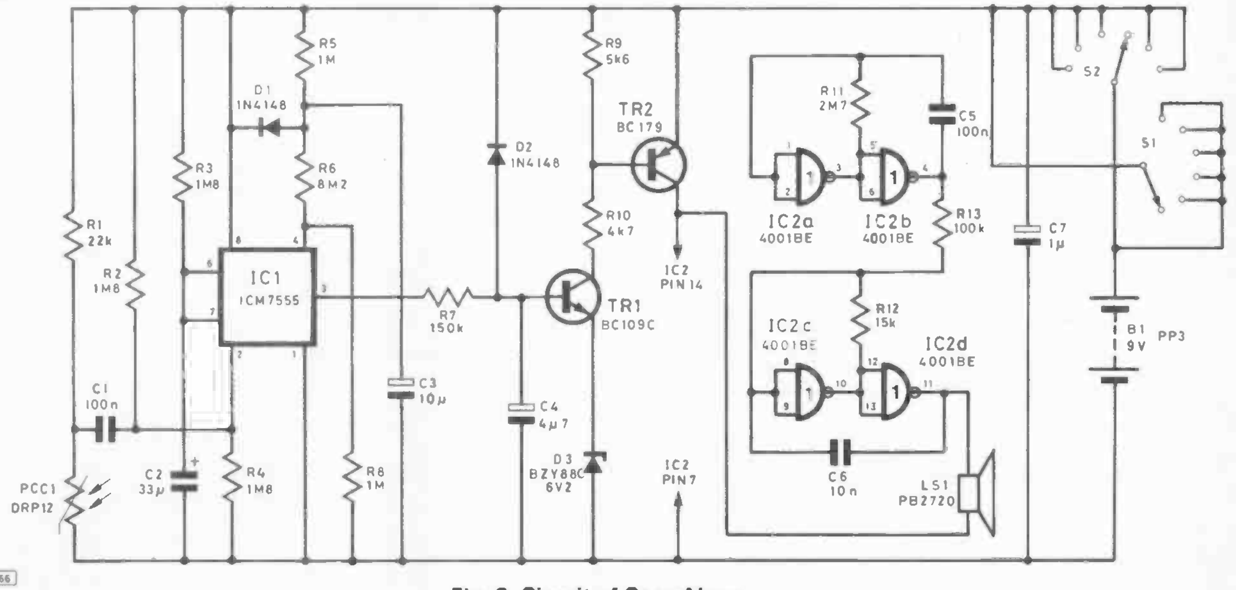


Fig. 2. Circuit of Case Alarm

over a minute, and the alarm signal is switched off at the end of this period. The circuit as a whole is not switched off though, and the unit will be retriggered if PCC1 is again taken from dark to light conditions. If preferred, the automatic switch-off feature can be eliminated by omitting R3 and replacing C3 with a shorting link.

ALARM SIGNAL

The two-tone alarm signal is generated by two CMOS astables which use the two input NOR gates of IC2 in a well known configuration. IC2c and IC2d are used to generate an audio frequency squarewave signal at a frequency of about 2kHz or so, while IC2a and IC2b are used as a low frequency (about 2Hz) astable which generates a squarewave modulation signal. The output of the modulation oscillator is coupled to the input of the tone generator via R13, and this provides frequency modulation with the tone generator being switched either side of its normal operating frequency.

The output of the tone generator is fed to a piezoelectric transducer which is very efficient at the frequencies involved here, and gives a reasonably loud alarm signal despite the limited output current available from IC2d.

Under stand-by conditions the output of IC1 is low, TR1 and TR2 are cut off, and the positive supply is not applied to the alarm generator circuit. When the unit is triggered and IC1's output goes high, TR1 is biased on and in turn biases TR2 hard into conduction so that the positive supply is fed to the tone generator circuit and the alarm sounds. However, there is a short delay while C4 charges via R7 to a high enough potential to bring TR1 into conduction, and this gives a delay of about two seconds between the circuit being triggered and the alarm being activated.

When the unit is switched off D2 largely discharges C4 into the supply lines and D1 similarly discharges C3. C2 discharges via internal circuitry of IC1. The circuit is therefore ready to operate properly as soon as it is switched on again.

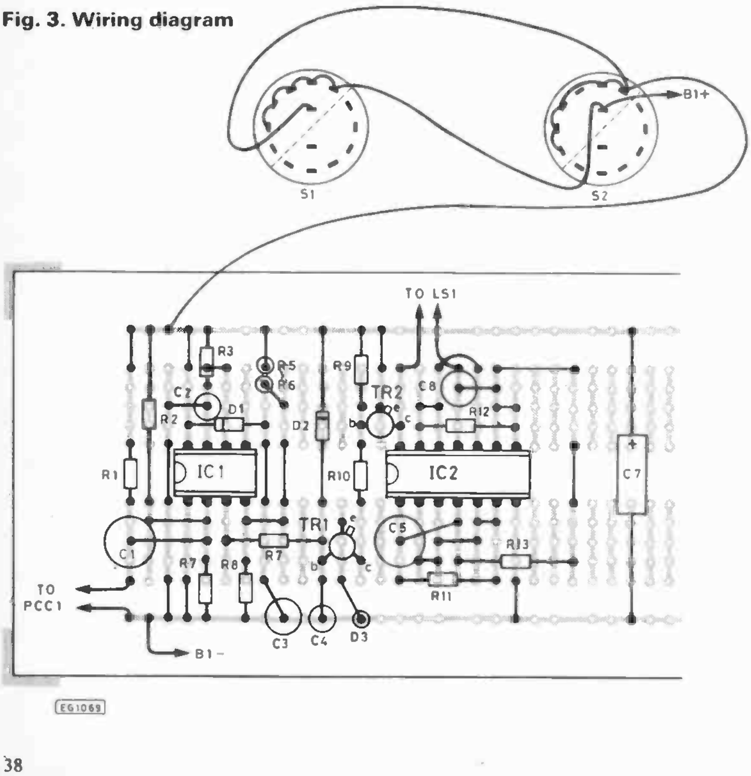
The on/off switch is actually two six way rotary switches connected in parallel, and each switch only cuts the supply in one of its six positions. It is therefore necessary to have both switches in the correct position in order to turn off the alarm. Without knowing in advance which is the correct position for each switch it is obviously impossible to quickly find these positions, and nothing more elaborate than this simple combination lock technique is needed in this application.

The cased, final unit

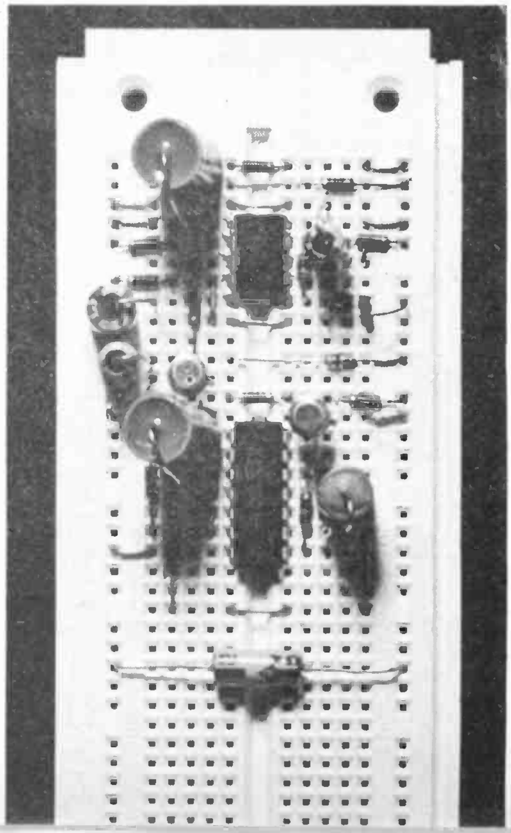
IC2 is a CMOS device and the appropriate handling precautions should be taken when dealing with this component, but as it is a very inexpensive device it is probably not worthwhile fitting it in an IC socket. IC1 is also a CMOS integrated circuit, but as it has a very effective internal protection circuit it does not require any special handling precautions.

When checking the completed unit bear in mind that it responds to a change from dark conditions to comparitively bright conditions after the switch-on delay has elapsed. Simply switching the unit on and leaving it in a normally lit room, or taking the unit from darkness to light immediately after switch-on will not result in the alarm being triggered. ★

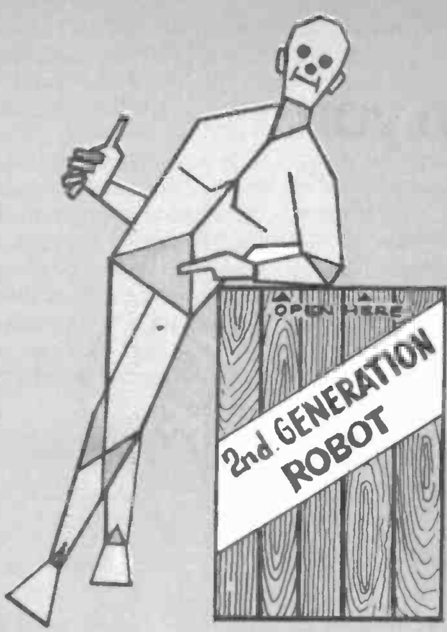
Fig. 3. Wiring diagram



Photograph of the built breadboard



NOT SUCH A RUMB DOBOT



L.N. OWEN B.Sc.

FEW people realise that the increasingly popular industrial robot has been in working existence since 1962; the result of a patent filed in 1954 by George Devol and the business acumen of Joseph Engelberger. However, much of the literature we come across today is not so much concerned with these dumb, re-programmable, open-loop machines, but with the 'sensible' or second generation robots—these are the impetus behind the recent upsurge of robotic interest. The initial stages of robot development have already passed, the next stage of growth is in robot intelligence and its associated 'intelligent' functions.

The first point, which must by fully appreciated, is that robots are machines and, providing our ethics are stable, always will be. As machines they are provided with a limited intelligence in order that they may make a number of valid decisions and thus reduce human intervention to a minimum. In other words robots are versatile machines which can work on their own. To achieve this the robot can be on one of two possible levels of development: The first generation robot, as mentioned above, is generally senseless (n.b. it has an open-loop control system). The operation of such machines depends upon the robot's repeatability—the action of repeating tasks over and over with little or no loss in accuracy. The open-loop system assumes good repeatability and thus assumes a specific and constant output will be achieved for a given input. Hence, first generation robots fall short of our requirements: Being open-loop they have no feedback concerning the actual output and, the robot has no knowledge or perception of either its surroundings or its workpiece.

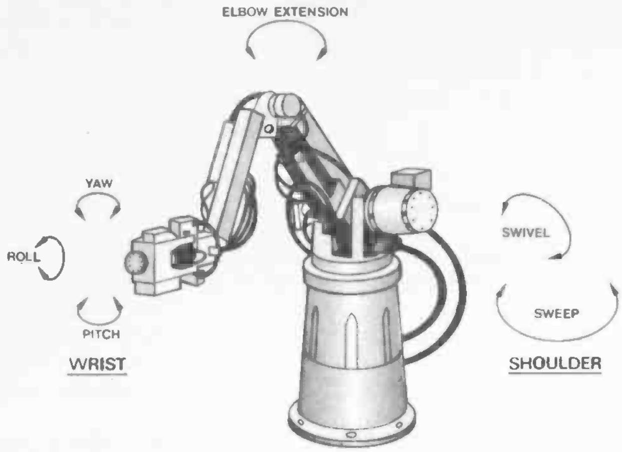


Fig. 1. Anthromorphology of a robot arm

The second generation is attempting to overcome this unawareness by equipping machines with senses and applying artificial intelligence techniques in order that the senses may be used in a human-like manner. In a nutshell, the most critical element in robotics is the interface with the environment, both in sensing (input) and manipulating (output). Until recently the current technology offered much on the output side but was lacking considerably on the input interface. Obviously the direction for research and development is in the application of sensors, the question therefore is how?

HUMAN MODELLING

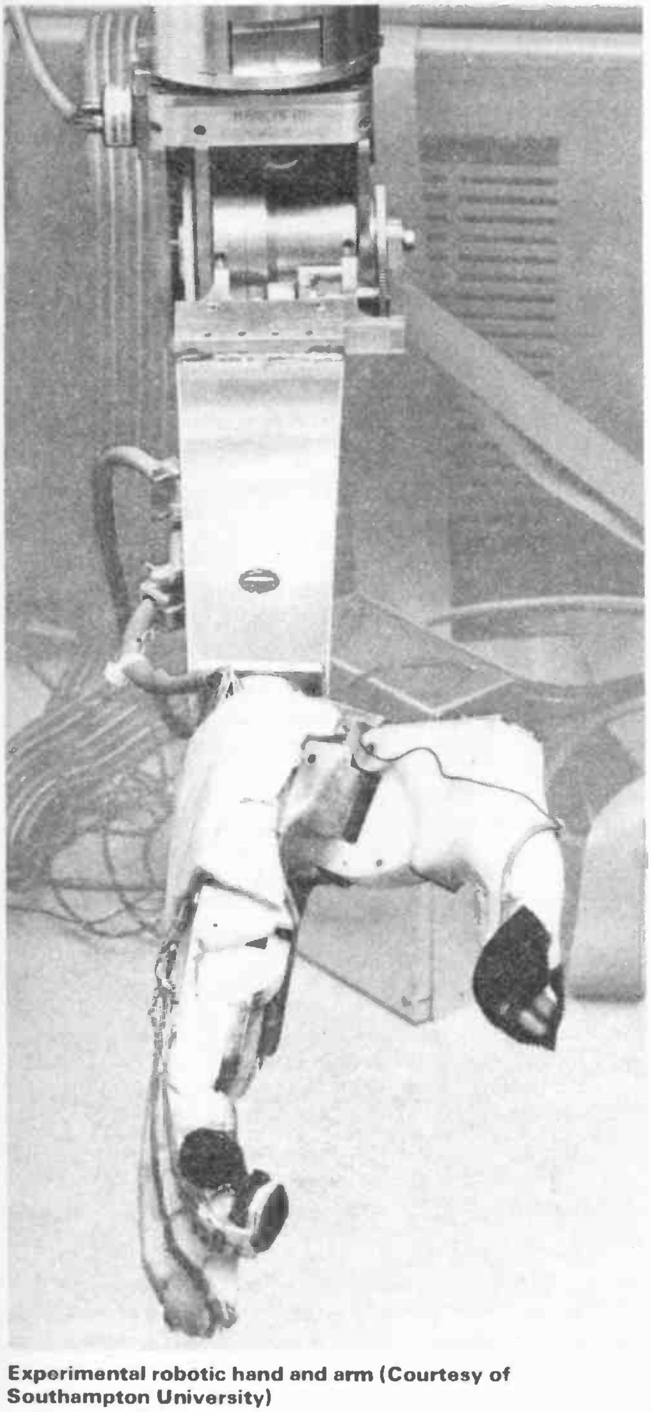
The human being is the best all round example of a perceptive, receptive and reactive control system. Because of this engineers are continually looking towards the human 'modus operandi' for solutions to robot design. First generation robots based many of their characteristics on the human arm (Fig. 1). For example many robots can swivel and sweep about a shoulder joint, bend at the elbow, bend and swivel at the wrist, and have various hands fitted (end-effectors). Naturally, second generation robots are inspired by human senses and the operating mechanism of the brain.

Each of our senses is dependent upon a particular, dedicated sensor mechanism which converts informative stimuli from the environment into electrical signals for the nervous system, and thence processed in the brain. The extremely complex arrangement which constitutes the human sensory system can be summarised according to the type of physical input and hence the corresponding response mechanism evoked. They are:

VISION	The perception of electromagnetic radiation in the 400–760 nm wavelength.
HEARING	The perception of oscillations of air pressure in the 20–20kHz frequency band.
TASTE/SMELL	Chemoreception of odorous molecules.
TOUCH	a) The perception of physical contact b) The perception of electromagnetic radiation in the form of heat (>760 nm wavelength).

All these sensory mechanisms are also capable of providing the associated direction of a particular stimulus, the reason being that more than one receptor acts at any one time and thus the brain is able to compare stimuli within both dynamic and directional frames of reference.

To generalise, the ability to detect a stimulus, find its range and to determine its relative direction are both necessary and sufficient for the intrinsic intelligence of the control system to respond to, and interact with. The greater the amount of useful data supplied to the controller, then the more complex an interaction is possible to increase the complexity of the workpieces and their orientation, handle a variety of components, and cope with non-uniform backgrounds (e.g. picking single components out of a bin of many types of workpieces all mixed together).



Experimental robotic hand and arm (Courtesy of Southampton University)

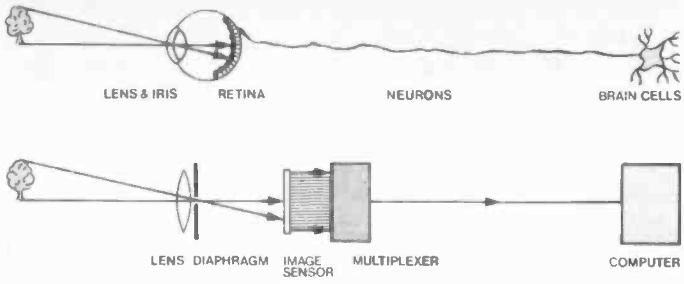


Fig. 2. Comparison between human and machine vision

The process which gives sight to robots is directly based on the human model. This consists of a lens, receptor and control unit (Fig. 2). Our control over such a system is unconscious, but to a computer there are two major problems: Firstly the scene has to be analysed into a number of discrete areas, each of which must be quantified according to the system's operating parameters. These are a series of rules which are valid for interpreting the nature of the image. By 'nature' we mean the length and position of boundaries between objects, light intensity, surface orientation to the camera, reflectance, etc. Secondly, all this data has to be analysed to make a tangible 'picture'. This is usually a vast amount of input information. For a single television picture, in colour, approximately 1Mbit of data is required for digital transmission (e.g. 1 page of PRESTEL, TELETEXT, etc.). This amount of data handling contains the intrinsic problem of speed. If the computer is unable to process its data extremely quickly then the manipulator may be given instructions which are simply too late to be of any use. In practical systems this means that the robot's camera receives an image, processes the useful data, and then directs the manipulator in the appropriate direction. The whole operation must take place in the order of 0·1 seconds. This demands a great amount of computer power and even then is pushing it to the limits.

The basic difficulty involved is the way in which computers operate. Information is processed serially, that is, one caclulation after another. Attempts have been made to improve the data handling of microprocessors by using hardware solutions such as arithmetic units and other miscellaneous functions. Also, there have been recent developments in array processors which act as a series of independent CPUs but constrained to a function within a single architecture. This then provides a form of parallel processing which is ideally suited to pattern recognition systems. Present research is also concerned with the development of new languages incorporating a decision making structure which therefore lends itself to sensory analysis applications (e.g. LISP, PROLOGUE, etc.). The techniques employed are drawn from current artificial intelligence findings.

The remaining parameter controlling robot vision is cost. Even with the recent drastic reductions in hardware prices, the vast power required does not come cheap. Due to this fact there are a variety of seeing robots on the market ranging from rudimentary, 'low cost' types, to the higher end of the market offering a very sophisticated machine. Typically the basic intelligence levels can detect a specific wavelength of light (in some cases this is infra red), assess its intensity and thus define crude borders for a fixed presentation of the workpiece.

The intermediate state-of-the-art offers 'grey-level' processing which in simple terms means that the analysis of a scene incorporates an undescribed state between the black and white pixels, and the associated software allows for this; thus light intensity thresholds are accounted for, which in turn allows for slight variations in the workpiece finish, background complexity, and non-uniform illumination.

The most sophisticated levels of intelligence offer a full analysis of the scene; the number of available pixels is generally greater thus offering a finer definition, the speed of operation is close to real time, and other factors such as colour recognition, shape and orientation, limit setting and adaptive manipulator control are generally available at considerable cost.

TOUCH

For intelligent behaviour the use of vision as a sensory organ not only has excellent power and a peculiar fascination for researchers, but, as mentioned above, has severe practical limitations such as cost, speed and definition when applying our current technologies. On the other hand, a much more viable proposition on the grounds of finance, speed and ease of implementation is that of tactile sensing. In addition to these 'pros', is the argument that the final result of a vision system is for the manipulator's end effector to touch the workpiece and so, development of a strong tactile sensory perception minimises the emphasis of the less practical visual facet.

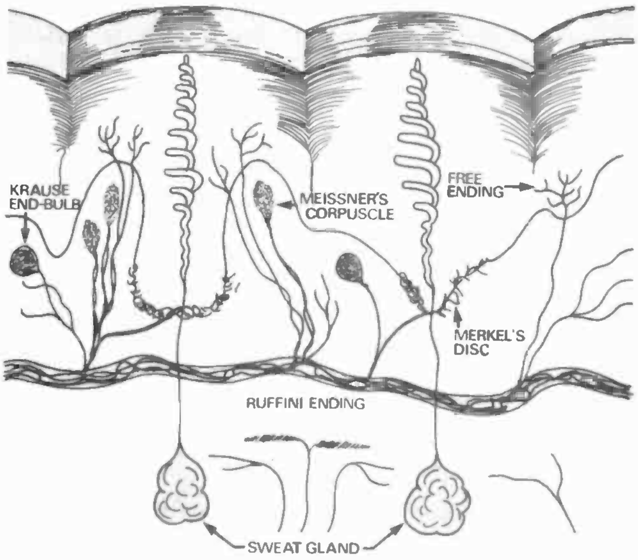


Fig. 3. Cross section of the human skin showing sensory receptors

Referring again to the human model we find that touch is a collection of several types of sensory receptors (Fig. 3). The sense embraces a position sensory (stretch receptors), two types of pressure detectors (one for impact, one for continuous loading), overload sensors (pain detectors such as structural damage or chemical attack interpretors), and heat detection mechanisms. In other words our skin is provided with a multiplicity of multifunctioning sensory organs. However, despite the vast amount of data input there is very little pattern recognition possible. In fact a simple experiment with two pins will show that many areas of the body are indiscriminant over a distance of less than 20mm between points (e.g. shoulder blade region, chest, etc.). The reasons for this are many, the major one being that many sensors use the same nerve channels. This is exemplified by our peculiar response to certain stimuli (e.g. a tap on the back of the neck can often make the toes twitch) and forms the basis for acupuncture. This apparent lack of ability is probably due to our high visual competence in pattern recognition thus eliminating any need for a duplicate role in the tactile system.

What then is the value in developing tactile sensing? Firstly, touch has the distinct advantage over vision in that it is three dimensional in its geometric and its physical structure; hence the vast amount of interpolation which is necessary with a 2D picture is redundant in the tactile domain. It is the geometric factor which makes touch such a valuable sense; this is exemplified in the fact that we use our hands to feel things—the culmination of shape and skin give us direct spatial feedback.

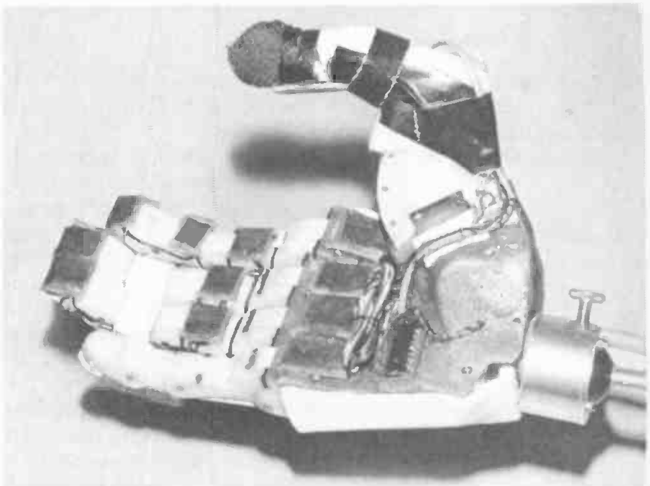
In denigrating the direct pattern recognition abilities of skin the other sensory assets must not be overlooked. The pressure sensors, for example, are extremely sensitive in detecting movement of several microns: (e.g. hairs, grit and dust are perceived when merely falling onto the skin). The remaining major ability touch exhibits is the detection of surface texture. This is achieved by picking up vibrations set up when our fingers are passed over the surface of a material. Our finger ends are specially developed for this purpose in the form of ridges and whorls (fingerprints). Texture detection is largely dependent on relative movement of the skin surface against the sample surface.

Transferring our knowledge from the biological touch processes to the industrial robot gives quite a range for inventiveness; the reason being that there is very little known about the actual workings of biological touch sensors. This being the case, many ideas are currently being experimented with.

For impact detection simple on/off switches are sufficient. Several methods have been used, from sprung flexible circuit board to small piezo-electric elements.

The measurement of load requires some quantitative system, but there are no commercially available sensors which copy the biological model; the response being logarithmic with approximately 30 discrete levels. Strain gauges have been used to some extent but they are limited due to their physical size and their poor susceptibility to noise. Various other resistive devices are being tested. One example is the use of graphite loaded neoprene rubbers in the form of two cords crossed over one another (Purbrick, Univ. of Warwick). The system works logarithmically due to the compression of the two circular cross-sections against each other; however there are still some problems with fatigue life. Another system is to use a felt made form carbon fibres (Dr. M.H.E. Larcombe, Univ. of Warwick). The method of working is the same as with the rubber cords but multiplied many times. Arrays of piezo-electric elements have been used for load sensing, the method being that of measuring the developed potential difference across the device due to the exerted force. The problem arising with piezo-electric cells, however is that the developed voltage decays with time due to the finite input impedance of the measuring equipment. Thus due consideration must be given to time constants when using this method.

Piezo-electric cells are also used in surface texture and slippage detection. The reason being that they are basically microphonic and as such are suitable vibration transducers. Similarly very small acoustic microphones have successfully been used in many different configurations.



Early prototype robotic hand (Courtesy of Southampton University)

A more recent prosthesis shown during gripping exercises (Courtesy of Southampton University)

Various other techniques are still being developed to give a full sensory complement to a manipulator. Research is being undertaken for both industrial robots and in the realm of prosthetics (bionics). Due to the relative 'simplicity' of tactile sensing (to vision), the concept of producing a fully articulate human hand is very close to reality. Several establishments have undertaken such work, one of which, Southampton University/Hangar Ltd., is now preparing the production models. Producing a hand is far more viable, and probably useful, than aiming for artificial sight. This particular hand uses sensory feedback in several of the forms described above to aid control of a number of preprogrammed manoeuvres and hence acting closely to that of a human hand. Knowledge gained from this research is being re-routed into industry by applying the techniques to commercial robots. (hand in hand?)

HEARING

Auditory sense is not widely used in robotics, however there are one or two cases. The subject of hearing can be divided into two sections: rangefinding and spoken instruction.

The rangefinding aspect provides an intermediary between vision and touch. Several systems have been developed using radar and sonar 'send and return' techniques. work has been undertaken at the University of Alabama, USA, in modelling an echolocation system directly parallel to that of the bat. It involves energising an array of transmitter elements and then comparing the phase differences of the reflected waves. The system is then able to determine the direction and the range of an object within its environs. A similar technique is being used by the Wolverhampton Polytechnic/Chubb & Son's Lock and Safe Co. Ltd. teaching company, where an echolocation system presents a viable measurement of distance between a welding rod and a steel joint. In such a hostile environment this proves to be a worthwhile method since touch sensing defeats the objective and vision is usually saturated due to the extreme brightness of the welding arc.

The purpose of using speech recognition is that human beings can tell robots what to do without being tied down to any programming language. This delves deep into complex artificial intelligence techniques. Unimation (UK) Ltd., displayed a speech receptive PUMA robot at the Automan exhibition in summer 1982, but it was confined to a very limited amount of short syllable words. To make robots understand human speech, we must in turn understand the way in which we construct our language. In its base terms, speech recognition is the receipt of aural stimuli and the subsequent interpretation into sounds, then words, then sentences. As humans we are able to focus on one person speaking and developing our own understanding of what he means. Obviously this is very difficult for a computer and because of this little development has taken place. The major problem is not one of signal analysis, despite the complexity of the human voice, but that of understanding. People do not enunciate words clearly and crisply, words merge into each other, word endings are not either clear or correct, words are omitted, etc., and so continuous speech recognition is well beyond our present grasp. Nevertheless much work is being undertaken in this field and there are signs that the barrier is not insuperable.

For the time being industry is only just accepting first generation robots, the operations of which are obviously limited. Very shortly there will be demands for more sophisticated, second generation robots, fully employing their senses of vision, touch and hearing. The more a robot can do for itself, the less it needs to be instructed, the safer and more efficient it becomes. In the twenty or so years of robot existence many people have spent a lot of time copying human characteristics in order to achieve greater machine intelligence and perceptiveness of the environment. From our basic understanding of ourselves it becomes very easy to accept that a human being is human and a robot is, and always will be, a complex and limited machine. ★

Patents Review

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

LOUDSPEAKER DIAPHRAGM

Loudspeaker designers are continually searching for the perfect material from which to mould their cones and diaphragms. Paper produces good results, but is affected by atmospheric conditions. Plastic is immune from atmospheric effects, but is often insufficiently rigid or chemically unstable, especially when exposed to daylight with its ultraviolet content. Over recent years there have been numerous patents for "magic" additives to improve the stability and performance of plastic loudspeaker cones. The latest, and one of the most interesting, comes from Kuraray Company of Japan. European patent 0 061 270 suggests that the performance of a polymer sheet can be greatly improved by incorporating mica flakes in the mix. The patent claims are very broad, covering virtually any percentage by weight of mica additive. So if the patent is granted, and held valid, it would cover any loudspeaker diaphragm made from a mix of polymer and mica flakes.

PSEUDO STEREO

RCA, in New York, has filed a string of European patent applications (numbered 0 060 097) on further developments in the company's ongoing quest for a system to synthesise acceptable pseudo stereo from a mono TV signal. The company has previously patented (see Practical Electronics May 1981, page 53) a synthesis chip for incorporation in a TV set. Now RCA proposes a modified system that can be hooked up to a home hi fi system. The circuit diagram given may suggest ideas for the home experimenter who would like to build their own synthesis circuits.

The crux of the RCA idea is to split the incoming mono audio signal into two halves and put notches in the frequency response of each half. These notches are deliberately mis-matched so that a peak in one channel corresponds to a dip in the other channel. So overall energy dispersion is constant. As shown in Fig. 1 the incoming audio signal is fed to transformer 20 with a centre tap on the secondary to produce two similar outputs, which are oppositely phased. One of these outputs is fed through circuit 50 which modulates the signal in intensity and phase in the function of frequency. In practice this means that notches are introduced at 150Hz and 4·6kHz. Part of this notched signal is bled across to the other channel by resistor 74. As a result of the antiphase relationship the signal at 94 has peaks where the signal at 92 is notched and vice-versa.

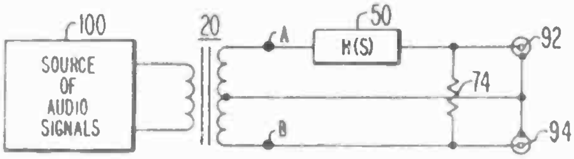


Fig. 1

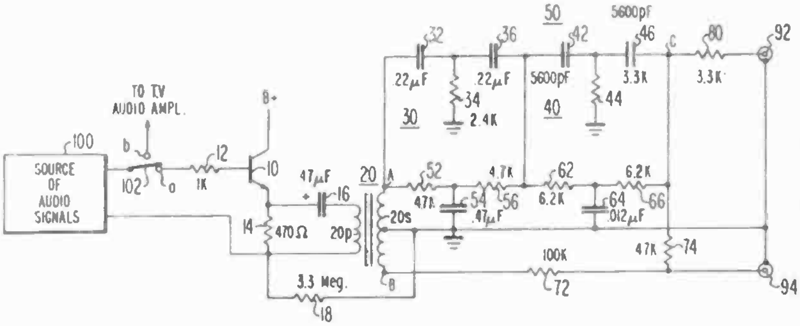


Fig. 2

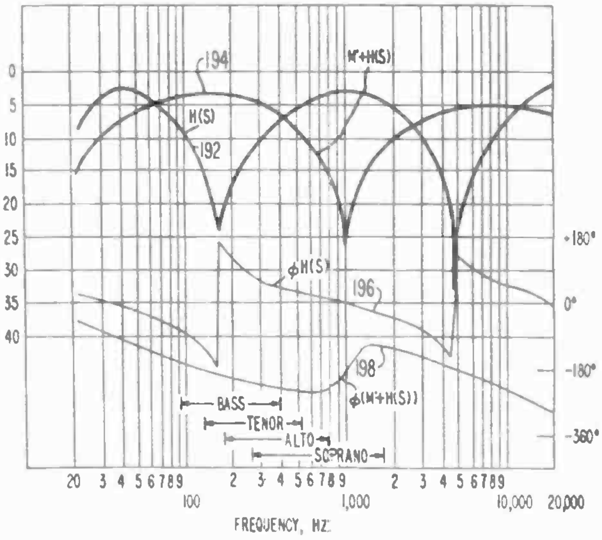


Fig. 3

Fig. 2 shows the layout of the transfer circuit 50, with suitable component values. The first notch filter 30 includes capacitors 32,36 serially coupled between one end of the transformer secondary and the second notch filter 40. This includes serial capacitors 42,46.

The phase response curves 196, 198 in Fig. 3 show how the two channel signals are in a constant phase relationship of 90° between the three notch frequencies. According to RCA this produces a distributed sound field that just extends between the loudspeakers. If the phase differential is less than 90° the distribution is too narrow and at phase angles above 90° it is too wide. The frequency distribution was chosen through analysis of the spectral characteristic of bass, tenor, alto and soprano voices, so that all voices appear to emanate from front centre while the sound of music is spread.

CAR ACCESSORY PSU

Michael TOOLEY B.A. David WHITFIELD M.A. M.Sc.

Provides switched negative earth supplies of 4·5V, 6V, 7·5V and 9V at 1A

THERE are many situations in which it is convenient to use a normal domestic cassette player, radio or other item of battery powered equipment in the car. Unlike car radios, CB sets and specially designed car accessories, most domestic equipment is usually unsuitable for operation directly from a vehicle's 12V supply. Typically, portable equipment is designed to use a number of 1·5V cells, with an overall supply somewhere in the range 4·5V to 9V; portable televisions are the usual exceptions, and most will operate from a 12V supply.

The use of dry batteries can be satisfactory if only occasional and limited use is required. Frequent usage, however, quickly becomes expensive and inconvenient; battery changes are needed more often due to higher volume levels required. The accessory power supply to be described allows most items of battery powered equipment to operate from a standard car cigarette lighter socket. Any equipment which requires a negative earth supply of 4·5V, 6V, 7·5V or 9V may be used, and a regulated output of up to 1A is available. Should no appropriate socket be available, the unit may be wired directly to the vehicle's accessory circuit.

The accessory supply is protected against overload, is simple to construct and install, and requires no setting up procedure. The unit is protected against incorrect connection, and is built in a rugged and compact case. The overall cost is less than £10; a sum which will rapidly be covered by the savings on replacement dry batteries.

The input voltage is likely to contain a substantial amount of noise, and the decoupling capacitors are used to obviate this.

CIRCUIT DESCRIPTION

The circuit for the accessory power supply is shown in Fig. 1. The vehicle's 12V supply is taken from the cigarette lighter socket via PL1,or from the vehicle's accessory circuit if no such socket is fitted. An in-line automotive fuse, FS1, is used to provide protection against possible failure conditions. Reverse polarity protection is provided by D1 as a wrongly polarised supply will forward bias it and cause FS1 to blow.

The voltage regulator, IC1, features internal over-current and over-temperature protection. The device is intended for use in variable voltage power supply applications, and is supplied in a 4-pin plastic package with a metal heatsink tab (which is connected to the common supply rail). The output voltage is set by means of the resistor network R2 to R6, selected by means of S1b. The way in which the output varies with resistor setting is shown in Fig. 2. An indication of which output has been selected is provided by four miniature l.e.d.s, D2 to D5, via S1a. The series output diode, D6, serves two distinct functions. Primarily it allows an output voltage of less than 5V to be produced (this is not otherwise possible, as shown by the equation in Fig. 2) by providing an almost constant voltage drop of approximately 600mV. In addition, the diode provides protection against the unit being accidentally connected back-to-front.

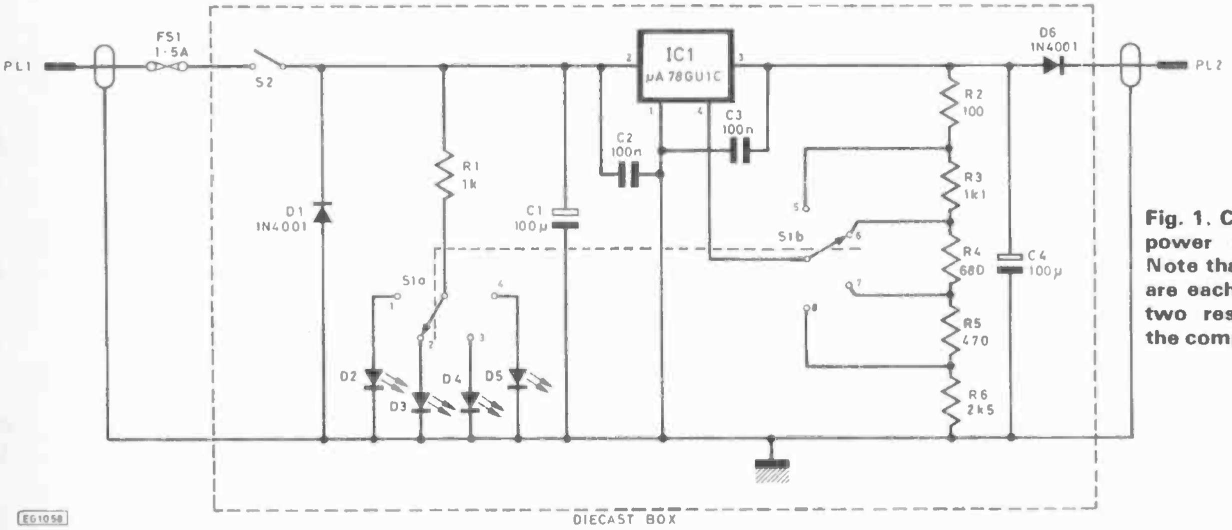


Fig. 1. Circuit for the power supply unit. Note that R3 and R6 are each made up of two resistors as in the components list

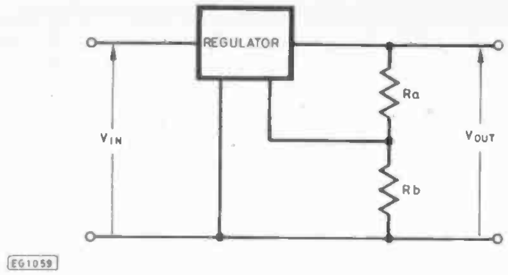


Fig. 2. Setting the output voltage for IC1. Here $V_{out}=5\,(R_a + R_b)/\,R_b$ and should typically be at least 2V lower than V_{in}

ASSEMBLY

A small printed circuit board is used to mount the majority of components inside the diecast box which is used to house the accessory power supply. The component layout for this board is shown in Fig. 4, with the corresponding copper foil pattern shown in Fig. 3. If preferred, constructors may use a similar sized piece of 0·1in. pitch Veroboard in place of the p.c.b. The use of terminal pins is recommended in order to facilitate the connection of the wiring and of the regulator device. The regulator i.c. itself is fixed directly to the base of the diecast box, which it uses as a heatsink, and is positioned close to the p.c.b.

The diecast box should be drilled to allow mounting of the printed circuit board, regulator i.c., l.e.d.s, and the switches. Two additional holes at the rear, lined with rubber or plastic grommet material, are required in order to allow the passage of the input and output power leads; suitable measures should also be taken to anchor these leads. A wiring and layout drawing for the complete unit is shown in Fig. 5. It should be noted that the components in the resistive divider chain are mounted directly on the tags of the selector switch, S1, and two of these resistors, R3 and R6, are actually composites of two components wired in series to give the required value.

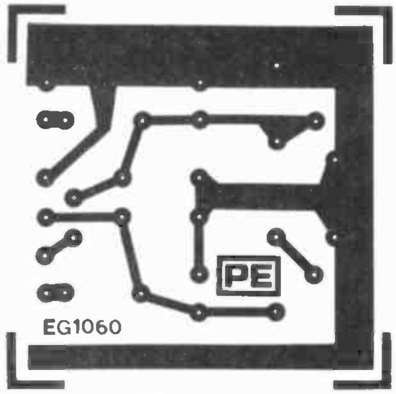
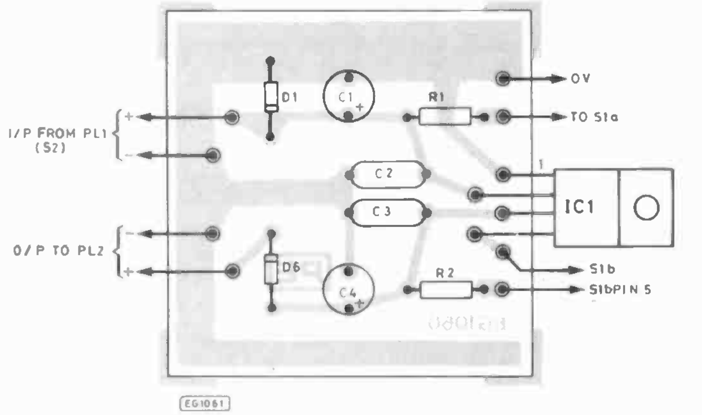


Fig. 3. Etching pattern for underside of p.c.b.

Fig. 4. Component layout of p.c.b. (below)



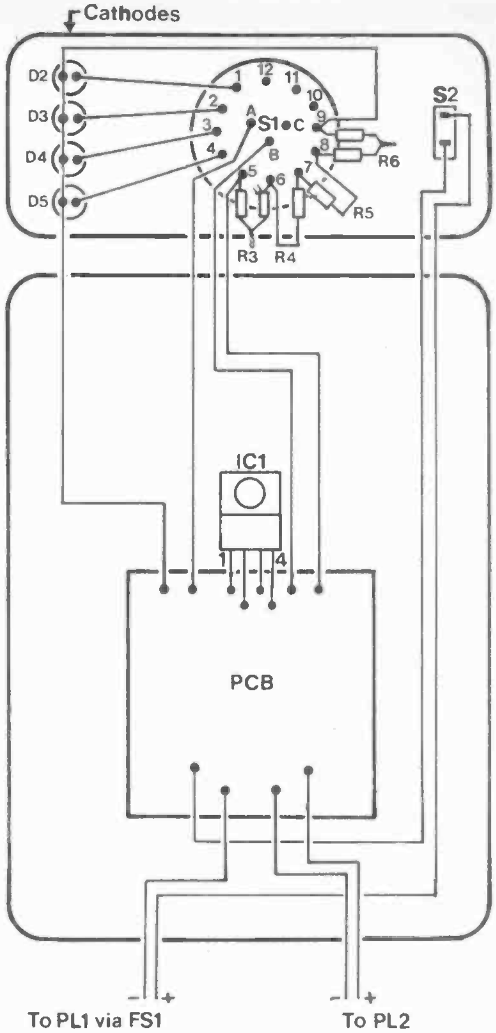


Fig. 5. Case wiring and layout

COMPONENTS

Capacitors

C1	100µ 16V electrolytic
C2	100n polyester
C3	100n polyester
C4	100µ 16V electrolytic

Resistors

R1	1k
R2	100
R3a	1k
R3b	100
R4	680
R5	470
R6a	1k
R6b	1·5k

All 1/4W 10% carbon

Semiconductors

D1	1N4001
D2	0·1in. green l.e.d. plus clip
D3	0·1in. yellow l.e.d. plus clip
D4	0·1in. amber l.e.d. plus clip
D5	0·1in. red l.e.d. plus clip
D6	1N4001
IC1	µA78GU1C

Miscellaneous

S1	3P4W rotary switch
S2	SPST ultra miniature toggle switch
FS1	1·5A fuse and in-line holder
PL1	Accessory socket plug
PL2	Auxiliary supply connector for the portable equipment (e.g. the Maplin universal plug HH38R)

Diecast box 120mm x 65mm x 40mm
Printed circuit board
Terminal pins
Knob

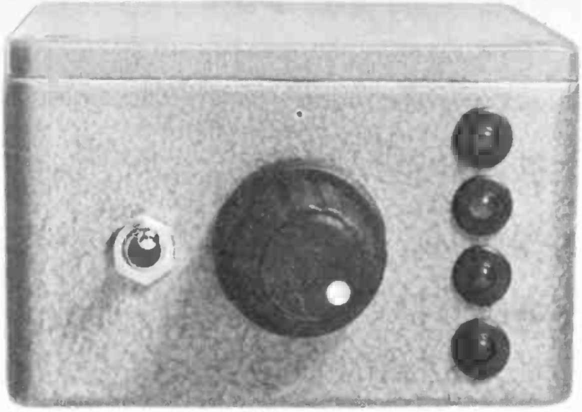
TESTING

When the p.c.b. assembly is complete, it should be carefully checked for dry joints and solder bridges between tracks. A careful visual inspection of the whole unit should include verifying that polarised components (l.e.d.s, diodes, etc,) are correctly orientated. The unit is now reest on either a 12V d.c. supply or on a car battery, via the accessory socket if appropriate.

Connect PL1 to the 12V supply, with S1 set to the 4·5 volt position and S2 set to 'Off'. Connect a suitable voltmeter to PL2. When S2 is switched on, D2 should be illuminated and an output indication of 4·5V should be obtained; any reading within ±5% of the expected value is acceptable. Should no output be obtained and no l.e.d. illuminated, a check on the polarity of the supply, on FS1, and the polarity of D1 and D6 should be made prior to a more detailed examination of the circuit. An incorrect output voltage indicates a possible problem with the resistive divider chain, R2 to R6. A correctly illuminated l.e.d. but no output, could be due to an incorrectly polarised output diode D6.

When the initial test has been completed satisfactorily, the three other ranges should be checked to ensure that their diodes function correctly, and that the output voltage is correct.

In use, range changing should be done without any load connected since momentary transients are possible. When installing in a vehicle, it should be borne in mind that the diecast box is connected to the negative rail by virtue of the common tab on the voltage regulator i.c. As mentioned earlier, the accessory power supply may either be connected in to the vehicle's accessory circuit (when S2 and PL1 may be omitted), or supplied from the cigarette lighter socket. The unit may be simplified for dedicated use at a fixed output voltage by removing S1 and three l.e.d.s, and replacing the resistive chain R2 to R6 by two single resistors of appropriate value.



Control layout of PSU

The accessory power supply may be used to supply continuous currents of up to 1A at the selected output voltage. It should be remembered, however, that with a 13·2V input and an output of 4·5V at 1A, the unit will be dissipating approximately 9W and a certain amount of warmth is to be expected. ★

BAZAAR

UK101 breaking up, Cegmon BASIC–5, 8K–2114, £10 each; case, sound + I/O £15 each. All parts available. Mr. M. A. Saunders, 7 Drumcliff Road, Thurnby Lodge, Leicester LE5 2LH.

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WANTED Rockwell AIM 65 and associated interfaces. Neil Dewar, 24 Nelson Road, Gourour, Renfrewshire. Tel: 0475 36704.

SUPERBOARD II + screen enhancement (20 formats) BASICS: 1, 3, 4, 5, X. Plus loads of extras. Offers? J. Marshall, 8 St. Vincent Drive, St. Albans, Herts AL1 5SJ. Tel: 0727 59397.

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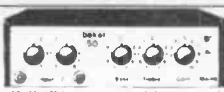

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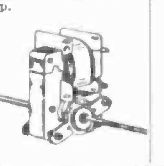

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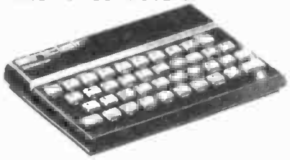

UK prices are shown first. The bracketed prices are export prices which include insured air-mail postage to all the countries of Europe including Norway, Sweden, Finland and Denmark. For overseas customers outside Europe an extra £5 postage per item is charged. ZX81 £43.43 (£52). ZX Printer £52.13 (£61). ZX Spectrum 16K £152 (£160). ZX Spectrum 48K £202 (£210). ZX Microdrive n/a (n/a). ZX RS232 n/a (n/a). 5 printer rolls £10.43 (£16). Ram packs:– 16K £26.04 (£28), 32K £39 (£41), 56K £49 (£51).

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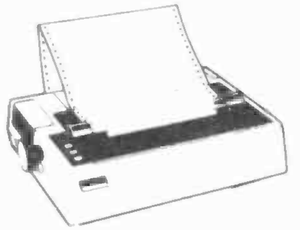
PRINTERS



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THE first part of this series was devoted to interfacing systems which involve purely digital control. This month we shall be concentrating on the interface between the digital world of the microprocessor and the analogue world associated with many external systems and devices.

Digital signals (i.e. those which exist in two states; logic 0 and logic 1) are essential to the operation of logic systems. Analogue devices, by definition, require a continuously variable control signal rather than one which is just simply 'on' or 'off'. Hence there is a need for an interface which can convert digital input signals to analogue output signals, and vice versa.

This second article in the series therefore considers some of the techniques and devices used for digital to analogue conversion. Also included is a practical example of a complete 8-bit digital to analogue converter. Full constructional and setting-up details are also given. This unit is eminently suitable for interfacing a wide range of analogue output devices and thus will be invaluable to anyone using an 8-bit microcomputer (including the PE Microcontroller) in control applications.

DIGITAL VERSUS ANALOGUE SIGNALS

In digital systems two voltage levels are used to represent the binary digits, 0 and 1. Most signal waveforms encountered in the digital world are therefore composed of a series of pulses; the voltage level at any particular instant being in one state or the other. In analogue systems an infinite number of voltage levels are employed and waveforms are therefore continuous rather than discrete. Typical time related digital and analogue signal waveforms are shown for comparison in Fig 1. A digital representation of an analogue quantity may be produced by sampling the waveform at regular intervals. The smoothly changing curve of Fig 1b can, for example, be sampled repeatedly and a digital code generated which approximates to the actual voltage level at the instant of sampling. This process, which is illustrated in Fig 2, is known as analogue to digital conversion and we shall be looking at this in a little more detail next month. If, alternatively, a digital code is used to generate a particular voltage level, an analogue signal can be synthesised in discrete steps, as shown in Fig 3. This technique is, of course, known as digital to analogue conversion.

into the REAL WORLD part 2

CONTROL CIRCUITS

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

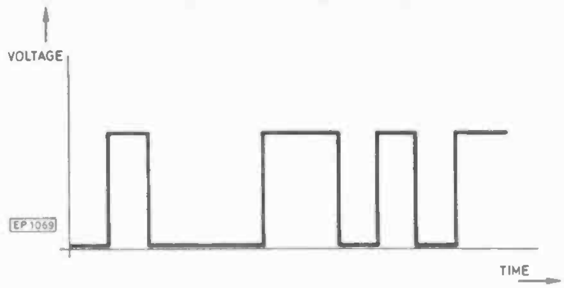

Fig. 1a. A typical digital signal waveform

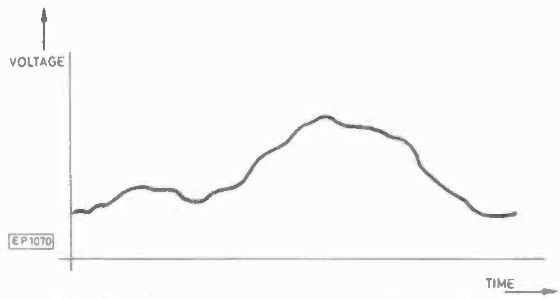

Fig. 1b. A typical analogue signal waveform

Fig. 1. Comparison of digital and analogue signals

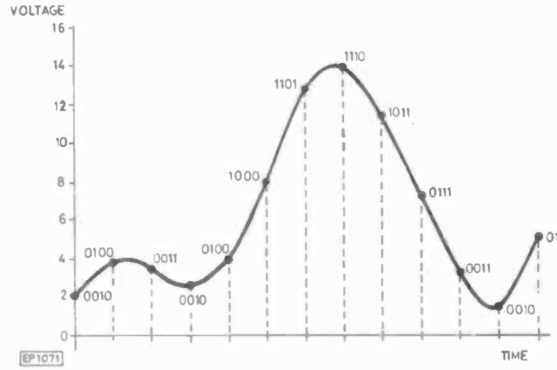

Fig. 2. Digital sampling of an analogue signal (4-bit code)

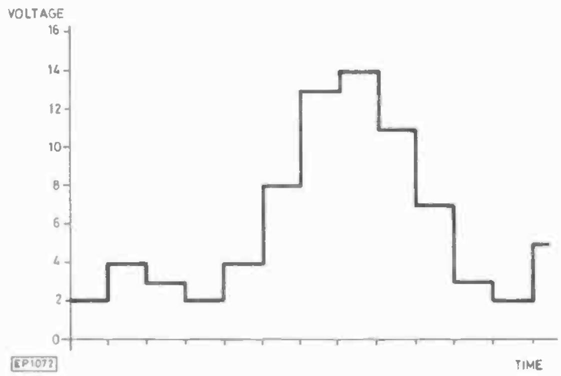

Fig. 3. Synthesis of an analogue signal using digital information (4-bit code)

DIGITAL TO ANALOGUE CONVERSION

One simple method of digital to analogue conversion involves the use of a binary weighted resistor network. A typical arrangement of such a device is shown in Fig 4. The switch symbols are used to represent the logic conditions present on each of the four input lines; logic '0' is represented by 0V whilst logic '1' is represented by +V. Since four input lines are provided the device caters for a 4-bit natural binary coded input, however extra lines can be added as appropriate. An eight bit digital to analogue converter would, for example, require a further four inputs such that one resistor was provided for each input line.

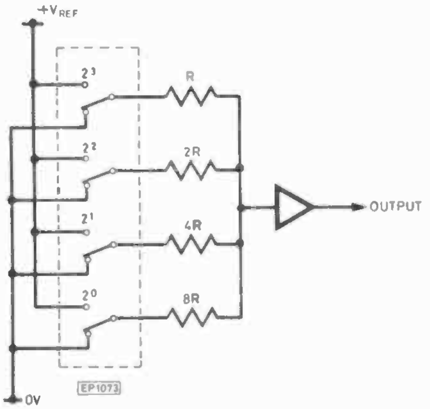

Fig. 4. Simplified form of 4-bit digital to analogue converter using "1–2–4–8" resistor weighting

The binary weighted resistor network is followed by a high input impedance amplifier stage which effectively buffers the network and helps to minimise the adverse effect of loading on the circuit. The amplifier is usually a conventional operational type with the summing junction of the resistor network taken to the inverting "virtual earth" input of the integrated circuit.

The lowest value resistor, R, of the network corresponds to the highest binary weighted input or 'most significant bit' (MSB). The highest value resistor, 8R, corresponds to the lowest binary weighted input or 'least significant bit' (LSB). The current through each resistor is inversely proportional to its resistance and hence the most significant bit will produce a current which is twice that produced by the next most significant bit, and so on. The currents are summed at the input of the amplifier and a voltage is developed which is an analogue representation of the digital input applied to the

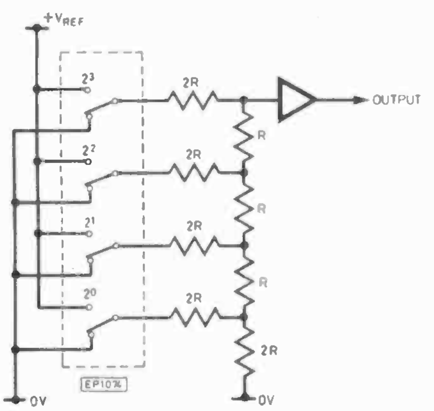

Fig. 5. Simplified form of 4-bit digital to analogue converter using an "R – 2R" resistor network

four lines. The principal disadvantage of this method of conversion is that it requires a number of different resistor values and, where a digital input of 8-bits, or more, is to be catered for, the values of the resistors become somewhat impractical.

Another method of digital to analogue conversion employs a somewhat more complex resistor network which is known as an "R-2R" ladder network. Since only two values of resistor are required, this arrangement overcomes the most significant disadvantage of the binary weighted method. Fig 5 shows a simple 4-bit digital to analogue converter which uses an R-2R network. Each successively lower weighted input produces an output voltage which is exactly half that produced by the preceding input.

The analogue output of a simple 4-bit digital to analogue converter is shown is Fig. 6. Since there are 16 different in-

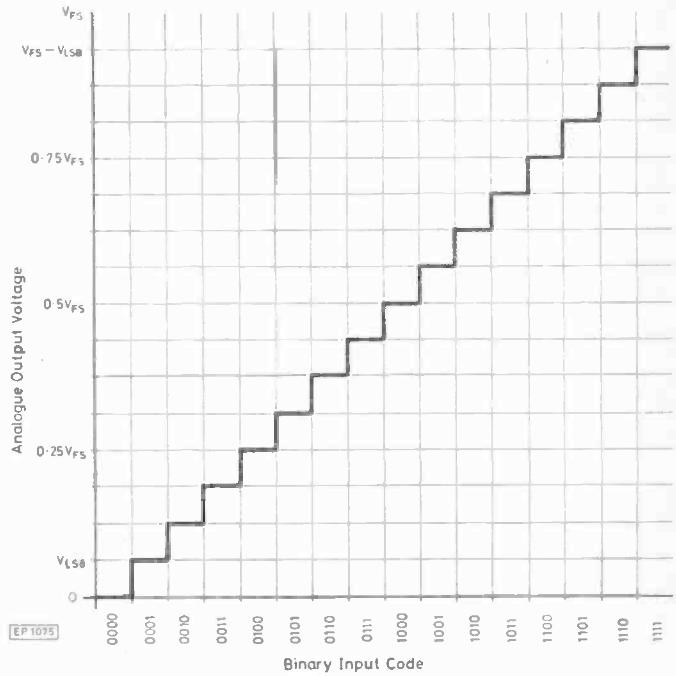

Fig. 6. Coding states of a 4-bit digital to analogue converter

put conditions, the output voltage can take any one of 16 different voltage levels. The output voltage resulting from a binary input code of 0000 is, of course, 0V. The further 15 different input codes permit 15 additional voltage levels, incrementing by the same voltage interval on each successive binary step. The increment in voltage level will be equivalent to the voltage produced by a binary input code of 0001 which is known as the 'least significant bit voltage', V_{LSB}. The voltage level resulting from a binary input code of 1111 will be the full scale output voltage less V_{LSB} (remember that there are only 15 discrete voltage steps excluding the first step which is, of course, zero). The output voltage level produced by a binary code of 1000 (decimal 8) will be exactly half the full scale voltage, and so on. If desired, the output voltage of the converter can be scaled by means of subsequent amplification or attenuation.

Before examining a practical solution to the problem of digital to analgue conversion it is, perhaps, worthwhile introducing some of the terms and expressions which are often encountered with such arrangements. Of these, 'accuracy' and 'resolution' are by far the most important.

ACCURACY AND RESOLUTION

The accuracy of a digital to analogue converter is a comparison of the actual output with that which would be predicted from a particular input condition and is usually expressed as a percentage of the full-scale or maximum output voltage. The output of a binary ladder network will, unfortunately, only be as 'good' as its input and hence the applied voltage (often called the 'reference') must be highly accurate and extremely stable. Furthermore, the resistors used in the network must themselves be highly accurate. Conventional 'off the shelf' resistors are neither accurate nor stable enough for use in ladder networks. Close matching of resistors is, fortunately, not a problem when monolithic construction is employed.

The accuracy of a digital to analogue converter is generally equivalent to half the voltage change associated with the least significant bit. The typical accuracy of a 4-bit converter is plus or minus 3% whereas that of an 8-bit converter is plus or minus 0·2%.

The resolution of a digital to analogue converter is the smallest increment of voltage that can be produced. It is thus essentially the voltage which is represented by the least significant bit (i.e. the smallest obtainable voltage increment). Resolution is thus a function of the number of input bits and the reference voltage. A 4-bit converter permits 16 different output states and thus its resolution is equivalent to 6·25%. With a reference input voltage of 1V this is a resolution of approximately 63mV. An 8-bit converter would improve this resolution to approximately 3·9mV.

Besides accuracy and resolution, three further terms are often encountered in conjunction with digital to analogue conversion. These are 'offset error', 'setting time' and "monotonicity". The offset error associated with a digital to analogue converter is the output voltage produced in response to a digital input consisting of all zeros. The settling time of a digital to analogue converter is the time taken for the output to settle within plus and minus 1 LSB of its final value after a change of input code. Finally, a digital to analogue converter is said to be monotonic if it does not miss a step (or take any reverse steps!) when a full digital input sequence is applied.

THE ZN428 D TO A CONVERTER

The ZN428 is a versatile monolithic digital to analogue converter which incorporates an input data latch facility for updating from a microprocessor data bus. It is thus ideal for interfacing to the system data bus of any 8-bit microcomputer or microcontroller. The internal architecture of the ZN428 is shown in Fig 7. The principal internal elements of the ZN428 are; a data latch, a switch array, an R-2R resistor network and an accurate voltage reference. The latching action is

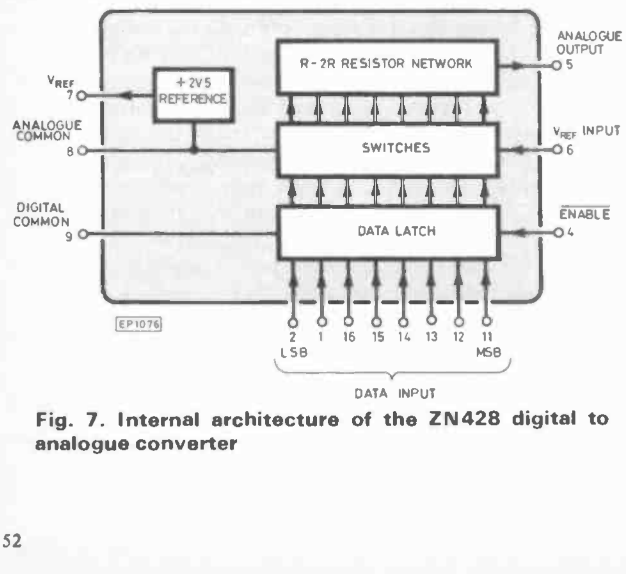

Fig. 7. Internal architecture of the ZN428 digital to analogue converter

controlled by an $\overline{\text{ENABLE}}$ input. When this input is held low the data inputs drive the device directly. When the $\overline{\text{ENABLE}}$ input is held high the input data word is held in the data latch and the output remains unaffected by the state of the data bus. In this condition the digital to analogue converter appears transparent to the microcomputer.

The ZN428 requires a nominal +5V supply at a typical current of 20mA. The device offers true monotonic operation and the offset voltage is less than 5mV. The settling time is typically less than 1μs and linearity better than plus or minus 0·5 LSB. (This corresponds to plus or minus 10mV in a 5V full scale arrangement). The accuracy and resolution will, of course, depend upon the external components and particular circuit configuration employed. It is thus unrealistic to quote typical figures in this context other than to mention that the accuracy and resolution of the practical digital to analogue converter described later can be expected to be better than plus or minus 0·25%.

The equivalent circuit of the data latch inputs of the ZN428 are shown in Fig. 8. The input current consumed by the data inputs is typically less than 50μA for a high (logic 1) condition and −5μA for a low (logic 0) condition. In common with nearly all logic devices, the input voltage must NEVER be allowed to exceed the positive supply voltage.

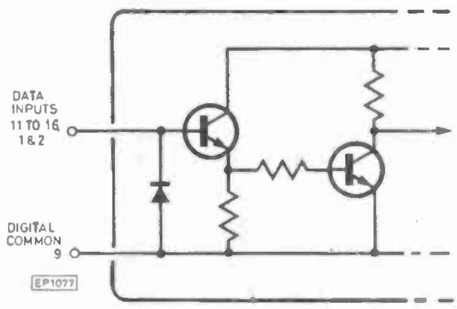

Fig. 8. Equivalent circuit of the data inputs of the ZN428

The equivalent circuit of the output of the ZN428 is shown in Fig. 9. This consists of a voltage source connected in series with an output resistance of approximately 4kohm. In order to prevent loading of the output, the following stage

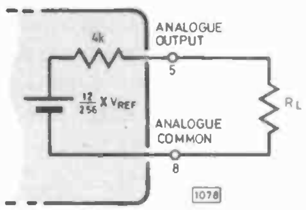

Fig. 9. Equivalent circuit of the output of the ZN428

should have an input resistance which is very much greater than 4kohm. Hence, for most applications, a high input impedance buffer stage is required. The analogue output voltage is given by the relationship:

$$V = (n/256) \times V_{REF}$$

where n is the decimal value of the binary input code and V_{REF} is the reference voltage.

The ZN428 contains its own internal reference. This is provided by an active band-gap device, the simplified equivalent of which is shown in Fig. 10. The device is equivalent to a highly accurate 2·5V Zener diode and exhibits an extremely low internal impedance. Two external

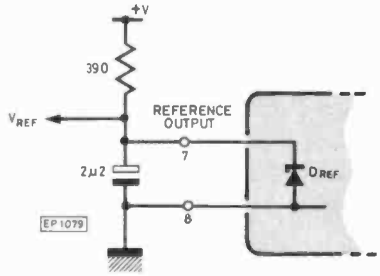

Fig. 10. Simplified equivalent circuit of the ZN428 internal reference

components are required in conjunction with the internal reference; a resistor to set the reference current and a capacitor to decouple the reference voltage. In order to achieve a high degree of voltage tracking where several converters are employed, a single voltage reference may be used to drive up to five ZN428's. If required, the internal reference may be dispensed with and an external voltage reference may be connected to the reference input, pin-6. Such external reference should exhibit a slope resistance of less than 2·5 ohm/N, where N is the number of converters employed.

A PRACTICAL D TO A CONVERTER

Having described the basic features and characteristics of the ZN428 i.c., we shall now consider the design of a practical digital to analogue converter which may be configured for either unipolar (single polarity output) or bipolar (dual polarity output) operation. The circuit diagram of the practical digital to analogue converter is shown in Fig. 11. Eight data inputs are provided with simple resistive voltage dividing networks comprising R1/R11 to R8/R18. A similar network, R9/R10, is provided for the $\overline{\text{ENABLE}}$ input. The

SPECIFICATION

OUTPUT VOLTAGE RANGE: 0 to ±12V max. (unipolar operation—see note). 0 to ±12V max. (bipolar operation—see note)
OUTPUT CURRENT: 10mA max. (without power amplifier module). 1A max. (with power amplifier module)
OUTPUT IMPEDANCE: Normal output; 500ohm typical. Complementary output; 40ohm typical. Power amplifier module; less than 0·1ohm
ACCURACY: Typically better than 0·2% (10V output)
RESOLUTION: Typically better than 20mV (10V output)
SETTLING TIME: Typically better than 10µs (5V step)
D.C. SUPPLY VOLTAGE: 7V to 15V
D.C. SUPPLY CURRENT: 75mA typical at $V_S = 12V$
DATA INPUT CURRENT: 'High' (logic 1) input; 60µA max. 'Low' (logic 0) input; −5µA max
ENABLE PULSE WIDTH: 100ns min.
NOTE: Complementary outputs are available in both operating modes

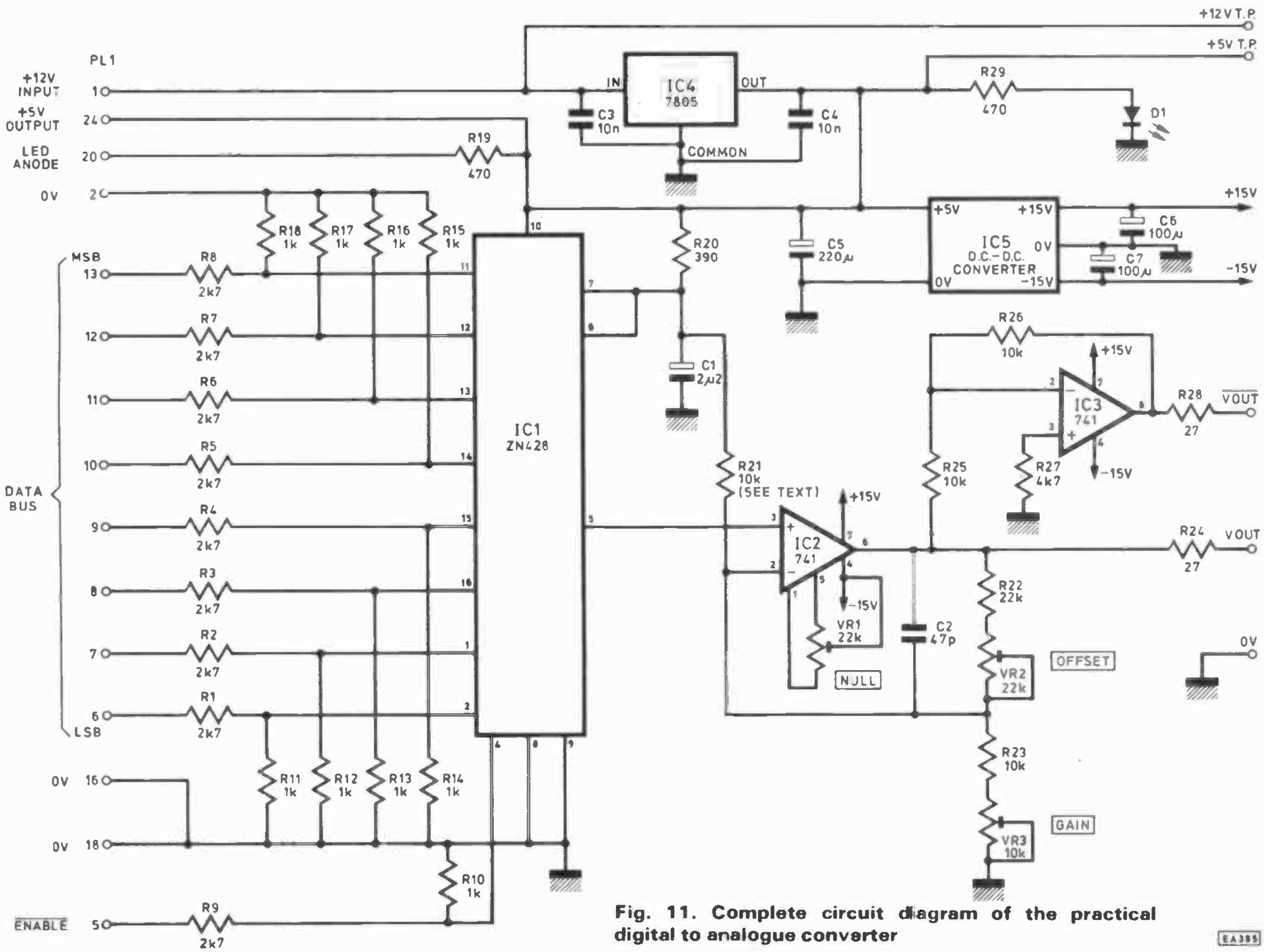

Fig. 11. Complete circuit diagram of the practical digital to analogue converter

values have been chosen so as to permit direct connection to the PE Microcontroller integrated peripheral drivers (IC16, 17, 18 and 19 of Fig. 1.9 in November 1982, PE). The voltage level produced by these drivers is approximately 17V in the high (logic 1) condition and 0V in the low (logic 0) state. Where the digital to analogue converter is required to be interfaced with a conventional TTL compatible data bus, resistors R1 to R9 should be replaced by short circuit links and R10 to R18 should be omitted. To cater for other values of data bus logic levels it is, of course, only a relatively simple matter of selecting appropriate resistor values for R1 to R18 inclusive (e.g. for operation from a 12V system, R1 to R9 should be 1·5k and R10 to R18 should be 1k). Note that, as mentioned earlier, it is important that the voltage level on the data bus should not be allowed to exceed the ZN428 supply voltage. In this particular circuit arrangement the ZN428 operates from a regulated +5V supply and hence the voltage appearing at the data and $\overline{\text{ENABLE}}$ inputs of IC1 should not be greater than +5V.

The analogue output of the ZN428 at pin 5 takes a value

DIGITAL INPUT CODE	ANALOGUE OUTPUT VOLTAGE
00000000	0
00000001	V_{LSB}
01000000	$\frac{1}{4}V_{FS}$
01111111	$\frac{1}{2}V_{FS} - V_{LSB}$
10000000	$\frac{1}{2}V_{FS}$
10000001	$\frac{1}{2}V_{FS} + V_{LSB}$
11000000	$\frac{3}{4}V_{FS}$
11111110	$V_{FS} - 2V_{LSB}$
11111111	$V_{FS} - V_{LSB}$

TABLE 1 Coding table for unipolar operation

between 0V and 2·56V (the value of the internal reference voltage). This results in an output voltage characteristic of 10mV/bit (i.e. V_{LSB} = 10mV). For many applications, however, a greater full-scale output voltage is required and hence IC2 is included to provide both amplification and a degree of isolation for IC1. IC2, a conventional operational amplifier, is used in a normal non-inverting configuration. Internal offset adjustment (null) is provided by VR1, whilst

DIGITAL INPUT CODE	ANALOGUE OUTPUT VOLTAGE
00000000	$-V_{FS}$
00000001	$-V_{FS} + V_{LSB}$
01000000	$-\frac{1}{2}V_{FS}$
01111111	$-V_{LSB}$
10000000	0
10000001	$+V_{LSB}$
11000000	$+\frac{1}{2}V_{FS}$
11111110	$+V_{FS} - 2V_{LSB}$
11111111	$+V_{FS} - V_{LSB}$

TABLE 2 Coding table for bipolar operation

offset and gain adjustment are provided by means of VR2 and VR3 respectively. C2 improves HF stability and, in conjunction with the slew-rate limiting characteristic of the operational amplifier, increases the overall settling time. A second operational amplifier, IC3, operates as a unity gain inverting stage to provide a complementary output voltage. Low value series resistors, R24 and R28, provide a measure of protection in the event of an inadvertent short circuit at the output.

Selection of either unipolar or bipolar operation is provided by means of R21. When R21 is omitted the circuit provides unipolar operation with the logic coding shown in Table 1. This shows that a data input of 00000000 produces an output of 0V whereas a data input of 11111111 results in an output of $(+V_{FS} - V_{LSB})$. For bipolar operation R21 must be added. In this case offset binary coding is employed such that a data input of 00000000 produces an output of $-V_{FS}$ whereas a data input of 11111111 again produces an output of $(+V_{FS} - V_{LSB})$. An output of 0V results from a data input of 10000000, as shown in Table 2.

The circuit requires several internal supply rails; a well regulated +5V supply for the ZN428 and plus and minus 15V rails for the operational amplifiers. In order to permit simple interconnection to almost any system, these rails are derived from a single nominal +12V d.c. input. This voltage may, however, be anywhere in the range of +7V to +17V, thus permitting direct connection to the +12/17V unregulated supply rail of the PE Microcontroller. The input current will not normally exceed 100mA. The +5V regulator, IC4, is a conventional monolithic type. An encapsulated d.c. to d.c. converter module, IC5, is used to provide the plus and minus 15V output rails. This device operates with an efficiency of approximately 75% and the output voltage is maintained within ±4% of the nominal 15V at load currents of up to 34mA. Constructors should, however, note that, unlike IC4, this device is not short circuit protected.

COMPONENTS . . .

Resistors

R1–R9	2k7 (see text) (9 off)
R10–R18	1k (see text) (9 off)
R19	470
R20	390
R21	10k (see text)
R22	22k
R23	10k
R24	27 $\frac{1}{2}$W
R25, R26	10k (2 off)
R27	4k7
R28	27 $\frac{1}{2}$W
VR1, VR2	22k miniature horizontal skeleton pre-set (2 off)
VR3	10k miniature horizontal skeleton pre-set

All fixed resistors, except where otherwise stated, are $\frac{1}{4}$W 5%

Capacitors

C1	2μ2	35V tantalum
C2	47p	ceramic
C3, C4	10n	polyester (2 off)
C5	220μ	10V axial electrolytic
C6, C7	100μ	16V p.c. electrolytic (2 off)

Semiconductors

D1	red LED
IC1	ZN428E
IC2, IC3	741 (2 off)
IC4	7805
IC5	d.c.—d.c. converter module

Miscellaneous

PCB Terminal pins (5 required) 24-way edge connector
Low profile d.i.l. sockets (2 x 8-pin and 1 x 16-pin)

Constructor's Note

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

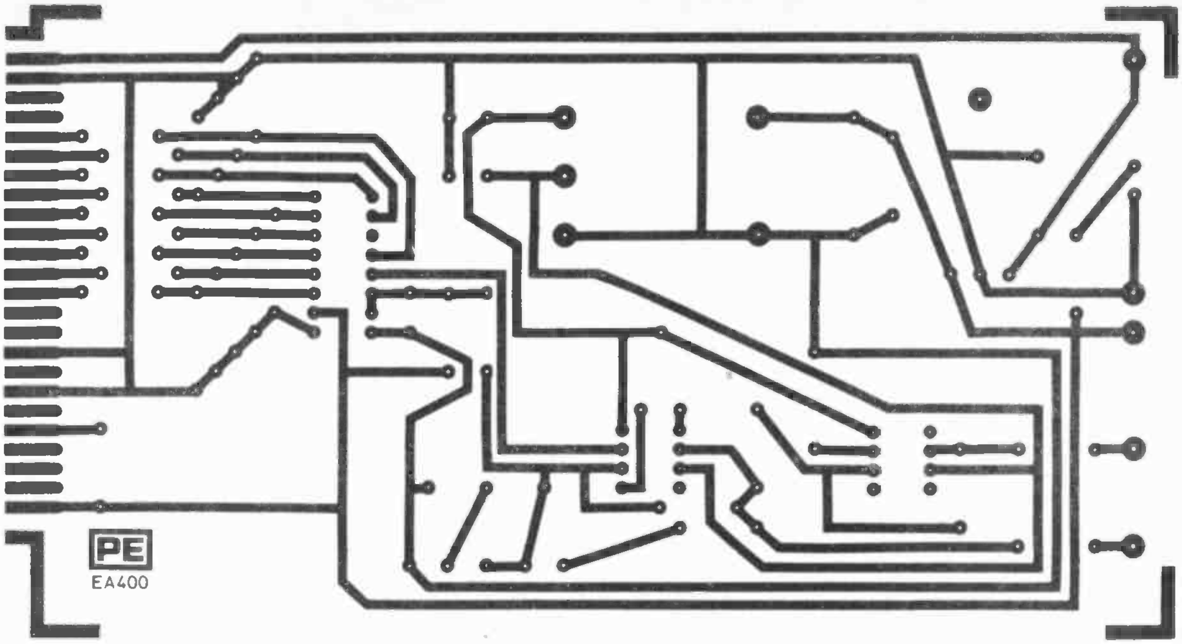

Fig. 12. P.c.b. foil pattern design for the D to A converter

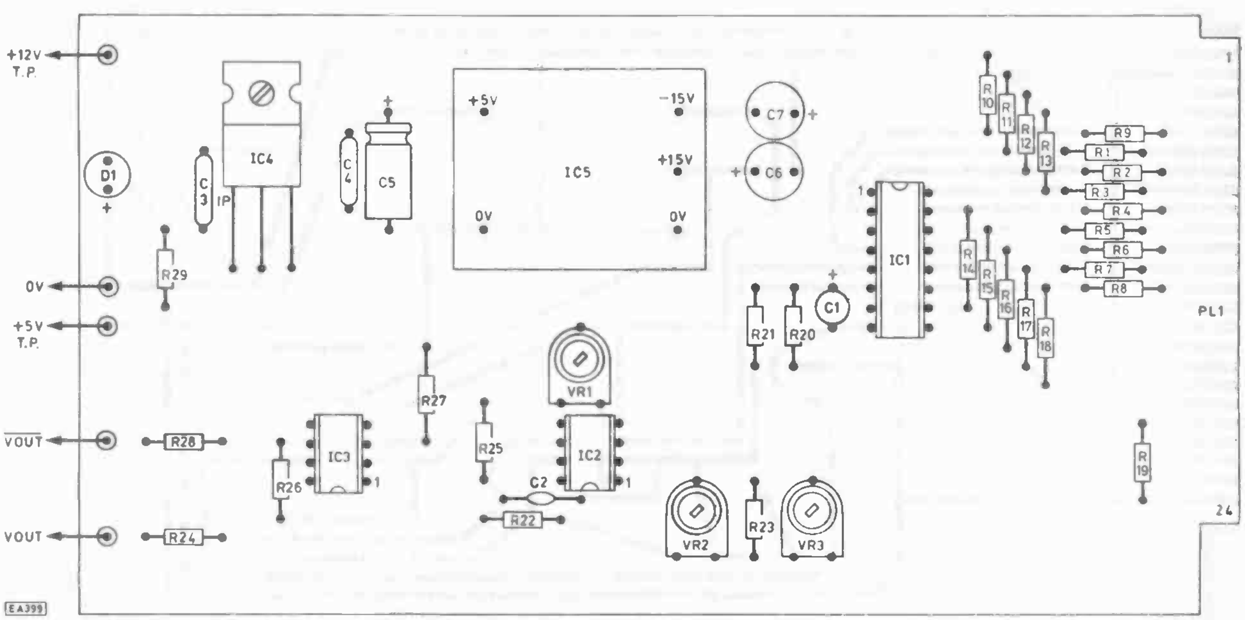

Fig. 13. Component layout

CONSTRUCTION

The digital to analogue converter is assembled on a single-sided p.c.b. measuring approximately 77 × 147mm. The p.c.b. is designed to mate with a 24-way edge connector thus, allowing ease of connection to a system whilst retaining the ability to interchange boards where necessary. The p.c.b. foil layout is shown in Fig. 12 and the corresponding component overlay is given in Fig. 13. Low profile sockets should be used for each of the dual-in-line integrated circuit devices. Heat sinking will not normally be required for the series regulator, IC4.

Construction is extremely straightforward and the following sequence of component assembly is recommended; terminal pins, i.c. sockets, resistors, capacitors, l.e.d., pre-set resistors, IC4 and IC5. When complete the p.c.b. should be carefully examined for correct placement and, in the case of polarised devices, orientation of components. The remaining i.c. devices should then be carefully inserted into their sockets and the unit is then ready for testing and initial adjustment.

TESTING AND INITIAL ADJUSTMENT

Testing and initial adjustment is best carried out using the arrangement shown in Fig. 14. Nine miniature s.p.s.t. toggle switches are required; eight to simulate the data bus inputs and one to provide the $\overline{\text{ENABLE}}$ input. These toggle switches should be connected to the appropriate pins of a 24-way edge connector, carefully following the pin numbering

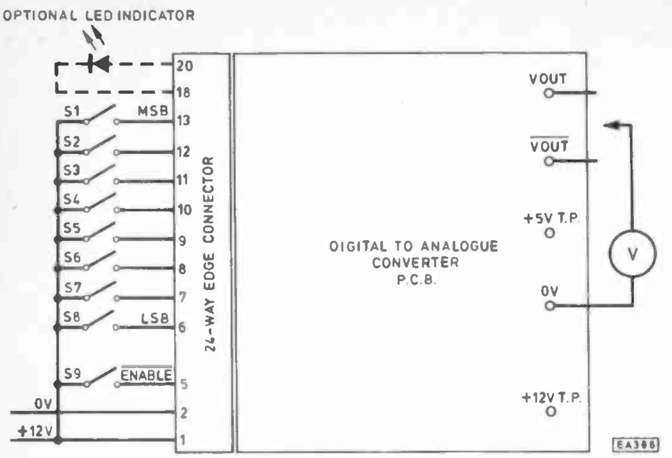

Fig. 14. Arrangement used in the initial testing and alignment of the D to A converter

shown in the figure. To prevent confusion, it is recommended that the switches be labelled appropriately! A regulated 12V d.c. supply should be connected to pins 1 and 2, taking care to observe the correct polarity. The power supply should preferably include a means of electronic over-current protection. However, if no such supply is available, a 500 mA fuse in the positive supply lead will at least offer a measure of protection. A d.c. voltmeter, or multi-range meter on the d.c. voltage range, should be connected with its negative input lead to 0V and its positive lead to a probe or miniature crocodile clip.

A d.c. milliammeter should, initially, be included in the positive supply lead. The supply should then be switched "on" and the supply current should be noted. This should be in the range 50mA to 80mA and under no circumstances should it exceed about 150mA. If the fuse blows, or if the overcurrent trip operates, carefully check for inadvertent short circuits or incorrect wiring of the edge connector. Having established that the d.c. supply current is normal check that D1 is illuminated. This l.e.d. indicates the presence of the + 5V supply rail and indicates that the unit is "active". The voltage of the + 12V and + 5V rails can then be checked; the latter should be within plus or minus 200mV of its nominal value and should remain within 1% of its actual value as the d.c. supply input is varied over the range 8V to 15V. The adjustment procedure for either unipolar or bipolar operation will be given next month.

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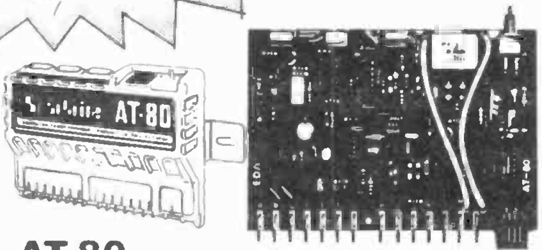

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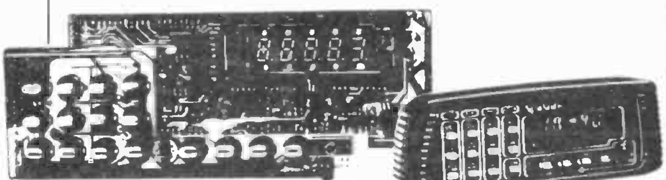

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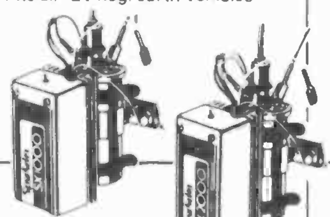

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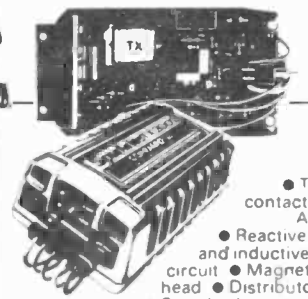

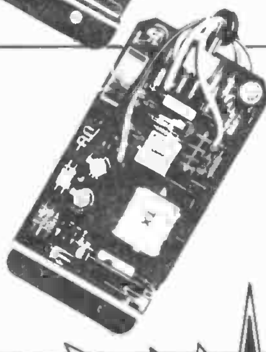

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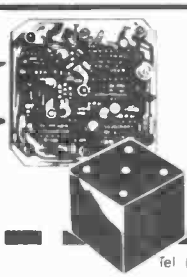

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Ultimum Computer Interface Part 5

WILLIAM EDWARDS   WATFORD ELECTRONICS

THIS month's add-on card for the ULTIMUM is a ROM Emulator (Romulator). It complements the PROM programmer of last month making the development of control systems, based on commercially available single board controllers or home brew systems, possible. The Romulator described here can emulate most of the single rail 1k, 2k and 4k PROMs as well as a large proportion of the three rail varieties.

EMULATION

Emulators come in two forms. The larger development system emulators plug into the microprocessor socket and will emulate memory (ROM and RAM) as well as the processor itself. These emulators are very useful when designing a development system from scratch. They usually provide some form of real time tracing which makes fault finding simpler. Such emulators usually cost several hundred pounds and, as such, are rather too expensive for the average enthusiast.

The second class of emulator emulates ROM only. The ROM being emulated is substituted with a header/cable assembly which is connected to memory filled from another system. For most applications this simpler (and much cheaper) form of emulation is quite adequate. The Romulator falls into this latter category.

The Romulator is a card which plugs into one of the sockets on the ULTIMUM motherboard. It can be used as standard static RAM by your computer, and may be filled with any code (or used as extra space for BASIC programs) and accessed as any other RAM in your system. When switched into emulation mode, it may be inserted into any other system to emulate PROM or ROM. Fig. 5.1 shows a typical example of such a set up.

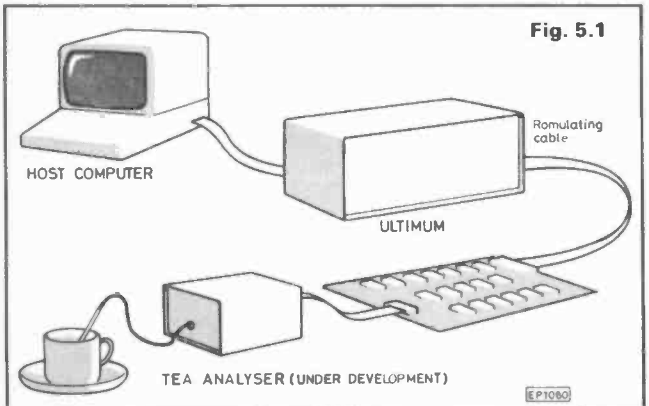


Fig. 5.1

The main advantages of this type of system are:

1) Programs can be developed on your host system which has many tools available (such as an assembler/disassembler and a screen to monitor RAM contents). The system being developed may only have an absolute minimum of tools and interfaces.

2) Any programs developed on the Romulator can be protected from overwriting by the system being developed as they can only be accessed as ROM. This is particularly useful when developing machine code programs which have a marked tendency to crash.

3) Once a program has been tested, it can be programmed onto ROM using the PROM programmer board. No intermediate paper or magnetic tape increases the chance of a successful transfer of data. Once programmed, the PROM can be inserted into the system being developed and the emulator removed for further use.

4) The alternative is to buy a separate emulator complete with its own processor. These usually cost as much as your main computer and it seems (to us at least) a waste of a computer to buy another system just for development.

THE CIRCUIT

The circuit is shown in Fig. 5.2. It does not need to be complicated as most of the extra circuitry for an emulator is provided by the motherboard and your own system.

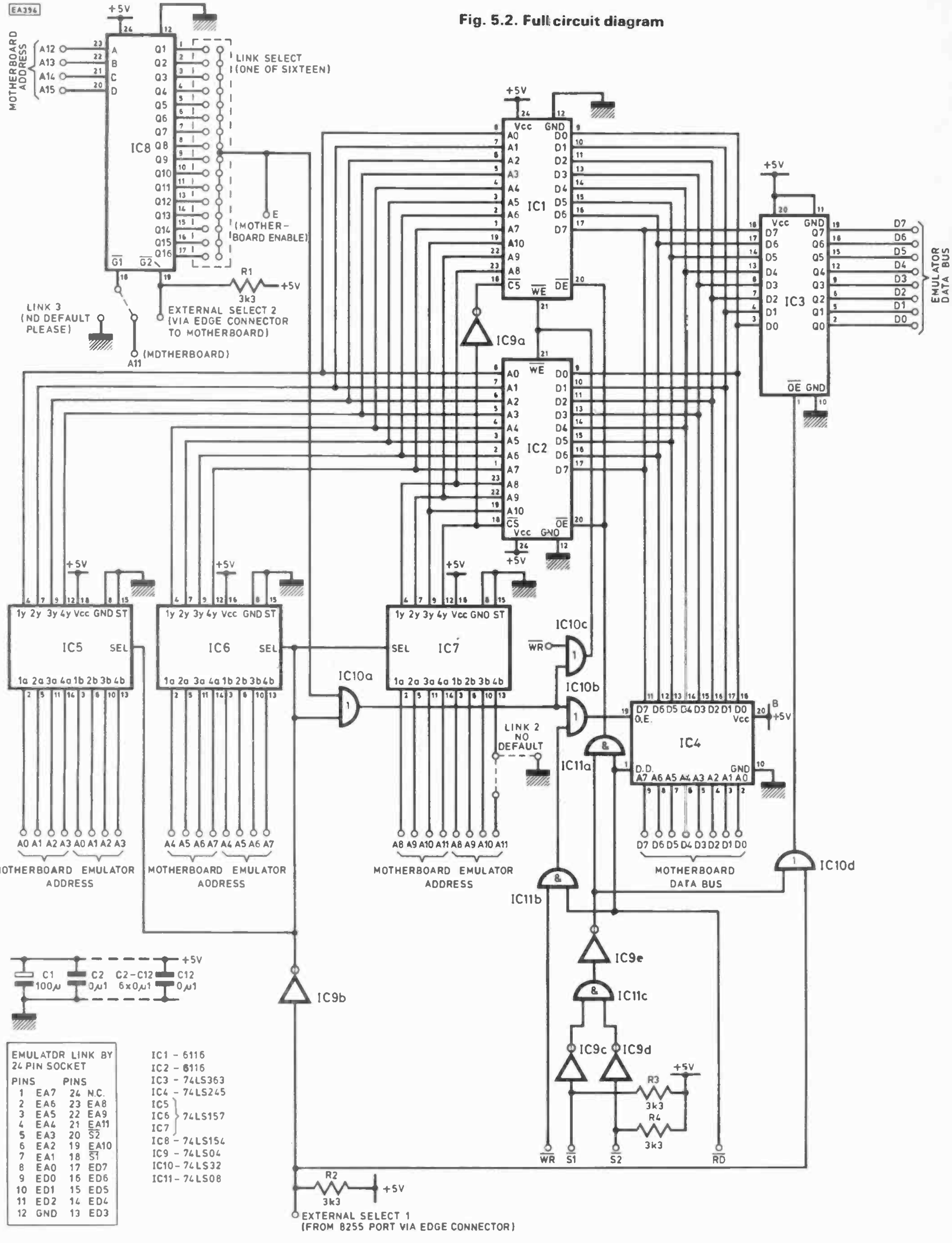
There are three basic elements: the decoding (motherboard and off-board), the multiplexing circuits (selecting between emulator signals and mother board signals) and the memory itself.

The decoding allows the board to be mapped into your computer as 2k or 4k portions. If you do not require a full 4k emulator, some memory can be omitted and the board can be mapped to occupy 2k of memory. The main decoding is done by IC8 which provides 16 lines each corresponding to a 4k boundary. Selection of a 2k boundary is achieved by additional decoding provided by bringing A11 into IC8.

The multiplexers are made of three quad two-to-one line multiplexers which can be set to accept signals from the motherboard or the emulator header. The selection is handled by a line fed from the port on the motherboard. When the port is set up, the multiplexers are set to accept signals from the motherboard, so that the board looks like ordinary memory.

Toggling the port line (marked as External Select in Fig. 5.2) will cause the signals from the motherboard to be deselected and the read/write control signals are disconnected to prevent spurious accesses from conflicting with signals on the emulator header.

Fig. 5.2. Full circuit diagram



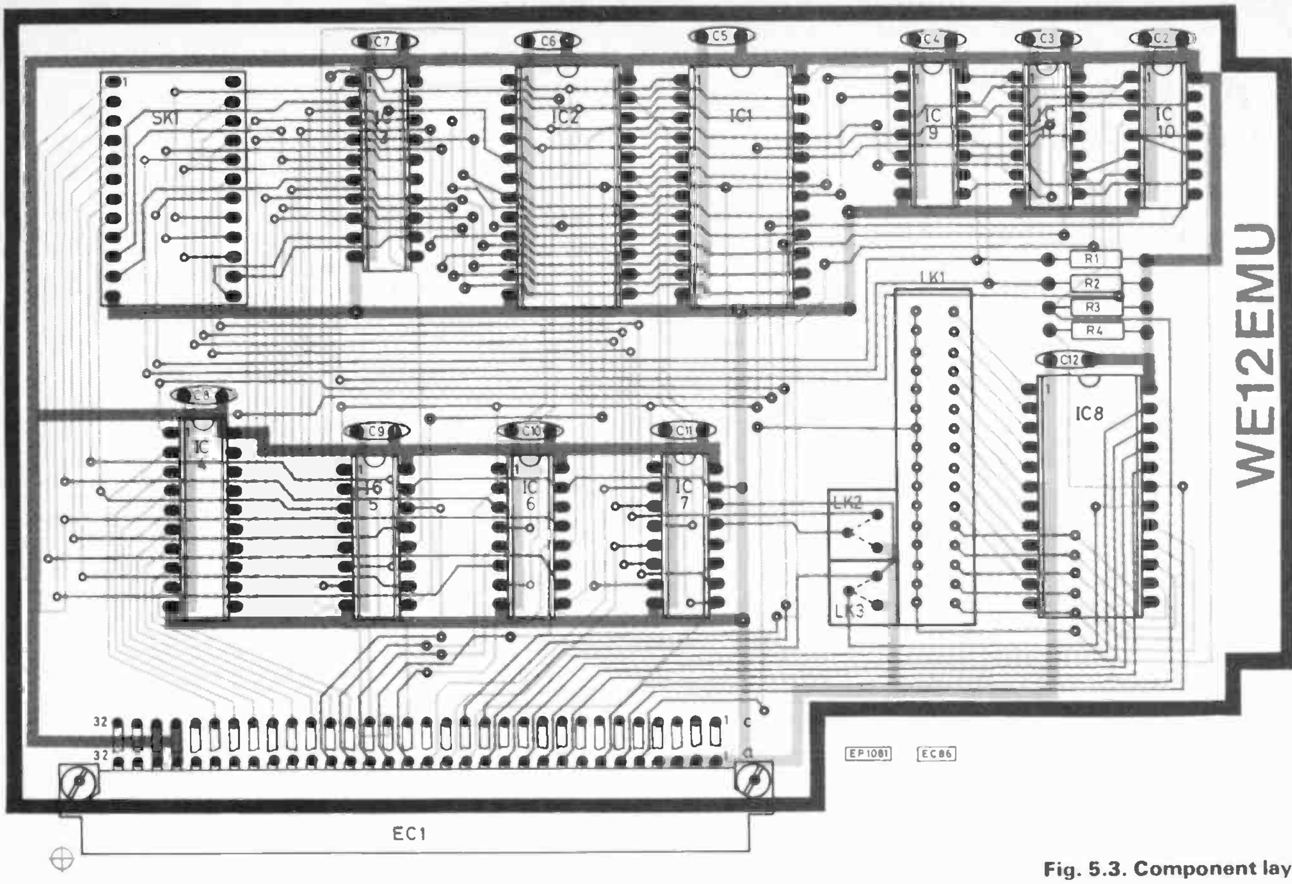


Fig. 5.3. Component layout

COMPONENTS . . .

Resistors

R1–R4 3k3 (4 off)

Capacitors

C1 100μ elect.
C2–C12 100n disc cer. (12 off)

Integrated Circuits

IC1, IC2	6116
IC3	74LS363
IC4	74LS245
IC5–IC7	74LS157
IC8	74LS154
IC9	74LS04
IC10	74LS32
IC11	74LS08

Miscellaneous

Printed circuit board
2 x 32 'A+C' DIN Euro Plug (right-angled pins)
14-pin d.i.l. socket (3 off)
16-pin d.i.l. socket
20-pin d.i.l. socket (2 off)
24-pin d.i.l. socket (2 off)

The memory itself is fast static RAM organised as two off 2k x 8. Various speeds of RAM are available allowing development of the newer fast processors. Allowing for leads and buffers a 200μs PROM can be emulated using 100ns RAM. The static RAM is always powered from the motherboard. A buffer is provided on the data lines to drive the emulator cable assembly.

ASSEMBLING AND SETTING UP

Refer to the overlay (Fig. 5.3) for component placement. The usual order of assembly applies, ie. Sockets and discrete components first, followed by a thorough check of your soldering and then insertion of the i.c.s. The header is prefabricated, as this is an insulation displacement assembly requiring special equipment.

To test the board, set up the mapping options. A maximum of three links are needed. Leave the emulator cable and the d.i.p. header off for the moment. Insert the card into the motherboard and power up (*not* the other way round). Set up the port on the motherboard (as per ULTIMUM article) so that the external select 2 line is a logic '0' and the external select 1 line is a '1'. You should then be able to read and write to the memory on the Romulator. Any memory test can be used to check for proper function.

To test the emulator, you can either use a second system or plug the emulator into a PROM socket somewhere in your own system, as the Romulator is quite capable of emulation on your own computer.

Once you have loaded a suitable program into the Romulator memory, you switch to emulator mode by making the External Select 2 a logic '1' and the external select 1 a '0'.

Two points to note. Firstly, *do not* insert the emulator socket in upside down, this may damage the Romulator memory or the system. Secondly, some systems make rather strange uses of the Read and Chip Select control signals to decode the ROM. Check a circuit diagram if in doubt.

NEXT MONTH: The phoneme speech card.

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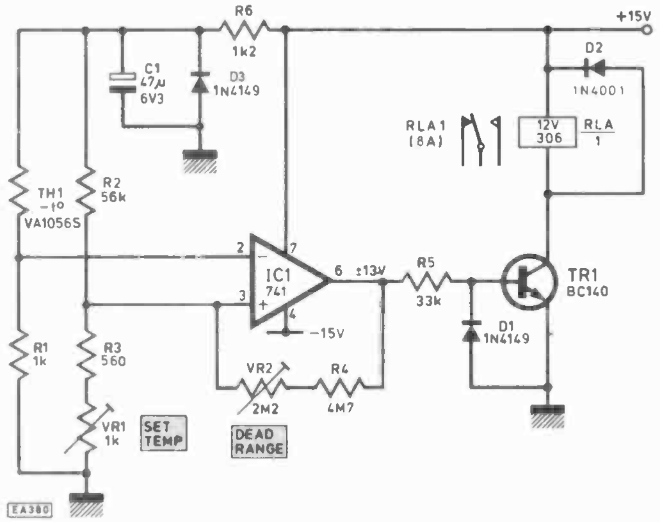
WINE HEATER THERMOSTAT



ALTHOUGH this circuit was devised to control a 22W heater plate under a 1 gallon wine demijohn to hold a nominal temperature of 22°C, with the larger relay used it can be used to switch much higher powers, and with the components shown, it has an adjustment range of 9°C to 31°C with a dead range from 0·9°C to 1·4°C. Other applications could be in darkrooms or greenhouses, etc.

TR1 and D2 are deliberately over dimensioned. D1 prevents negative V_{be} >0·6V on TR1. An alternative approach would be to use a single-ended supply, although this could cause problems with the increased values of R1, R3, VR1, if one tries to keep the signal and reference near the middle of the 741's input range rather than relying on common-mode rejection; the ratio of R4 × VR2 to the input source impedance (R2/R3+VR1) governs the dead range, and for about 1°C this ratio needs to be around 6000, leading to impractical values for a source impedance much greater than the present 1040 or so.

Andrew Fogg,
Maidenhead,
Berks.

INTRUDER ALARM

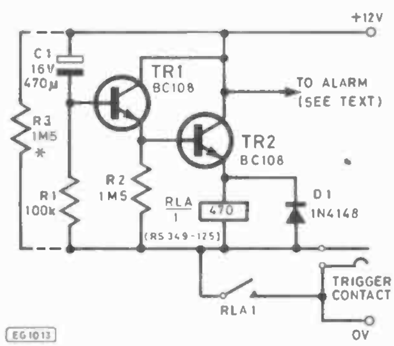
EVEN with constant weekend use during the summer months, most boats, or caravans, are left unattended for an extremely high proportion of the year and some form of alarm system is therefore highly desirable to frighten off intruders.

It will be evident from the circuit diagram that the unit is switched-off until the trigger connects it to the battery negative, whereupon TR2 immediately conducts, closing the relay and thereby latching on the supply, since initially the capacitor is uncharged and the base of TR1 is also positive. C1 now commences to charge slowly via the 100 kilohm resistor causing the base to become progressively more negative until the transistors cease conducting and the relay opens. With the values shown, the alarm cuts off after one to one and a half minutes, but different periods of operation can be obtained by trying other capacitors. After discharging the alarm resets itself, but to speed up this process to about a minute or so, a 1·5 to 2 Megohm resistor (R3) can be connected as shown dotted in the diagram. The diode across the relay coil protects TR2 by damping the back-e.m.f.

The alarm to be operated is largely a matter of choice and can be a 12V d.c. siren or bell, a lamp, or even a car horn. In the latter case, particular care must be taken to check polarity and current consumption. Although the relay contacts used are rated at 5 amps, some car horns take a very large current.

The trigger contacts are constructed from spring-metal strips (e.g. draught excluder), or, more elegantly, with reed contacts and magnets. In this system the trigger contacts are required to be open, so ensure that they can be closed by the magnet (or are of the 'change-over' type) to suit your particular installation requirements.

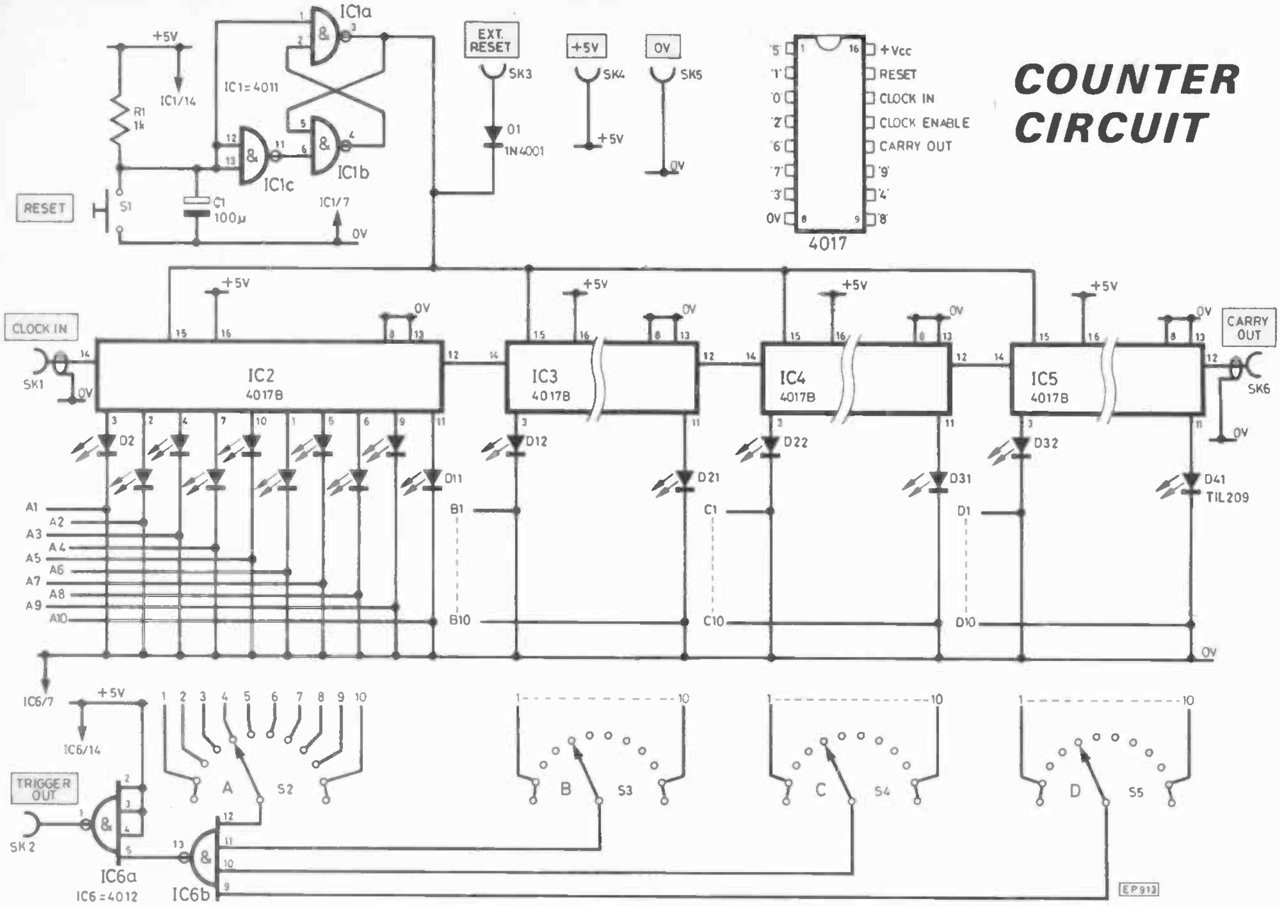
The foregoing also applies if you decide on switch-pads for placing under carpets.



A possible method of contruction could consist of two sheets of tin separated by a thin layer of plastic foam, which would be penetrated when trodden on by the spikes of a few panel pins, or tacks, soldered to the lower piece of metal; the whole being fitted into a strong plastic bag.

R. P. Machrell,
Lytham St. Annes,
Lancashire.

COUNTER CIRCUIT



THIS circuit counts digital pulses up to 9999 and then resets to 0000, a socket is provided to carry out the 10,000th pulse.

Clock pulses enter IC2 via the "Clock In" socket. This counts the input pulses to ten and resets to zero carrying the tenth pulse to IC3 via pin 12.

Similarly IC3 counts tens carrying the hundredth pulse to IC4, and so on along the chain. The unit can have the chain shortened or extended if desired.

The pulses are counted visibly on four rows of ten l.e.d.s (TIL209) which the 4017 drives directly. The small circuit around IC1 is an anti-switch bounce circuit generating clean pulses when S1 is pressed which reset the display to zero. When S1 is open circuit the voltage to the reset pins is 0V, the condition necessary for automatic reset on the tenth count. After any count from 0000 to 9999 a facility is added to trigger an external circuit, e.g. an alarm, model railway points, the radio etc.

IC6a is wired as an inverter to save using extra space with inverter chips.

The circuit can be used to measure digital frequency, as a stop watch once the input frequency is known, as a photographic or kitchen timer and as if this is not enough it can be used as an intriguing display on the mantlepiece at parties.

Power is applied externally in the prototype but can be built into the unit very simply.

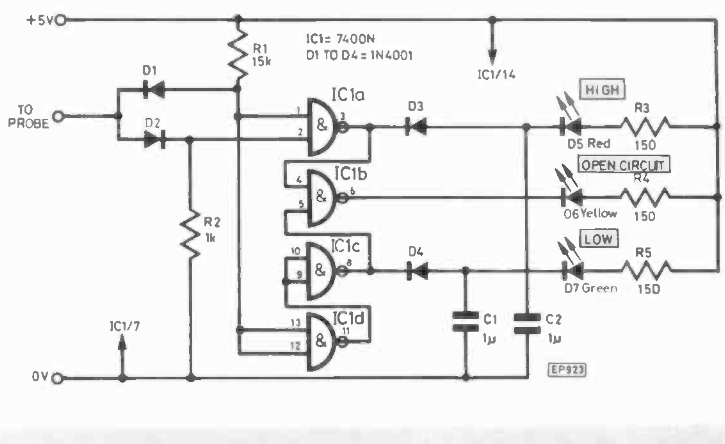
Michael J. Walker,
N. Ascot,
Berks.

TTL LOGIC PROBE

THIS probe uses a 7400N consisting of quad dual input NAND gates, and detects high, low and open circuit with pulse stretching on high and low indications so that any combination of signal will be visually detected. The thresholds are 0.8V and 2V.

The assembly should easily fit into a plug case with flying leads for the supply and 0V connections and a needle probe. Pulse stretching may be increased with larger capacitors.

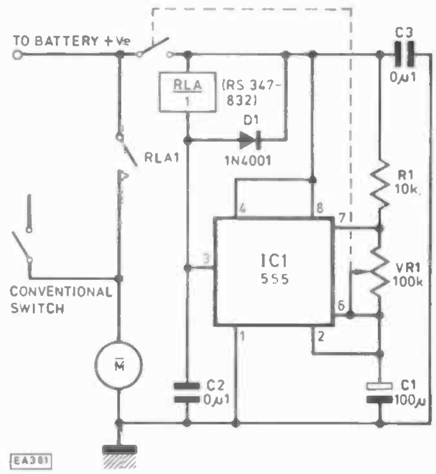
G. Coleman,
Rochester,
Kent.



WINDSCREEN WIPER CONTROL

THIS circuit will vary the speed of a car's windscreen wipers from one sweep per second to around one sweep per minute. When switched on IC1 will start to oscillate at a rate set by VR1 which in turn switches RLA1. This in turn supplies the wiper motor power at the same time intervals. The conventional switch can now be disregarded. If the washer pump is wired to a pushbutton it can be removed altogether. D1 soaks up any back e.m.f. from the relay coil while C2 and C3 suppress the spike cause by IC1's output going high.

A.D. Billington,
Rotherham,
S. Yorkshire



TOUCH-SWITCHED SPEAKER MUTING

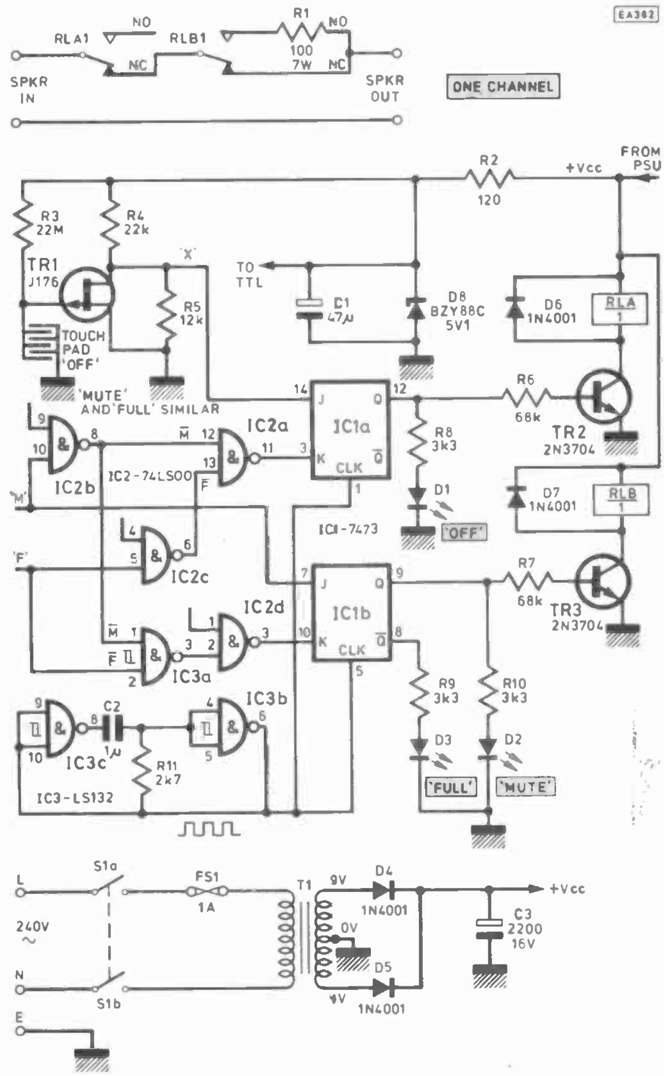
THIS unit was designed for a friend who had a set of extension speakers conflicting with a telephone in his bedroom. He specifically requested touch switches since, although much more expensive than a 2 pole 3 way switch, they are more pleasant to use and are aesthetically pleasing.

The touch switches are a resistive type as these are easier to implement than the capacitive variety. The three switches set up the JK flip-flop inputs when touched, and the oscillator formed by IC3b,c, C2, R11 clocks the outputs to the required state which will then be held by the flip-flops. An ordinary 7473 is used to allow the l.e.d.s to be driven directly.

Note that points M and F should be connected to identical circuits as to the left of point X.

The relays are 2 pole to provide switching for a stereo pair of speakers. R1 at 100 7W is adequate for up to around 35W input. For amplifiers which dislike high impedance loads, R1 could be shunted with a 10 25W resistor to ground (or the return line if the speaker connections are left floating as shown). R1 is calculated for about 20db of muting against 8 speakers. Clearly a single secondary transformer and a bridge rectifier could be substituted for T1, D4 and D5.

Andrew Fogg,
Maidenhead,
Berks.



ELECTRONIC CRUISE CONTROL

COMMERCIALLY available cruise control units for petrol engined cars work on the principle of a speed sensor connected to an electronic unit which converts speed differences to an electrical output. This drives a solenoid valve on a vacuum operated servo (Fig. 1) which operates the throttle. When the speed is below the preset cruising speed the servo is activated and it opens the throttle to regain speed. When the speed is above the preset speed the throttle is released by the servo. Fig. 2 shows the valve arrangement in the servo.

Fig. 1. Showing the carburettor servo

Speed may be sensed by means of a device on the speedometer cable, on the drive shaft or by using the pulses on the ignition coil primary (or points).

The servo should be purchased from suppliers or servicers of cruise equipment and a suitable unit is manufactured by Associated Engineering. The solenoid valve in the servo has a coil resistance of about 45 ohms and operates as follows;

rising voltage:	suction opens	6.3V
	vent closes	7.3V
falling voltage:	vent opens	6.6V
	suction closes	5.0V

The circuit can be divided into D/A converter, memory with clock and bistables, difference amplifier and servo drive, as shown. The power supply is regulated to 11·0 volts by means of TR5, TR6, TR7, D4. An i.c. regulator cannot be used due to the small voltage drop available.

The engine (and therefore car) speed is sensed from the pulses at the points by TR1, IC1 and IC2 which form a D/A converter and the output of IC2 is linearly proportional to revs. TR1 acts as an inverter to trigger the 1·5ms monostable IC1. The voltage across C4 is proportional to revs. IC2 acts as a voltage follower with gain. VR1 adjusts the gain to give an output on pin 6 of a maximum of 5·5V at maximum revs (6000 r.p.m. for a 4 cylinder engine).

IC3, a dual counter, forms a digital memory for the analogue voltages. The two counters are cascaded and the outputs feed a ladder resistor network which is used as a 256 step memory from 0 to 5·5V. The memory resolution is thus 0·021V per step or approximately 0·4 m.p.h. The memory is activated in the following manner. When S1 is switched to "Engage" the "a" section of electronic switch IC7 closes and produces a reset on IC3. When S1 is released to its centre off position the negative edge trigger formed by IC5a is activated which in turn sets the bistable formed by IC6c and d. The output on pin 11 goes low to produce an "enable" on IC3. Since IC5 "c" and "d" form a clock running at 1·5kHz continuously, IC3 now commences to count upwards from zero and the voltage output of the ladder network rises in 0·021V steps per 0·6ms. As soon as the voltage equals or exceeds the D/A output the output of IC4 goes low and triggers the negative edge trigger of IC5b via IC7b which was switched on by the bistable IC6c and d. The trigger pulse switches the bistable into a reverse condition with pin 11 high and pin 10 low and IC3 is then disabled from counting further. At the same time the output of IC4 is isolated. The memory is therefore fixed at the D/A voltage the moment S1 is released to off.

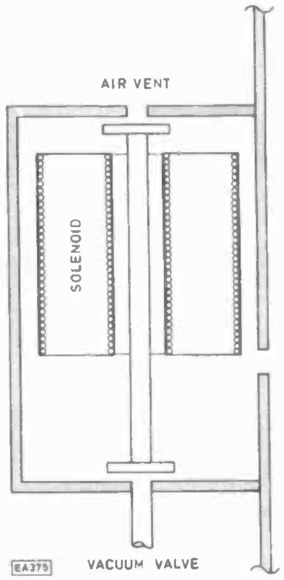


Fig. 2. The valve arrangement in the servo

A second bistable IC6a and b was triggered on when S1 was switched to "Engage" and this in turn switched on IC7 "c" and TR4. Current is thus able to flow through the solenoid of the servo. During "Engage" IC7d and TR3 were also switched on to energise the solenoid. The servo now produces an acceleration. On releasing S1 to off, IC7c and TR4 remain on while IC7d and TR3 are switched off, removing the acceleration.

IC8 acts as a differential amplifier with a large offset voltage. If the voltage on pin 3 equals that on pin 2 (D/A output equal to memory) then the output on pin 6 equals the offset voltage set by VR3. TR2 acts as a voltage follower to drive the solenoid in the servo. Should the car slow down then the voltage on pin 2 is less than on pin 3 of IC8 and the difference is amplified in the ratio of VR2 to 10k and added to the offset voltage. The servo is thus energised more and exerts more pull on the throttle to accelerate the car. The reverse happens if the speed is in excess of that set in the memory and the amplified difference is subtracted from the offset voltage. The servo is then de-energised and a deceleration occurs.

To release the cruise control the bistable IC6a and b is de-activated by pressing the "Stop" switch S2. This turns off IC7c and TR4, isolating the solenoid. However, the memory is not affected and if subsequently S1 is switched to "Resume", the bistable is re-activated and TR4 is switched on again without disturbing the memory as D2 isolates the positive pulse from the negative edge trigger and reset circuit.

A similar release action is obtained by pressing the brake pedal to activate the stop lights and therefore putting a positive pulse on the bistable to de-activate it. A similar switch to that of the stop lights can be fitted to the clutch pedal to de-activate when the clutch is depressed. This prevents the engine racing during gear changing.

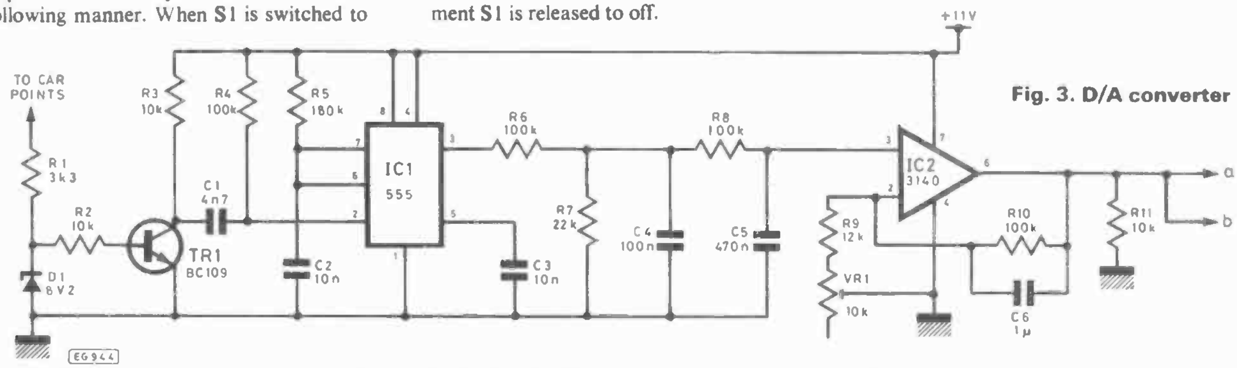


Fig. 3. D/A converter

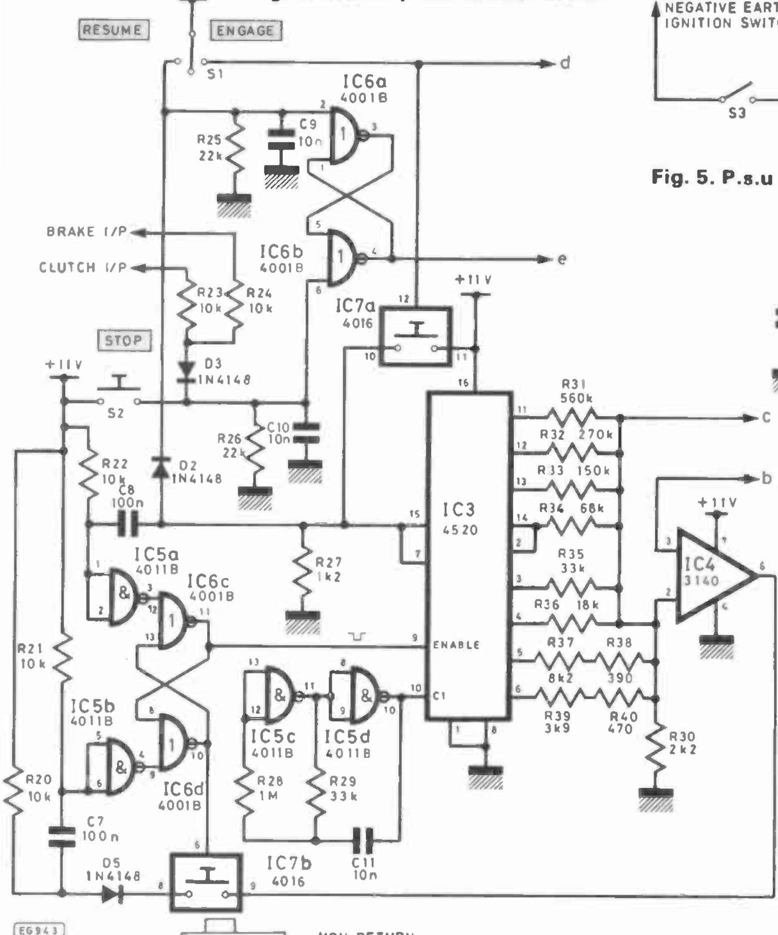


Fig. 4. Memory and control circuit

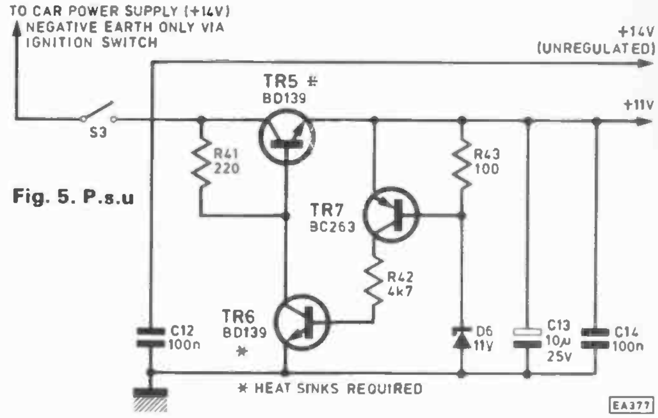


Fig. 5. P.s.u

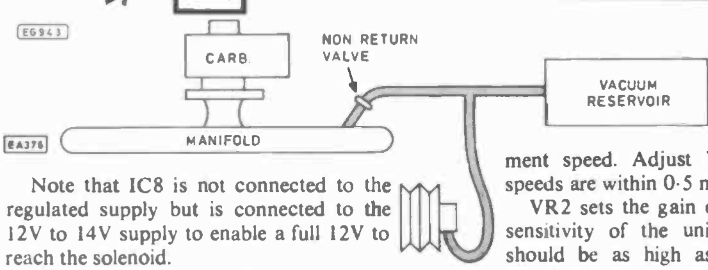


Fig. 6. Vacuum circuit

Note that IC8 is not connected to the regulated supply but is connected to the 12V to 14V supply to enable a full 12V to reach the solenoid.

VR1 to 3 are set after installation. Initially they can be set at mid position. VR1 is set to produce a voltage of 5·5 on pin 6 of IC2 at maximum revs. Since this is difficult to do in practice, setting can be done at half revs to give 2·75V.

A road test is required to set VR2 and VR3. Drive at a constant speed on a level road and engage the unit, noting the exact speed. Note the speed the car takes up which may not be the same as the engagement speed. Adjust VR3 until the two speeds are within 0·5 m.p.h. of each other.

VR2 sets the gain of IC8 and thus the sensitivity of the unit. Ideally the gain should be as high as possible for least speed variation but at high gains a surge tends to occur. Should the car tend to accelerate and decelerate repeatedly when the unit is engaged without becoming steady, then surge is occurring and the gain should be reduced. A gain of 20 to 30 should be satisfactory.

While S1 is being held on "Engage" the car will accelerate gently and continue to do so until S1 is released, at which point the cruise control takes over. A new higher speed can be set up by moving S1 to "Engage" without first releasing the unit, allowing the car to accelerate to the new speed and then releasing S1.

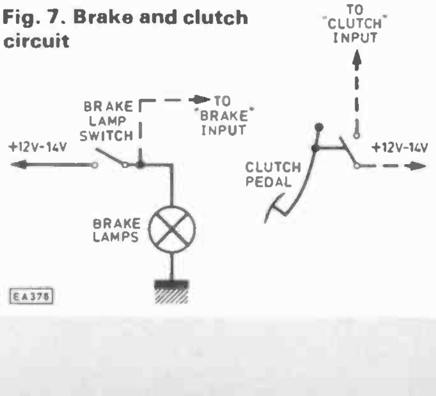
With a clock frequency of 1·5kHz the memory is set in about 100 milliseconds on release of S1, so speed variation during setting is of no importance.

The vacuum servo is self-restricting regarding throttle opening as there is no vacuum at full throttle to operate it. Throttle opening is limited to about 50% or 60%. This can be overcome by using a vacuum reservoir as shown in Fig. 6. Speed control is, of course, limited to the power of the engine during hill climbing (at 60% throttle) and to compression on downhill runs.

The solenoid valve in the servo must be mounted vertically with the vacuum pipe below for correct operation. The link to the throttle must have a sliding joint to allow normal throttle operation.

R. Immelman,
Somerset West,
South Africa.

Fig. 7. Brake and clutch circuit



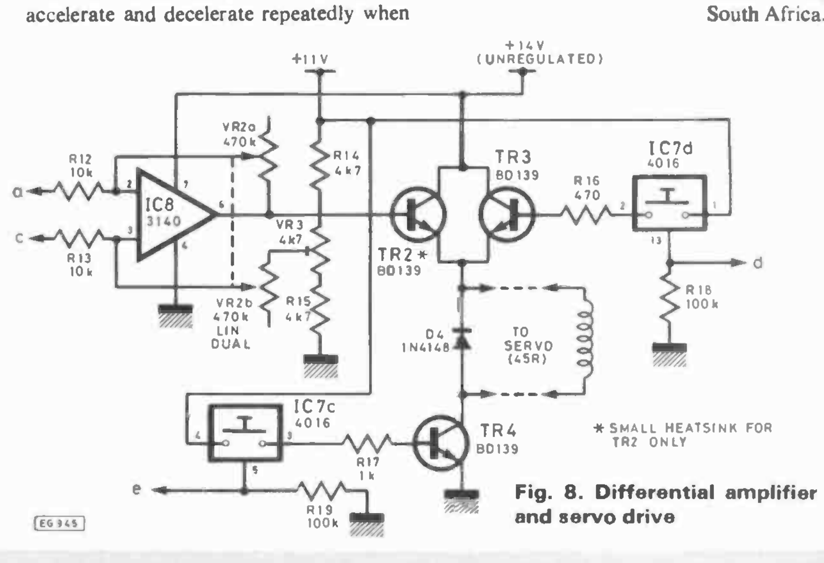


Fig. 8. Differential amplifier and servo drive

MICRO-BUS

Compiled by DJD.

Appearing every two months, Micro-Bus presents ideas, applications, and programs for the most popular microprocessors; ones that you are unlikely to find in the manufacturers' data. The most original ideas often come from readers working on their own systems; payment will be made for any contribution featured.

TWO of the most popular microcomputers currently on sale, the Acorn Atom and the Dragon, have many similarities because they both use the same video display chip, the Motorola 6847. This versatile chip not only contains 64 programmed characters for a 32 × 16 text display, but will also give graphics displays up to a resolution of 256 × 192. However the 6847's internal character set does not include lower case, and so both the Atom and the Dragon display lower case as inverted upper-case characters.

NEW CHARACTERS FOR ATOM

The following circuit shows how to add an external character generator to the 6847 to provide 256 different characters in the alphanumeric display modes. The circuit can be added as a plug-in module, and no alterations are necessary to the Atom (or Dragon). With careful choice of the new character set lower-case can be added, while retaining compatibility with the Atom's existing VDU software. The circuit was designed by *W. A. Chadwick* of Welwyn, and the following description is based on his letter.

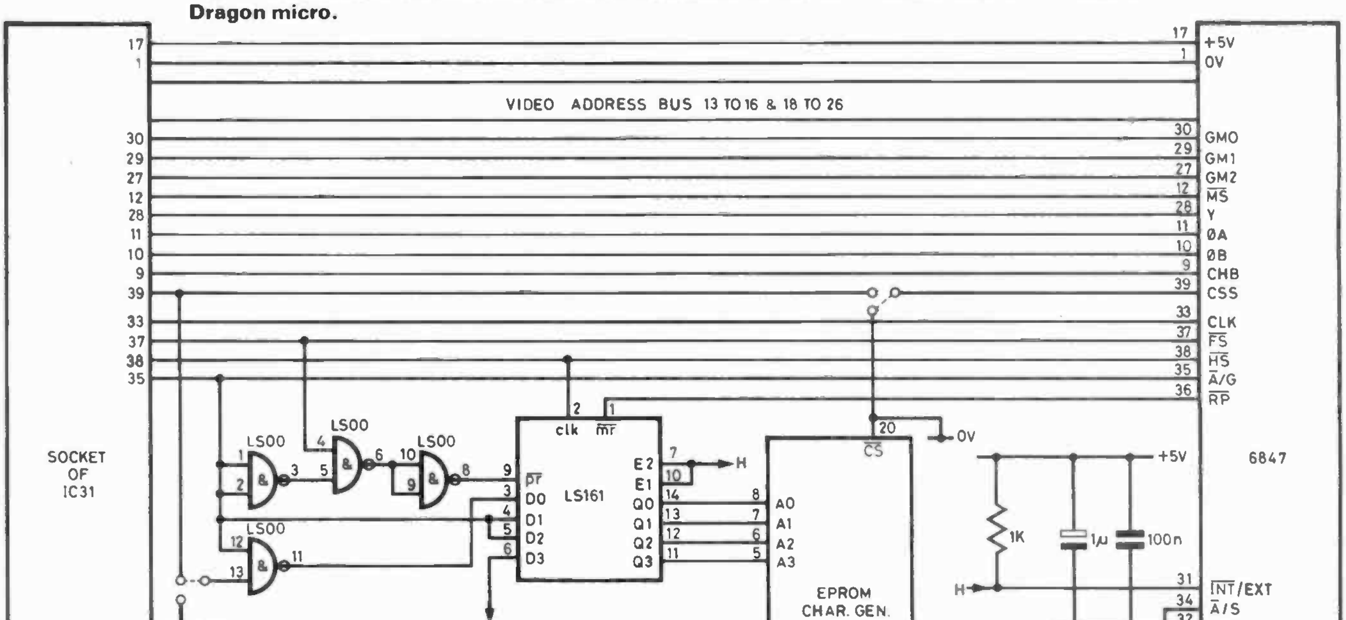
CIRCUIT DESCRIPTION

The new character generator is stored in a 4k × 8 EPROM. The top 8 address lines of this are connected to the 6847's Video Data Bus; see Fig. 1. When the 6847 puts data onto these lines they will select one of 256 groups of 16 EPROM locations. Each displayed character is 8 dots wide and 12 scan lines deep, so that the first 12 EPROM locations of each group contain the precise bit patterns for each character.

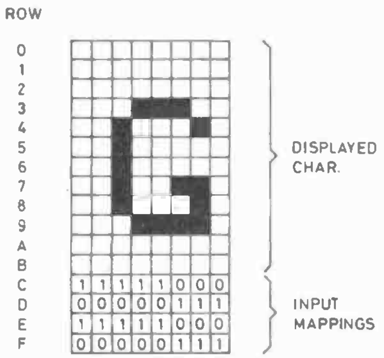
The lowest 4 address lines of the EPROM are connected to a row counter (74LS161). This counter is clocked once per scan line by the HS signal from the 6847 and so will sequentially select character row information from the EPROM. The 6847 provides a clear control, RP, every 12 scan lines for the row counter. The beginning of each display frame contains a border of non-active display lines, but unfortunately the 6847 does not provide an RP pulse to clear the character counter for the first character row. Thus, to ensure that the top line of the display is displayed correctly the Frame Synch (FS) signal is used to preset the row counter to 9 at the beginning of each frame.

When using the graphics modes of the 6847 the video data must be passed on to the chip unchanged. The control line A/G is used to select between alphanumeric and graphics modes. Since only 12 out of every 16 ROM locations are used for each character dis-

Fig. 1. Circuit adds an external character generator to the 6847 Video chip in an Atom or Dragon micro.



played, the 4 unused locations in each case are programmed to contain logical mappings of the top eight address lines. The signal A/G is used to hold the row counter preset to row 12 or above when graphics are selected, thus causing the ROM to appear transparent. To illustrate how this works the coding of a single character is shown in Fig. 2.



EPROM

ROW	ADDR.	DATA
0	070	00
1	071	00
2	072	00
3	073	1C
4	074	22
5	075	20
6	076	20
7	077	26
8	078	22
9	079	1E
A	07A	00
B	07B	00
C	07C	F8
D	07D	07
E	07E	F8
F	07F	07

Fig. 2. (left) ROM programming details for a sample character.

CHARACTER SET

To maintain compatibility with existing software, the following character set is recommended:

Character Code:	Description:
00 to 1F	@ to ← as standard Atom.
20 to 3F	Space to ? as standard Atom.
40 to 7F	White block characters as standard Atom.
80 to 9F	Inverted @, a to z, inverted [\] ↑ ←.
A0 to BF	Inverted space to inverted ? as standard Atom.
C0 to FF	64 custom characters; C0 should be blank.

Two examples of possible charactrer sets following this design are given in Fig. 3. The only limitation of this set is that if the cursor is placed on an upper-case character it will appear as lower-case and vice-versa.

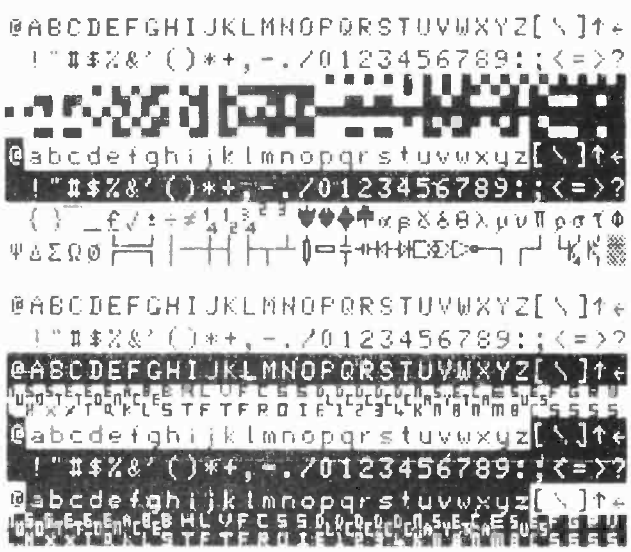
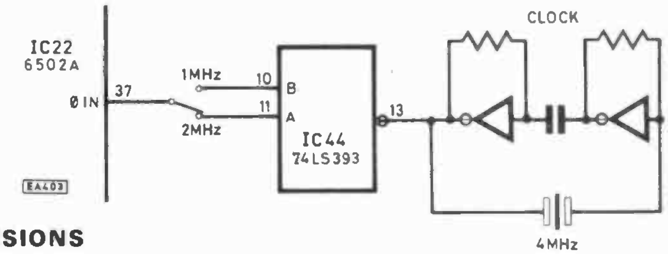


Fig. 3. (left) Two possible character sets maintain compatibility with the 6847's internal set.

CIRCUIT CONSTRUCTION

The circuit can be constructed on a piece of perforated board using a 40-pin header to fit in the socket of IC31. The board should easily fit inside the Atom's case, though be careful to avoid the case support pillar. The only precaution needed is to keep wires carrying video signals as short as possible.

Fig. 4. (below) Circuit increases the speed of the Atom to 2MHz.



POSSIBLE EXTENSIONS

In the Atom the 6847's Colour Select Signal CSS is used to select between two possible sets of four colours. However, on monochrome displays this signal has little use, and so it can alternatively be used to add extra facilities to the character generator board. At power-up the CSS signal is set to logic 0. By gating CSS with A/G it is possible to cause the counter to preset to either row 14 or row 15 depending on the state of CSS. If rows 13 and 15 are programmed with a true logic mapping, and rows 12 and 14 with an inverted mapping, as shown in Fig. 2, then the CSS signal (which is controlled by bit 3 of the port at address B002) can be used to invert the entire graphics display. The circuit in Fig. 1 shows the links made for monochrome use to provide this facility; for colour use, both links should be changed so that CSS operates in the usual way. Good animated effects can be achieved with the colour graphics modes by drawing the background colour, then changing CSS to make the drawing instantly visible.

An alternative use for CSS would be to switch between one of two character-generator EPROMS, one compatible with the existing Atom software, and the other giving 256 totally different display characters.

FASTER ATOM

Three other ways of improving the Atom's circuit have been submitted by *Richard Brain* of Devon. First, the Atom can be persuaded to run at 2MHz rather than the usual 1MHz by fitting a switch as shown in Fig. 4. Note that some of the other components, such as the memory or the 8255, may not be capable of the extra speed, and faster versions may have to be fitted.

The second modification, shown in Fig. 5, speeds up the rate at which characters are printed to the Atom's screen. Normally, character output is synchronised with the FS output of the 6847 to prevent screen noise. By feeding a high frequency to the 8255 this delay of 1/60th of a second is circumvented.

The third modification, shown in Fig. 6, eliminates screen noise on the Atom by giving the micro and the 6847 display generator the same clock source. Note that this means that the microprocessor speed will not be exactly 1MHz, and programs recorded using the cassette interface will have to be re-saved at the new frequency.

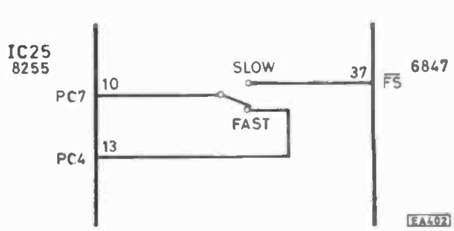


Fig. 5. Circuit increases the speed of displaying characters on the Atom screen.

ZX81 ANAGRAMS

Over the past year several readers have sent in programs for the ZX81 to produce random anagrams of a given word. The shortest of these, taking 13 lines, is shown in Fig. 7 and it fits into an unexpanded ZX81. It was submitted by *G. Wheaton* of Bolton, and he writes:

"This program is of use to anyone trying the 'make-up' or 'break down' anagrams. Any word or combination of words is inputted; the program will then print possible combinations of the letters. To enter a new word press key '0', and then type the new word followed by NEWLINE. Of course the program doesn't guarantee a solution, but is of help in finding

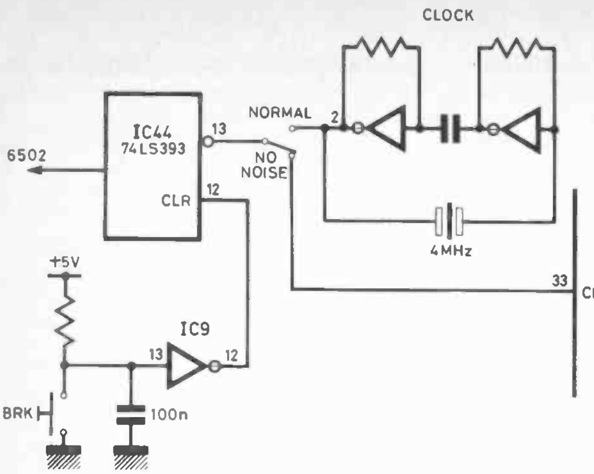


Fig. 6. Circuit eliminates screen noise on the Atom display.

```
 10 INPUT A$
 20 LET L=LEN A$
 30 FOR F=1 TO L
 40 LET X=INT(RND*L)+1
 50 LET Y=INT(RND*L)+1
 60 LET Z$=A$(X)
 70 LET A$(X)=A$(Y)
 80 LET A$(Y)=Z$
 90 NEXT F
100 PRINT AT 21,0; A$
110 IF INKEY$ <> "" THEN GOTO 10
120 SCROLL
130 GOTO 30
```

Fig. 7. Program generates random anagrams of a word on the ZX81.

the answer. The program helped me win the coveted prize of a Piccadilly T-shirt from the local commercial radio station."

"The program is fairly easy to understand; lines 70 to 130 shuffle the letters of the inputted word and lines 140 to 180 print out the resulting arrangements of letters; lines 30 to 60 set up the array B."

ZX81/SPECTRUM MORTGAGE REPAYMENTS

The following programs, shown in Fig. 8, will be of use to all those who are repaying a mortgage, or are contemplating taking one

Fig. 8. Programs calculate mortgage repayments on the (a) ZX81, and (b) Spectrum.

```
  10 REM MORTGAGE REPAYMENTS
  20 PRINT "WHAT CAPITAL SUM?"
  25 INPUT C
  30 PRINT C
  40 PRINT "FOR HOW MANY YEARS?"
  45 INPUT Y
  50 PRINT Y
  60 PRINT "HOW MANY PAYMENTS PE
R YEAR?"
  65 INPUT N
  70 PRINT N
  80 PRINT "ANNUAL PERCENT INTER
EST?"
  85 INPUT I
  90 PRINT I
 100 LET R=I/100
 110 PRINT "TO OBTAIN PERIODIC R
EPAYMENTS ENTER ""CONT"""
 120 STOP
 130 CLS
 140 LET A=(R/N+1)**Y**N
 150 LET B=C*A*R/N/(A-1)
 160 PRINT "PERIODIC REPAYMENTS=
";B
 170 PRINT "TOTAL ANNUAL REPAYME
NT=";B*N
 180 REM ENTER "RUN" TO START
```

(a)

```
  10 REM Mortgage repayments
  20 PRINT "What Capital sum?"
  30 INPUT c: PRINT c
  40 PRINT "For how many years?"
  50 INPUT y: PRINT y
  60 PRINT "How many payments pe
r year?"
  70 INPUT n: PRINT n
  80 PRINT "Annual % interest?"
  90 INPUT i: PRINT i
 100 LET r=i/100
 110 PRINT "To obtain periodic r
epayments ENTER ""CONT"""
 120 STOP
 130 CLS
 140 LET a=(r/n+1)↑y↑n
 150 LET b=c*a*r/n/(a-1)
 160 PRINT "Periodic payment=";b
 170 PRINT "Total annual payment
=";b*n
 180 REM Enter RUN to start
```

(b)

out; they were submitted by *J. W. H. King* of York. In use simply type RUN, and then answer the questions presented on the screen. When satisfied that all is correct, type CONT followed by ENTER (or NEWLINE), and the repayment amounts for each period, and annually, will be shown.

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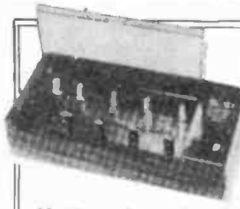

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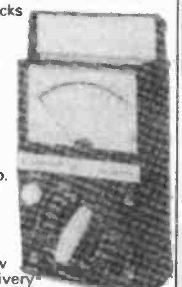

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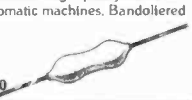

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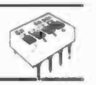

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