EVERYDAY ELECTRONICS and computer PROJECTS

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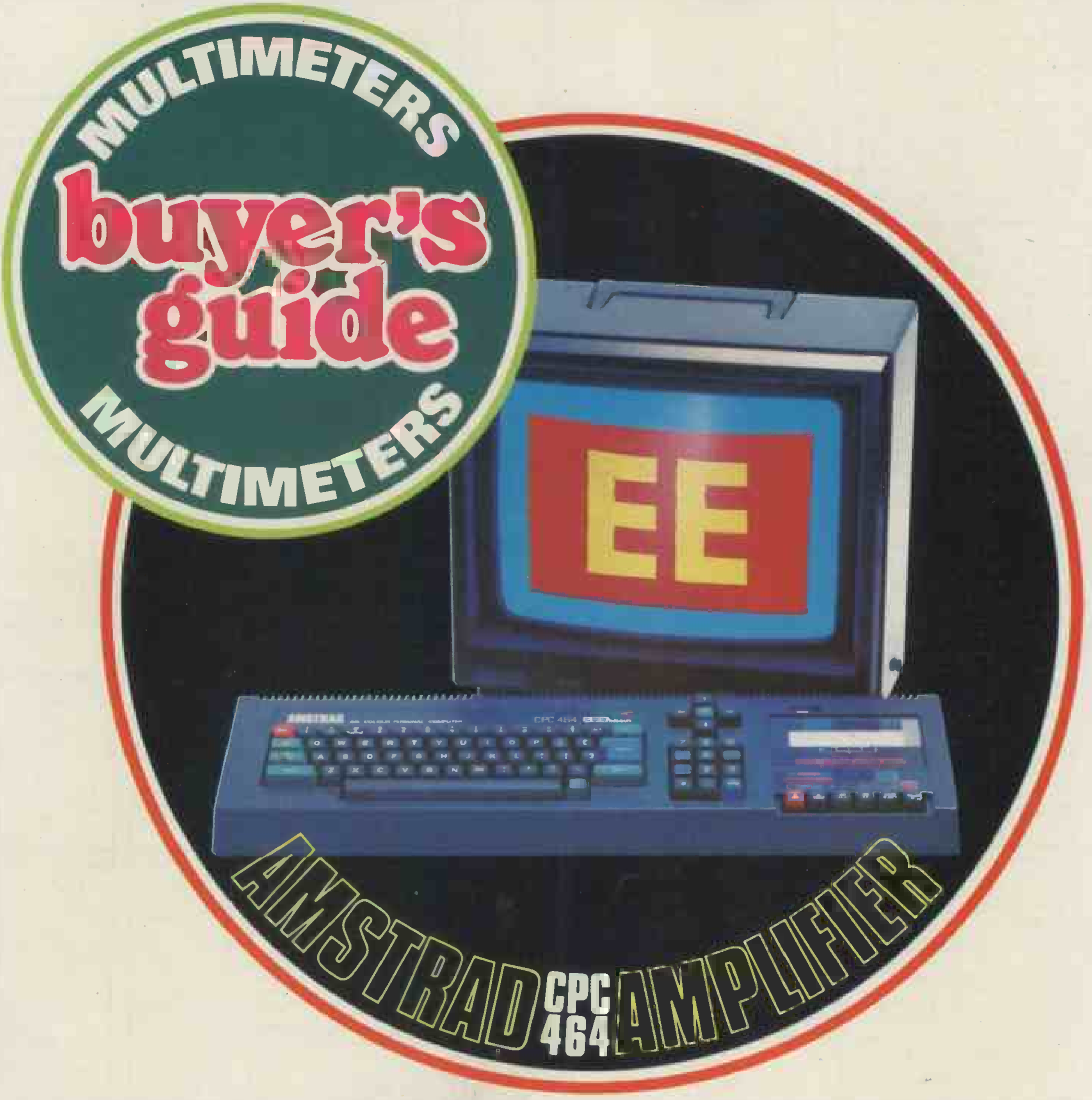


AUTO PHASE * VOLTAGE PROBE

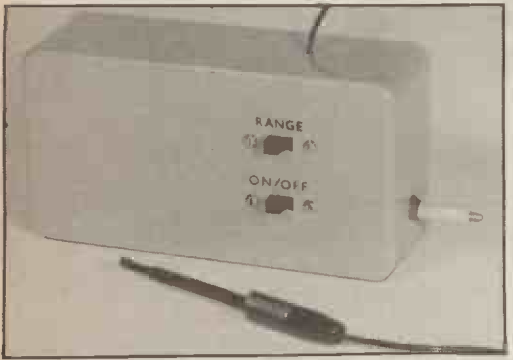
Australia $1.75 New Zealand $1.95 Malaysia $4.95

EVERYDAY ELECTRONICS and computer PROJECTS

VOL 14 Nº5 MAY '85

ISSN 0262-3617

PROJECTS . . . THEORY . . . NEWS . . .
COMMENT . . . POPULAR FEATURES . . .



PROJECTS

SERIES

FEATURES

BUYER'S GUIDE

Our June 1985 issue will be published on Friday, May 17. See page 279 for details.

NEW THIS MONTH

"SENSING & CONTROL PROJECTS FOR THE BBC MICRO"

Have you ever wondered what all those plugs and sockets on the back of the BBC micro are for? This book assumes no previous electric knowledge and no soldering is required, but guides the reader (pupil or teacher) from basic connexions of the user sockets, to quite complex projects. The author, an experienced teacher in this field, has provided lots of practical experiments, with ideas on how to follow up the basic principles. A complete kit of parts for all the experiments is also available. Book, 245×185mm 120pp £5.95. Kit £29.95.

GREENWELD

— The Pack People! —

K524 OPTO PACK – a variety of single point and seven segment LEDS (incl. dual types) of various colours and sizes, opto isolators, numicators, multi digit gas discharge displays, photo transistors, infra red emitters and receivers. 25 assorted £3.95; 100 £14.95; 250 £36.

K525 PRESET PACK – Big, Big variety of types and sizes – submin. min and std. MP, slider, multiturn and cermets are all included. Wide range of values from 20R to 5M. 100 assorted £6.75; 250 £12.95; 1000 £48.

K526 HEATSINK PACK – Lots of different sizes and shapes of heatsink for most diode and transistor case styles. A pack of 25 assorted including several large finned types – total weight over 1kg £5.50; 100 £19.50.

K528 ELECTROLYTIC PACK – All ready cropped for PCB mounting, this pack offers excellent value for money. Good range of values and voltages from 0.47µF to 1000µF. 6v to 100v £3.95; 250 £8.95; 1000 £32.

K531 PRECISION RESISTOR PACK – High quality, close tolerance R's with an extremely varied selection of values mostly ¼ and ½w tolerances from 0.1% to 2% – ideal for meters, test gear etc. 250 £3; 1000 £10.

K532 RELAYS – Wide selection of styles, voltages and contacts. 4v-240v, AC/DC, SP to 4PCO. 20 for £6; 100 £25.

K517 TRANSISTOR PACK – 50 assorted full spec marked plastic devices PNP NPN RF AF. Type numbers include BC114 117 172 182 183 198 239 251 214 255 320 BF 198 255 394 2N3904 etc. etc. Retail cost £7+; Special low price 275p.

K523 RESISTOR PACK – 1000 – yes 1000 ¼ and ½ watt 5% hi-stab carbon film resistors with pre-formed leads for PCB mounting. Enormous range of preferred values from a few ohms to a several megohms. Only 250p; 5000 £10; 20,000 £36.

K520 SWITCH PACK – 20 different assorted switches – rocker, slide, push, rotary, toggle, micro etc. Amazing value at only 200p.

K522 COPPER CLAD BOARD – All pieces too small for our etching kits. Mostly double-sized fibreglass 250g (approx 110 sq. ins.). For 100p.

K530 100 ASSORTED POLYESTER CAPS – All new modern components, radial and axial leads. All values from 0.01 to 1uf at voltages from 63 to 1000!! Super value at £3.95.

K518 200 DISC CERAMIC CAPS – Big variety of values and voltages from a few pF to 2.2uF; 3v to 3kv £1.00.

K203 100 WIREWOUND RESISTORS – From 1w to 12w, with a good range of values £2.00.

K505 20 ASSORTED POTENTIOMETERS – All types including single, ganged, rotary and slider £1.70.

W4700 PUSH BUTTON BANKS – An assortment of latching and independent switches on banks from 2 to 7 way, DPCC to 6PCO. A total of at least 40 switches for £2.95;. 100 £6.50; 250 £14.00.

Goods normally despatched by return of post

1984/85 CATALOGUE

84 page A4 size – Bigger, Brighter, Better – more components than ever before! With each copy there's discount vouchers, Bargain List, Wholesale Discount List, Bulk Buyers List, Order Form and Reply Paid Envelope. All for just £1.00!! Winter Supplement now out – Send large SAE for your free copy.

"TORUS"

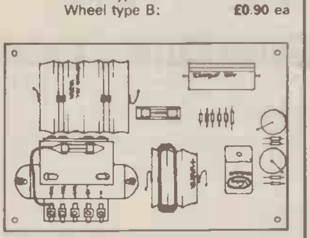
Computer-controlled Robot built around the gearbox described below. Complete kit of parts inc PCB, program listings for BBC (other micros soon). £44.85. 20W ribbon cable (min 3m recommended – 5m better) £1.30/m. SAE for illustrated leaflet.

MOTORIZED GEARBOX

The unit has 2 × 3V motors, linked by a magnetic clutch, thus enabling turning of the vehicle, and a gearbox contained within the black ABS housing, reducing the final drive speed to approx 50rpm. Data is supplied with the unit showing various options on driving the motors.

Two new types of wheels can be supplied (the aluminium discs and smaller plastic wheels are now sold out). Type A has 7 spokes with a round black tyre and is 100mm dia. Type B is a solid heavy duty wheel 107mm dia with a flat rigid tyre 17mm wide.

PRICES:	
Gearbox with data sheets:	£5.95 ea
Wheel type A:	£0.70 ea
Wheel type B:	£0.90 ea



NI-CAD CHARGER PANEL

177×114mm PCB with one massive Varta Deac 57×50mm Ø rated 7.2v 1000mAH and another smaller Deac 32×35mm Ø rated 3.6v 600mA. The price of these Ni-cad stacks new is over £20. Also on the panel is a mains input charger transformer with two separate secondaries wired via bridge rectifiers, smoothing capacitors and a relay to the output tags. The panel weighs 1kgm. All this for just £6.00.

PCB MOUNTING NI-CADS

Much sought after 4.8V 150mA batts with PCB mntg tags on 25mm pitch. Batt size 25×16 Ø. Ideal for paralleling. 99p ea; 10+ 85p; 25+ 70p; 100+ 60p.

NI-CADS: AA 99p; C 199p; D 220p; PP3 395p.

1W AMPLIFIER

Z914 – Audio amp panel 95×65mm with TBA820 chip. Gives 1W output with 9V supply. Switch and vol. control. Just connect batt. and speaker. Full details supplied. Only £1.50; 10 for £12; 25 for £25; 100 £75.

AM TUNER PANEL

Z916 – For use with mono amp above. Neat panel 60×45mm. Only £1.50; 10 for £12.00.

FIBRE OPTICS

Scoop purchase of single and twin cable. For use with visible light or infra-red. Core 1mm dia, overall 2.25mm dia. Single 50p/m; 20m coil £6.30. Twin 90p/m; 20m coil £11.00.

Our shop has enormous stock of components and is open 9-5.30 Mon-Sat. Come and see us!!

GREENWELD

All prices include VAT; just add 60p P&P. Min Access order £5.00 No min. CWO value. Official orders from schools etc. welcome – min invoice charge £10.

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Southampton SO1 0HX
Tel (0703) 772501/783740

AA117	9	BCY42	20	BF259	18
AA119	9	BCY56	16	BF262	25
AAY32	9	BCY70	16	BF263	25
AC107	28	BCY71	16	BF270	18
AC126	17	BCY72	16	BF273	15
AC127	15	BD115	26	BF311	21
AC128	15	BD124P	50	BF324	25
AC128K	23	BD124	10	BF336	20
AC141K	30	BD128	35	BF337	20
AC142K	30	BD131	25	BF338	20
AC153L	23	BD132	25	BF356	28
AC176	18	BD135	20	BF362	30
AC176K	20	BD136	20	BF367	13
AC187	15	BD137	20	BF371	17
AC187K	20	BD138	20	BF414	18
AC188	17	BD139	20	BF420	16
AC188K	23	BD140	20	BF421	18
ACY18	48	BD144	90	BF422	21
ACY19	48	BD150	30	BF423	15
AD142	60	BD157	38	BF440	16
AD149	45	BD158	38	BF451	17
AD161	22	BD166	30	BF455	14
AD162	22	BD177	30	BF458	19
AF124	25	BD179	32	BF459	19
AF125	25	BD181	45	BF461	60
AF126	25	BD182	60	BF462	62
AF126	25	BD183	60	BF469	30
AF139	22	BD201	33	BF470	28
AF239	22	BD202	38	BF471	28
AL112	70	BD203	42	BF479	30
AL113	80	BD204	42	BF493	18
ASZ15	100	BD222	31	BF494	16
ASZ17	100	BD232	31	BF595	16
AU110	110	BD234	32	BF596	16
AY102	180	BD235	28	BF597	10
AY106	180	BD236	30	BF615	30
BA145	10	BD237	21	BF758	41
BA148	10	BD238	24	BF869	22
BA154	6	BD244	50	BF870	22
BA157	12	BD245	50	BF872	23
BB101	13	BD433	28	BF960	38
BB103	16	BD434	30	BF963	40
BB105B	18	BD435	31	BF964	38
BB205B	24	BD437	28	BF966	40
BC107	7	BD438	36	BFR40	25
BC108	7	BD439	40	BFR51	21
BC109	7	BD440	40	BFR62	21
BC115	10	BD441	40	BFR79	25
BC118	11	BD442	40	BFR90	52
BC140	19	BD533	50	BFR91	99
BC141	19	BD534	38	BFX29	20
BC142	19	BD535	30	BFX84	20
BC143	19	BD536	38	BFX85	20
BC147	6	BD537	40	BFX87	15
BC148	6	BD538	40	BFX88	15
BC149	6	BD675	40	BFX89	60
BC157	6	BD676	40	BFY17	30
BC159	6	BD677	38	BFY18	40
BC182	6	BD678	40	BFY41	28
BC182L	6	BD680	40	BFY50	14
BC183	6	BD679	40	BFY51	14
BC183L	6	BD681	45	BFY52	14
BC184	6	BD682	45	BFY56	20
BC184L	6	BDX32	100	BFY57	25
BC212	6	BDX65	80	BFY64	25
BC212L	6	BDY92	100	BFY90	45
BC213	6	BF180	16	BLY48	85
BC213L	6	BF181	18	BLY49	85
BC214	6	BF183	20	BR100	14
BC214L	6	BF184	20	BR101	43
BC237	7	BF185	20	BR103	37
BC238	7	BF194	5	BSX20	15
BC300	16	BF195	5	BSX26	18
BC301	18	BF196	6	BSX29	19
BC302	18	BF197	7	BT106	90
BC303	18	BF198	7	BT109	90
BC327	6	BF199	6	BT116	80
BC328	6	BF200	16	BT119	100
BC337	6	BF240	16	BT120	100
BC338	6	BF241	10	BT138/600	60
BC557	6	BF255	12	BT146/750	99
BCY32	150	BF256	18	BT151/650	58
BCY33	150	BF257	18	BT151/800	58
BCY34	150	BF258	18	BTY79/500	140

BU100A	110	TIP42A	22
BU104	110	TIP42C	25
BU105	80	TIP47	40
BU108	100	TIP48	40
BU110	110	TIP50	60
BU111	140	TIP51	120
BU124	60	TIP52	120
BU126	70	TIP53	120
BU204	75	TIP54	140
BU205	70	TIP105	65
BU208	75	TIP106	65
BU208A	80	TIP107	65
BU208D	100	TIP110	47
BU325	55	TIP111	50
BU326	85	TIP112	40
BU406	85	TIP115	45
BU406D	95	TIP116	45
BU407	75	TIP117	50
BU407D	95	TIP120	43
BU408	85	TIP121	46
BU408D	95	TIP122	47
BU409	95	TIP125	47
BU426	120	TIP126	56
BU500	110	TIP127	56
BU526	80	TIP141	90
BU801	95	TIP142	90
BU806	120	TIP145	65
BU807	95	TIP146	90
C106D	23	TIP147	100
MJ2500	100	TIP2955	42
MJ2501	110	TIP3054	45
MJ2955	55	TIP3055	42
MJ3000	115	TIS43	45
MJ3001	115	TIS44	40
MJE29A	30	TIS61	15
MJE30A	30	TIS88A	45
MJE340	25	TIS90	15
MJE350	80	TIP91	18
MJE520	30	TIP93	20
MJE2955K	90	VK1010	88
OC28	100	VN.10KM	60
OC29	80	VN.46AF	88
OC35	100	VN.66AF	100
OC36	120	VN.88AF	115
OC45	50	VN.89AF	110
OC71	30	ZTX107	11
OC72	50	ZTX108	11
OC200	180	ZTX109	12
R2008B	100	ZTX212	27
R2010B	100	ZTX300	13
TAG4443	76	ZTX301	16
TAG4444	76	ZTX302	16
TIP29	15	ZTX303	24
TIP29A	22	ZTX304	17
TIP29C	25	ZTX320	29
TIP30	25	ZTX326	29
TIP30C	30	ZTX500	13
TIP31A	24	ZTX501	13
TIP31C	30	ZTX502	18
TIP32	24	ZTX503	18
TIP32A	24	ZTX504	25
TIP32C	28	ZTX550	24
TIP33	50	2N.696	26
TIP34	50	2N.697	22
TIP41A	22	2N.698	40
TIP41C	25	2N.699	45

2N.706A	22
2N.708	22
2N.914	28
2N.918	35
2N.930	18
2N.1131	28
2N.1132	28
2N.1613	24
2N.1711	24
2N.2102	50
2N.2160	300
2N.2218A	24
2N.2219	24
2N.2221	23
2N.2222	23
2N.2369	15
2N.2484	20
2N.2646	40
2N.2904	20
2N.2905	20
2N.2906	18
2N.2907	18
2N.2926	8
2N.3019	28
2N.3053	18
2N.3054	35
2N.3055	35
2N.3055H	50
2N.3440	58
2N.3442	85
2N.3702	9
2N.3703	9
2N.3704	9
2N.3705	9
2N.3706	9
2N.3707	9
2N.3708	9
2N.3771	85
2N.3772	90
2N.3773	100
2N.3819	29
2N.3866	68
2N.3903	11
2N.3904	11
2N.3905	11
2N.3906	11
2N.4031	25
2N.4036	25
2N.4037	25
2N.4058	13
2N.4443	76
2N.4444	76
2N.5061	20
2N.5294	30
2N.5296	30
2N.6106	40
2N.6107	40
2N.6109	40

DIODES

AA119	9
BY100	40
BY103	32
BY126	6
BY127	8

BY133	8
BY164	40
BY176	85
BY179	35
BY182	32
BY184	32
BY187	32
BY196	20
BY206	11
BY207	11
BY208	18
BY210	22
BY223	72
BY225	120
BY226	18
BY227	19
BY228	32
BY296	20
BY298	26
BY299	28
BY476	90
BYX10	15
BYX55/350	30
BYX55/600	30
BYX55/800	32
BYX70/300	29
BYX70/500	32
BYX70/800	36
BYX71/600	80
OA74	6
OA90	4
OA91	4
OA200	7
OA202	7
IN.914	2
IN.4001	4
IN.4002	4
IN.4003	4
IN.4004	4
IN.4005	4
IN.4006	4
IN.4007	5
IN.4148	2
IN.5400	9
IN.5401	10
IN.5402	10
IN.5403	11
IN.5404	11
IN.5405	12
IN.5406	13
IN.5407	13
IN.5408	13

ZENERS

400MV BZY88 Range 2V7 to 39V	6
1.3W Zeners BZX61 Range 2V7 to 39V	12

JAPANESE TRANSISTORS

2SB324	55

2SB507	68
2SB754	80
2SC495	60
2SC1060	99
2SC1061	200
2SC1096	78
2SC1161	110
2SC1172	150
2SC1306	90
2SC1307	100
2SC1678	120
2SC1969	130
2SC2028	75
2SC2029	120
2SC2078	120

LOW PROFILE SOCKETS

8 pin	6
14 pin	8
16 pin	9
18 pin	12
20 pin	14
22 pin	16
24 pin	18
28 pin	20
40 pin	25

VOLTAGE REGULATORS

7805	35
7812	35
7815	35
7818	35
7824	35
7905	35
7912	40
7915	40
7918	40
7924	40
78L05	28
78L12	28
78L15	28
78L18	28
78L24	28
79L05	40
79L12	45
79L15	48
LM309K	100
LM317K	220
LM317T	180
LM323K	420
LM723	32
78HGKC	570
78H05KC	520
78GU1C	190
79GU1C	215
79HGKC	670

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AN-360	120

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CA3080	65	MM74C915	96
CA3130	85	MM74C922	3.90
CA3410	40	MM74C926	4.50
ICL7107	9.00	NE567	1.25
ICL7126	8.00	S566B	2.20
ICM7555	95	S576D	2.20
ICM8038	3.10	SAB0529	3.50
LF351	40	SAB0600	2.50
LF353	70	SL440	1.95
LF356	80	SL441	1.35
LM324	40	SL486	1.85
LM334Z	85	SL490	2.05
LM335Z	1.20	TBA800	70
LM339	40	TBA810AS	90
LM348	55	TDA1024	1.20
LM358	48	TDA4290	1.98
LM380	1.20	TL061	40
LM381	1.40	TL062	60
LM382	1.10	TL064	1.30
LM386	88	TL071	45
LM1035	3.95	TL072	70
LM1458	34	TL074	1.30
LM2917	1.90	TL081	35
LM3900	68	TL082	48
LM3909	80	TL084	1.00
LM3911	1.75	TL170	50
LM3914	2.40	TL507C	1.20
LM3915	2.40	TMS1121	8.50
LM13600	1.10	TMS1601	9.50
LS7210	4.75	UA2240	1.45
LS7220	2.75	ULN2003	75
LS7225	2.60	ULN2004	75
MF10C	2.97	ZN414	80
ML922	3.80	ZN425	3.40
ML924	2.50	ZN427	5.70
		ZN428	4.50
		ZN1034E	1.80

TRANSFORMERS

Chassis Mounting

6-0-6V/100mA	1.10
9-0-9V/100mA	1.25
12-0-12V/100mA	1.25
9-0-9V/1A	2.30
12-0-12V/1A	2.90
15-0-15V/1A	3.40

CMOS

4000	16	4027	28
4001	18	4028	45
4002	18	4040	49
4007	16	4043	42
4011	18	4046	60
4012	18	4047	55
4013	25	4049	32
4015	42	4050	35
4016	30	4060	55
4017	39	4069	18
4019	28	4070	18
4023	18	4071	18
4024	35	4077	20
4025	16	4081	16
4026	70	4093	35
		4511	48
		4514	1.00

COMPUTER ICs

6802	2.45	6852	2.40
6809	4.95	Z80A CPU	1.55
6821	1.20	Z80A CTC	1.55
6850	1.50	Z80A PIO	1.55

MEMORIES

2716	3.10	2764	4.75
2732	3.20	6810	1.40

CRYSTALS

32kHz	80	4.0M	1.20
1.8432M	2.30	1.1943M	1.50
2.4576M	1.80	4.1952M	1.80
3.2768M	1.60	6.0M	1.30
		6.144M	1.40

REGULATORS

78L05/12/15	30	7805/12/15	50
79L05/12/15	55	7905	55
Variable: LM723	40		
LM317T	85	LM338K(5A)	5.00

OPTO

		LED CLIPS	3
3mm red	9	5mm red	9
3mm green	12	5mm green	12
3mm yellow	12	5mm yellow	12

Rectangular, square, arrow or triangular (flat face)
Red 15 Green 18 Yellow 18

Bicolour	65	Flashing Red	50
Tricolour		Red/	
Round	32	Continuous	55
Rectangular	45		
IL74/TIL111	55	MOC3020	1.10
ILQ74	1.70	MOC3040	1.50
ORP12	75	MEL11	35

Seven Segment LED Displays

DL704 .3 cc	75	4 Dig 1.8" cc	
FND500.5 ca	85	DIRECT DRIVE	
FND507.5 ca	85	Display	7.00

BOXES

Plastic with lid

B1 75×56×35mm	85
B2 95×71×35	90
B3 115×95×37	1.10
B4 140×90×55	1.50
B5 207×122×77	2.75
B6 213×142×57	2.70

Other boxes including wide range of diecast, aluminium and Vero-boxes in our catalogue.

SPEAKERS

1.5in. 8ohm	85	2in. 8ohm	70
2.25in. 8ohm	70	2.5in. 64ohm	80

5.5in. 8ohm 8W Horn	6.75
Crystal Earpiece	50
Magnetic Earpiece	25
Ultrasonic trans (pair)	3.50
Crystal mic insert	50
Telephone pick up coil	65

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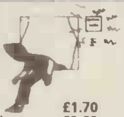

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MK 18 Transmitter Kit for use with MK 11/MK 12 receivers. Requires PP3 battery. Size 8 × 2 × 13cms. Range approx. 60 ft. £6.80

Keyboards for MK 18
MK 9 4-way for use with MK 12 £1.90
MK 10 16-way for use with MK 12 £5.40
Mk 13 11-way for use with MK 11 £4.35

MK 11 Receiver Kit mains powered. Provides 10 latched plus 3 analogue outputs ideal for controlling audio amplifiers. TV or lighting where control of light brightness is required £13.50

MK 14 AC Power Controller Kit for (phase) controlling AC loads from MK 11 analogue outputs, eg lamp dimming. £5.20

MK 19 Stereo Amplifier Controller Kit for remote control of bass, treble and volume (or balance) by MK 11. Includes a one of 10 decoder remote channel or input selection. May be connected between the pre-amp and power amp of almost any audio system. £10.70

MK 12 Receiver Kit mains powered with 16 latched or momentary outputs. Latched version is for applications requiring one output on at a time, eg TV channel selection. Momentary type gives an output only during transmission. Lines may be latched as required.
Size: 9 × 4 × 2cms. £13.50

MK 15 Dual Latched Solid State Relay for switching mains loads such as lamps, TVs, etc, from the outputs of the MK 12 (momentary). 15 items may be switched independently using 8 MK 15s. Triacs (not supplied) switch at mains zero to reduce interference. £4.50

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BC184L	16p	LM382	150p	1N4148	4p	4025BE	28p	4082BE	28p
BC212	14p	LM384	170p	1N914	5p	4026BE	110p	4085BE	59p
BC214	12p	LM387	175p	2N2219	37p	4027BE	38p	4089BE	140p
BC327	14p	LM389	150p	2N2369A	28p	4028BE	55p	4093BE	40p
BC328	14p	LM3914	380p	2N2646	90p	4029BE	60p	4094BE	110p
BC337	14p	MJ2955	115p	2N2904	32p	4031BE	130p	4098BE	85p
BC547	9p	ML922	505p	2N2907	26p	4032BE	65p	4099BC	96p
BC548	12p	MPF102	85p	2N3054	79p	4033BE	94p	40106	44p
BC549	12p	NE555	37p	2N3055H	105p	4035BE	65p	40109	86p
BCY70	23p	NE556	65p	2N3703	14p	4038BE	85p	40162	68p
BCY71	22p	NE565	155p	2N3704	12p	4040BE	60p	40174	72p
BD131	49p	NE566	160p	2N3705	12p	4041BE	69p	40194	79p
BD132	50p	OA200	9p	2N3706	14p	4042BE	56p	4502BE	60p
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BD139	40p	OA90	9p	2N3711	11p	4044BE	63p	4508BE	150p
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BF259	37p	TDA1024	179p	2N3905	14p	4048BE	50p	4568BE	310p
BFX29	34p	TIP122	95p	2N5458	59p	4049UBE	56p	7106	810p
BFX84	34p	TIP127	75p			4050BE	38p	7107	810p
BFX85	37p	TIP2955	95p	4000BE	23p	4051BE	60p	741	28p
BFX87	38p	TIP3055	87p	4001BE	28p	4052BE	60p	748C	59p
BFX88	35p	TIP31A	39p	4002BE	28p	4053BE	72p		
BFY50	31p	TIP41A	45p	4006BE	75p	4054BE	88p		
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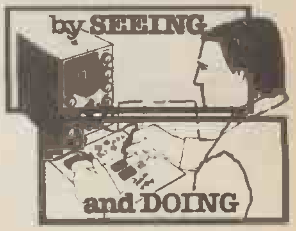

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VOL 14 No5 MAY '85

EVERYDAY ELECTRONICS and computer PROJECTS

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We are unable to offer any advice on the use, purchase, repair or modification of commercial equipment or the incorporation or modification of designs published in the magazine. We regret that we cannot provide data or answer queries on articles or projects that are more than five years old. Letters requiring a personal reply must be accompanied by a **stamped self-addressed envelope** or a **self-addressed envelope and international reply coupons.**

COMPONENT SUPPLIES

Readers should note that we do not supply electronic components for building the projects featured in EVERYDAY ELECTRONICS, but these requirements can be met by our advertisers.

All reasonable precautions are taken to ensure that the advice and data given to readers are reliable. We cannot, however, guarantee it and we cannot accept legal responsibility for it. Prices quoted are those current as we go to press.

OLD PROJECTS

We advise readers to check that all parts are still available before commencing any project in a back-dated issue, as we cannot guarantee the indefinite availability of components used.

We regret that **we cannot provide data or answer queries on projects that are more than five years old.**

SUBSCRIPTIONS

Annual subscription for delivery direct to any address in the UK: £12.00. Overseas: £15.00. Cheques should be made payable to IPC Magazines Ltd., and sent to Room 2613, King's Reach Tower, Stamford Street, London SE1 9LS.

BACK ISSUES & BINDERS

Certain back issues of EVERYDAY ELECTRONICS are available world-wide price £1.00 inclusive of postage and packing per copy. Enquiries with remittance should be sent to Post Sales Department, IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF. In the event of non-availability remittances will be returned.

Binders to hold one volume (12 issues) are available from the above address for £5.50 inclusive of postage and packing worldwide.

BUYER'S GUIDES

IN THIS issue we continue what will become an occasional feature in EE—the buyer's guides. Regular readers will have noted our recent *Monitor Buyer's Guide* in the March issue. Reader response to this guide was good and it appears that the need for basic information on products is growing as the range of products increases. With so many companies selling a wide range of equipment, just knowing what is available in your price range is becoming difficult.

In this issue we carry a fairly extensive guide to multimeters. Rather than just listing available products with a brief specification, each guide will give an introduction to the equipment and try to assist the understanding of the figures being quoted or the various types, etc. In this way, the guides are educational as well as informative.

Since the range of multimeters is vast we have concentrated on the lower priced models likely to be purchased by the average hobbyist. Multimeters are extremely versatile and represent one of the essential items of equipment required by anyone involved in electronics—so take a good look before you buy.

We should point out that we have made no attempt to review or rate the meters shown, neither have they been selected for quality or value. The guide simply shows what is available and assists in giving the data necessary to make your choice. Products purchased as a direct result of the guide are not covered by the mail order protection service unless the supplier has placed a display advertisement for them in the issue. We therefore do recommend that you look carefully at advertisers' products—many of them carry a good range in this particular area of interest—before you purchase.

Would you please mention EE when ordering or requesting more information on any item seen in our pages. By doing this you help to make sure the companies keep us informed of all their products and news so, in turn, we can keep you up to date.

VALUE

It appears that we have escaped most of the dreaded VAT. It was feared that all publications would be forced to add VAT to their cover price but for the time being this has not happened. We had no wish to increase the price of EE which we believe represents good value, particularly in comparison with our competitors. The information we publish is educational and it would have been a pity to see it taxed. However, VAT on advertising will affect the small companies and that is not very helpful.

Mike Kenward

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We regret that lengthy technical enquiries cannot be answered over the telephone

AMSTRAD AMPLIFIER

CPC 464

P. DOOLEY

THE new Amstrad computer is equipped with a three channel sound system, all channels being directed to the internal speaker. To appreciate the full sound capabilities of this machine, a stereo amplifier is required. The stereo signals for driving the amplifier are available at the 3·5 jack socket marked (I/O). When amplified through a stereo system the three channels (A,B, and C) appear as Left, Right and Centre.

Any 8 ohm speakers rated at several watts each will be suitable. The prototype uses a pair of car stereo speakers which are supplied in sloping front enclosures, and perform well. A pair of small hi-fi speakers would also be suitable if they are available. Although the output of the amplifier is only 0·25W, per channel, using speakers of a higher rating will enhance the sound, particularly at lower frequencies, and alleviate distortion at full volume.

CIRCUIT DESCRIPTION

The amplifier (see Fig. 1) is based on the LM386 audio power i.c. In order to keep the external components count to a minimum, the gain is set internally to 20.

Provision is made to increase the gain using additional components connected to pins 1 and 8, but is not utilised in this application. As the output from the computer is at a fixed level, a volume control, VR1, is required.

Power is derived from a mains transformer which has a secondary winding of 6V. This is then full wave rectified by D1–D4 and smoothed by C7, giving an input voltage of 7·5V to the regulator, IC3. This is the minimum that can be applied to the device to enable it to function as a 5 volt regulator, and has been kept low to minimise the dissipation. D5 is mounted on the front panel, and serves as a power 'on' indicator.

CONSTRUCTION

Fit and solder all components to the p.c.b. Note that although a 16-pin socket has been used to mount the two LM386 i.c.s, two 8 pin sockets could be used if they are to hand. Veropins are inserted at all positions where flying leads are terminated.

The prototype uses a plastic case measuring 127×133×54mm, which splits into two halves (top and bottom), and has removable front and rear panels. This greatly simplifies construction, as the p.c.b., mains transformer, and fuse holder can be placed in position and the mounting holes marked. This should be done with the front panel in position with the controls fitted, to ensure clearance from the p.c.b.

The rear panel requires drilling for the speaker sockets and a grommet for the mains cable. See Fig. 2 and Fig. 3 for p.c.b. layout.

FINAL ASSEMBLY

Install C1,C2, and the 0V link between SK1 and VR1. Position the l.e.d. in the clip and connect the cathode to the 0V terminal on SK1. The completed front panel, rear panel, p.c.b. transformer and fuse holder can now be fitted in position and all interwiring completed, as shown in Fig. 4. A solder tag must be fitted under one of the transformer mounting screws for connection of the *earth lead.*

An input lead, of a length to be determined by the constructor, is required, and consists of a length of twin screened cable terminated at both ends with a 3·5 stereo jack plug.

After the usual last check for obvious faults, fit a 250mA fuse and switch on. Check that the l.e.d. is lit and the regulator output is 5 volts. If all is well plug in the speakers and the input lead (with amplifier switched off). Touching the two outer rings of the jack plug should cause a buzzing noise, due to pick-up, in the speakers. If there is a fault on one channel of the amplifier, comparisons can be made with the other.

Connect the amplifier to the computer and load a selection of programs. Some programs will only emerge as mono reproductions, as they only contain single channel commands. If any imbalance is detected on multi-channel programs, this could be due to the software, as the volume, as well as other parameters, is software selectable.

TWO STEREO AMPS TO BOOST YOUR AMSTRAD MICRO'S SOUND EFFECTS

ONE MAINS UNIT AND ONE MICRO POWERED UNIT

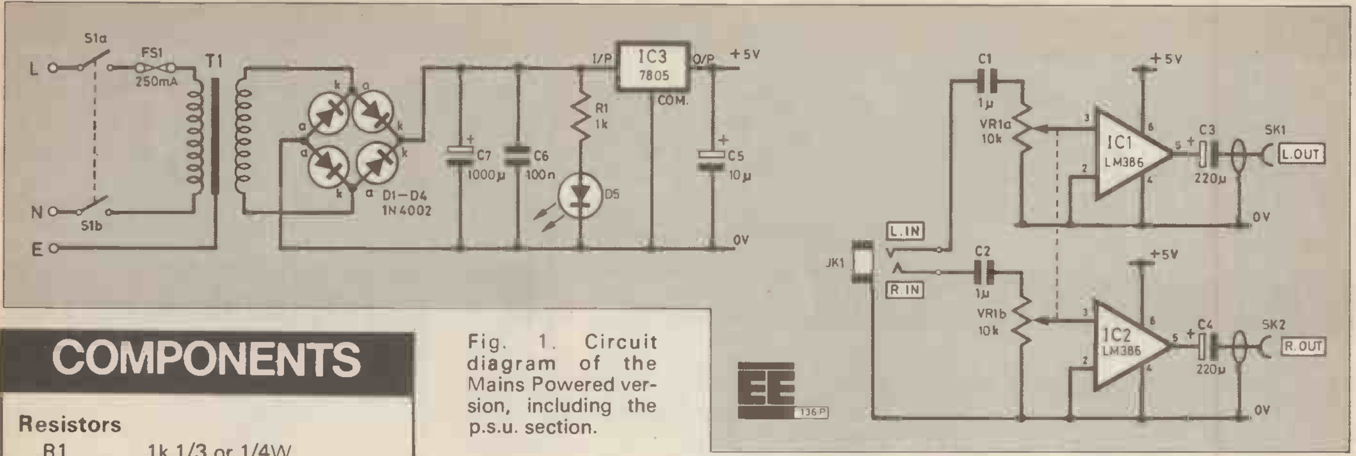


Fig. 1. Circuit diagram of the Mains Powered version, including the p.s.u. section.

COMPONENTS

Resistors
R1 1k 1/3 or 1/4W

Potentiometers
VR1 10k log dual gang

Capacitors
C1,C2 1µ polyester (2 off)
C3,C4 220µ 16V electrolytic axial (2 off)
C5 10µ 16V electrolytic axial
C6 100n ceramic disc
C7 1000µ 25V elect axial

Semiconductors
IC1,IC2 LM386 (2 off)
IC3 7805 regulator
D1-4 1N4002 (4 off)
D5 0·2in red + clip

Miscellaneous
JK1 3·5mm stereo jack socket
SK1,2 phono socket (2 off)
S1 rotary mains switch
T1 mains transformer—6 volt 500ma secondary
FS1 250mA fuse and chassis holder (20mm)
Case Tandy 270–218

P.c.b., 2 knobs, 16 pin i.c. socket, p.c.b. pillars, Veropins, connecting wire, twin screened cable, 1 amp mains cable, grommet, 3·5mm stereo jack plug
Phono plug (2 off)

See Shop Talk page 256

Printed circuit board: single-sided 106 × 48mm, *EE* PCB Service, code 8505–02

Approx. cost Guidance only **£15.00**

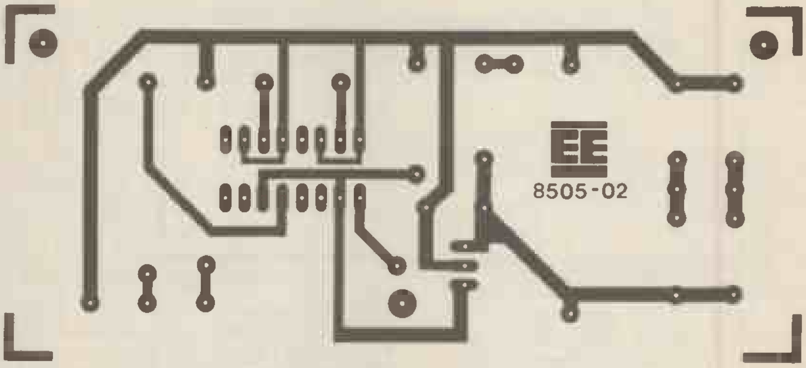


Fig. 2. P.c.b. track layout (actual size).

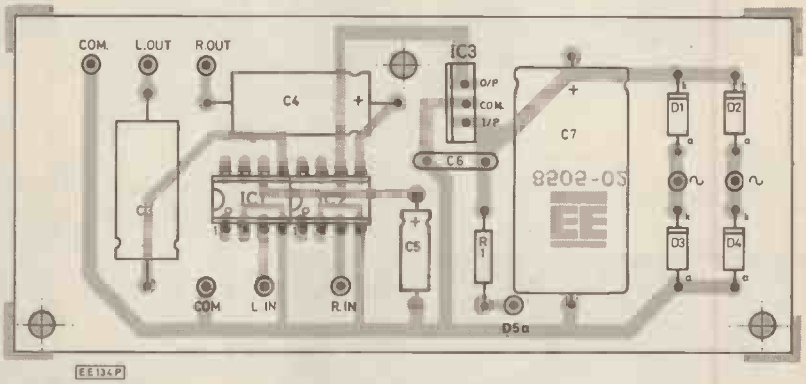


Fig. 3. Component layout.

COMPUTER POWERED VERSION

For those who intend to use the amplifier solely for the Amstrad, a computer powered version will be described. The unit is basically the same as the mains powered version (see Fig. 5), the differences being as follows:

1) The mains transformer, bridge diodes D1 to D4, regulator IC1, and other power supply components, are omitted.
2) Extra de-coupling components are added to prevent interference with the computer circuitry and display.
3) A smaller case can be used.

CIRCUIT DIAGRAM

For C1 and C5, 1µ non-polarised tantalum capacitors have been used because of their smaller physical size (see Fig. 7). Resistors R1 and R2 and capacitors C3 and C7 are to suppress any tendency for the LM386 to break into oscillation, as is sometimes the case. Capacitors C2, C6 and C9 de-couple the 5 volt supply.

CONSTRUCTION

The p.c.b. shown in Figs. 6 and 7 is 102mm × 41mm, and will slot into the specified case without the need of any mounting hardware. The front and rear panels require drilling. To prevent a volt drop occuring in the power leads, cable with a rating of 3 amps (0·5mm) should be used. For the same reason, the power lead to the computer should be kept as short as possible.

The assembled p.c.b. with all flying leads attached, is slid in to the case. When the front and rear panels have been assembled, they should be laid in a posi-

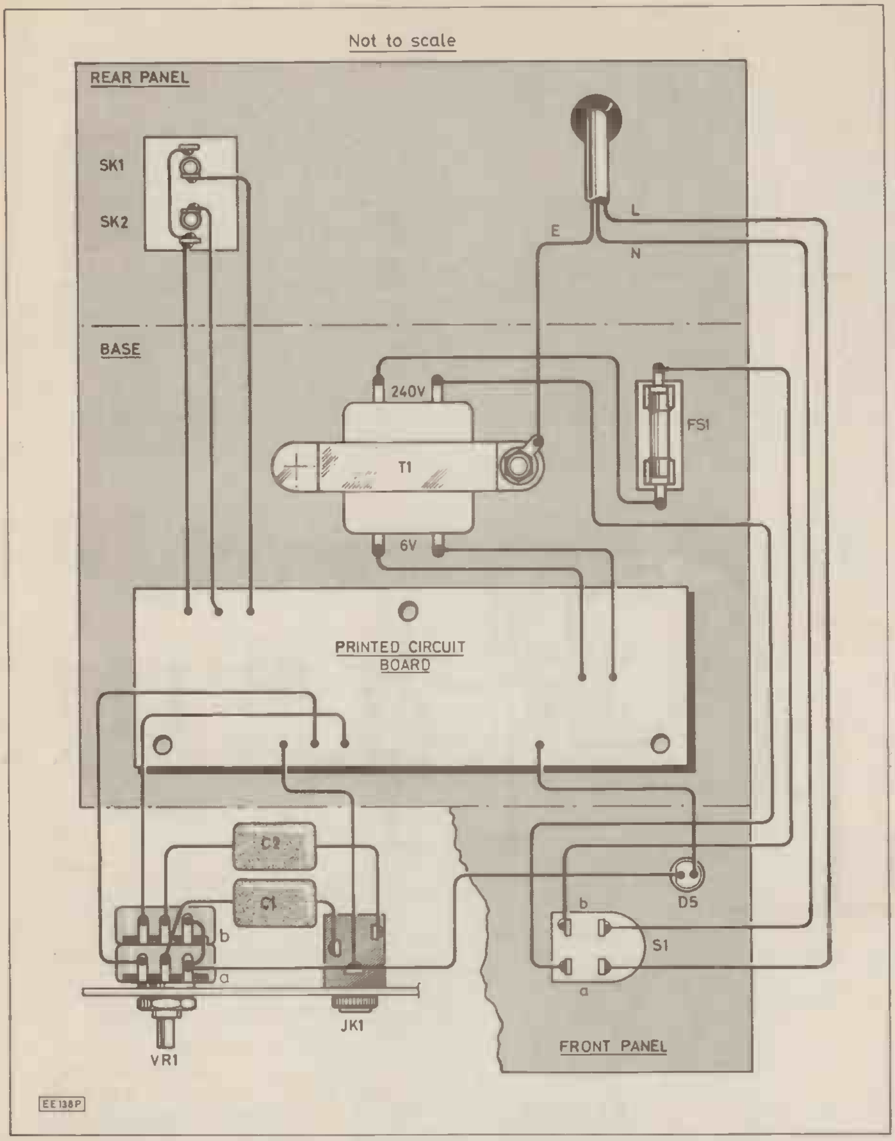
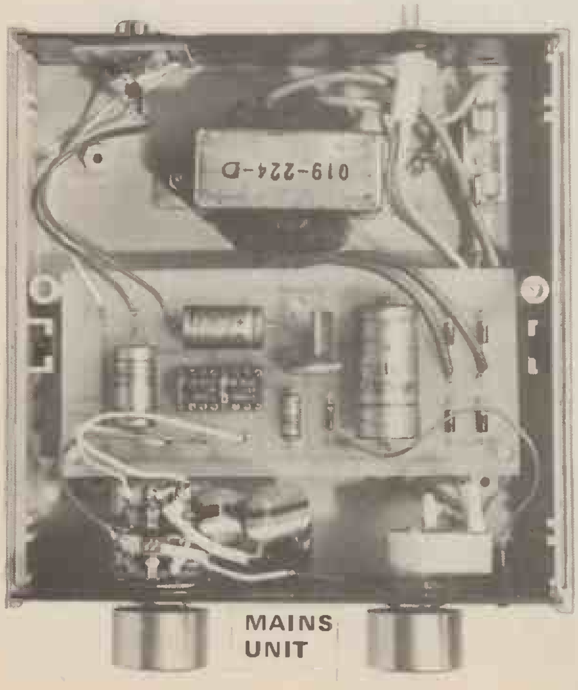


Fig. 4. Wiring and layout diagram. Note: C1 and C2 should go to the left-hand tags of VR1 and, instead, the wipers to the p.c.b.



MAINS UNIT

tion to enable the interconnections to be carried out (see Fig. 8).

With all wiring completed, the amplifier can be tested using the procedure previously described. It is recommended that the amplifier be tested using an external supply, e.g. a 6 volt battery or battery eliminator, and not powered by the computer until the unit has been proven to work correctly. The current consumption should be in the region of 100mA at high volume levels. □

COMPONENTS

Resistors

R1,R2	10 ¼W (2 off)
R3	1k ¼W

Potentiometers

VR1	10k dual gang log.

Capacitors

C1,C5	1µ tantalum non-polarised (2 off)
C2,C6	10µ 10 volt electrolytic (2 off)
C3,C7	47n ceramic (2 off)
C4,C8	220µ 16 volt elec. (2 off)
C9	220n polyester

Semiconductors

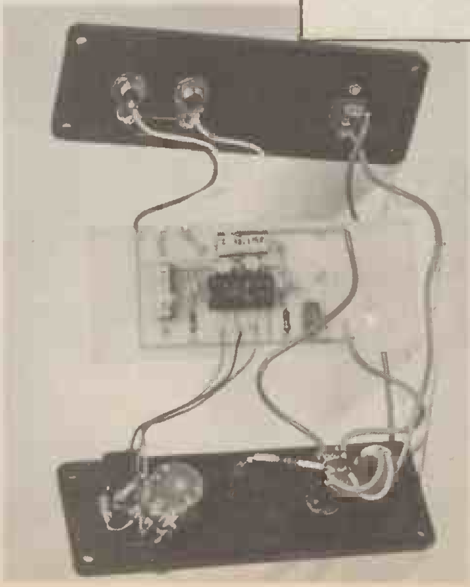
IC1,IC2	LM386 (2 off)
D1	0·2in red + clip

Miscellaneous

JK1	3·5mm stereo jack socket
SK1,2	2 × single phono skts (or 1 double)
SK3	D.c. power skt 2·1mm Tandy 274–1565
S1	D.P.S.T. min toggle switch
Case	Tandy 270–286

P.c.b., 1 knob, 16-pin i.c. skt, p.c.b. pins, connecting wire, 0·5mm wire (power), twin screened cable, grommet, 3·5mm stereo jack plug (for input lead), Phono plug (for speakers) (2 off), D.C. power jack plug 5mm. Tandy 274–1567

Printed circuit board: single-sided 106 × 48mm, *EE* PCB Service, code 8505–03



MICRO-POWERED UNIT

See Shop Talk page 256

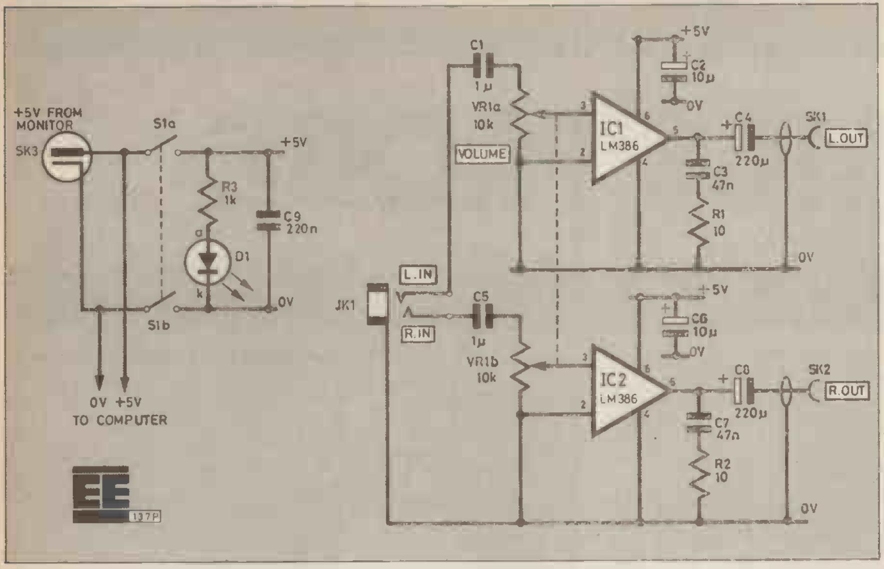


Fig. 5. Circuit diagram of the unit powered from the Amstrad microcomputer itself. The LM386 audio power amplifier i.c. has its gain set internally to 20, although there is a provision for increasing the gain using additional external components. The facility, which is available through pins 1 and 8, is not taken advantage of here, in order to keep the project simple.

COMPONENTS
approximate cost £12.00

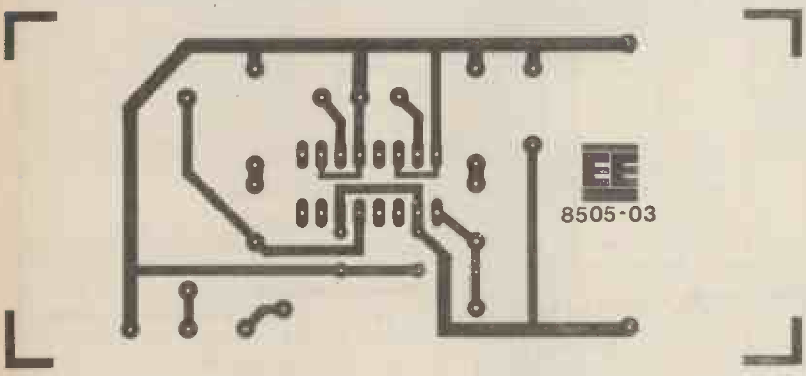


Fig. 6. P.c.b. track layout of the Micro-Powered version (actual size). This p.c.b. is of dimensions which allow it to slide directly (horizontally) into the Tandy box specified in the components list (part No. 270-286).

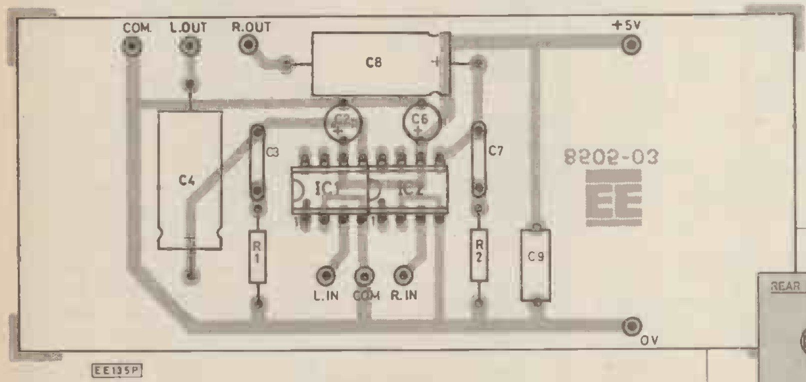


Fig. 7. Component layout. The input capacitors are mounted off the board (between JK1 and VR1) and are non-polarised tantalum types for compactness.

0·25 WATTS PER CHANNEL

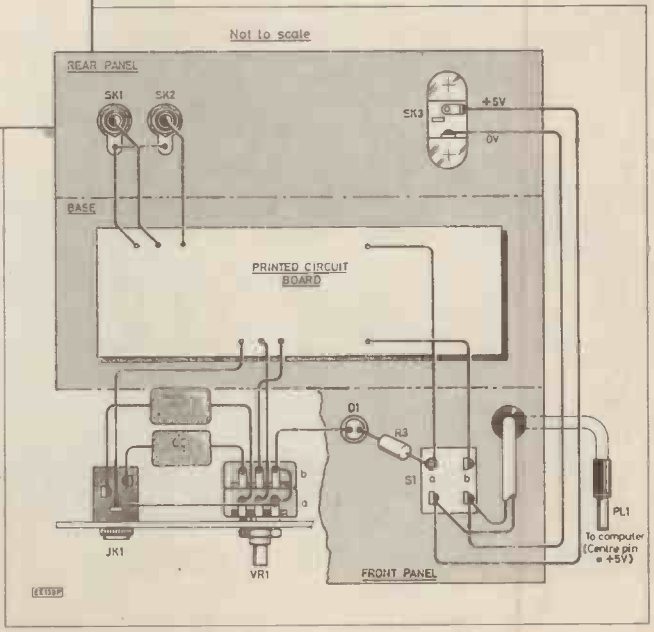


Fig. 8. Wiring diagram of the Amstrad powered version. Note: VR1a wiper should go to L.IN, not COM, and likewise the 0V wire from JK1, VR1a, etc. should go to COM on the p.c.b.

VOLTAGE PROBE

R.A.PENFOLD

THE STANDARD ITEM of test equipment for making voltage checks on electronic equipment is, of course, an ordinary multimeter. However, there is an alternative which is becoming increasingly popular, and this is the "voltage probe" type of voltage tester. The facilities offered vary considerably from one unit to another, but all have a bargraph l.e.d. display with the l.e.d.s being used to indicate whether or not the test voltage is above certain threshold levels. This obviously gives only a limited degree of accuracy, but the accuracy is sufficient for much electronic servicing, and a voltage probe is very quick and convenient in use.

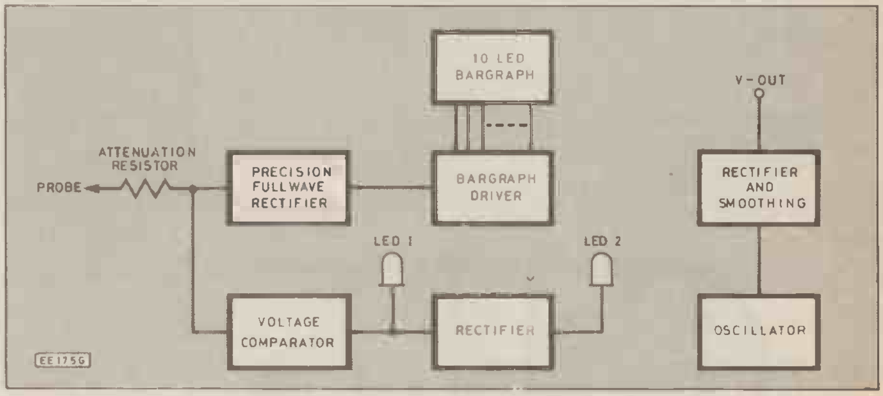


Fig. 1. Block diagram of the Voltage Probe.

DISPLAY

The voltage probe described in this article is a fairly sophisticated type which has a ten l.e.d. bargraph display. Two measuring ranges are available, giving a total of twenty threshold voltage levels. On the most sensitive range the switching levels are at approximately 0·5, 0·75, 1, 1·5, 2, 3, 4·25, 6, 8·5 and 12 volts. On the high voltage range these threshold potentials are boosted by a factor of ten, giving a maximum switching level at about 120 volts.

A logarithmic scale is used so that the ten l.e.d.s cover a wider range of voltages, and although this initially makes results a little more difficult to interpret, one soon gets used to the scaling. It has to be emphasised that the threshold levels are only approximate, and that the unit is not intended for use in applications where precise measurements are needed. It is intended as a quick checker where limited accuracy is adequate.

The unit will respond to both positive and negative inputs, and a l.e.d. indicates the polarity of the input signal. The unit will also respond to a.c. signals, and a second indicator l.e.d. switches on if the input is an a.c. signal. When the input signal is an a.c. type the unit responds to the peak voltage (which is about 1·4 times the r.m.s. value for sinewave signals). Overload protection against both positive and negative inputs is included in the unit. The sensitivity of the probe is, like a standard multimeter, 20k/volt.

SYSTEM OPERATION

The block diagram of Fig. 1 helps to explain the overall operation of the probe.

An attenuation resistor at the input reduces the sensitivity of the unit to a suitable level. In practice there are actually two switched attenuation resistors which give the units its two ranges. The input signal is applied to a precision fullwave rectifier, and the purpose of this circuit is to give a positive output voltage regardless of the polarity of the input signal, so that the probe will respond to inputs of either polarity. This also makes the unit respond to a.c. as well as d.c. input signals. The output of the precision rectifier is coupled direct to the input of the bargraph driver, and as explained earlier, this is a ten l.e.d. logarithmic type.

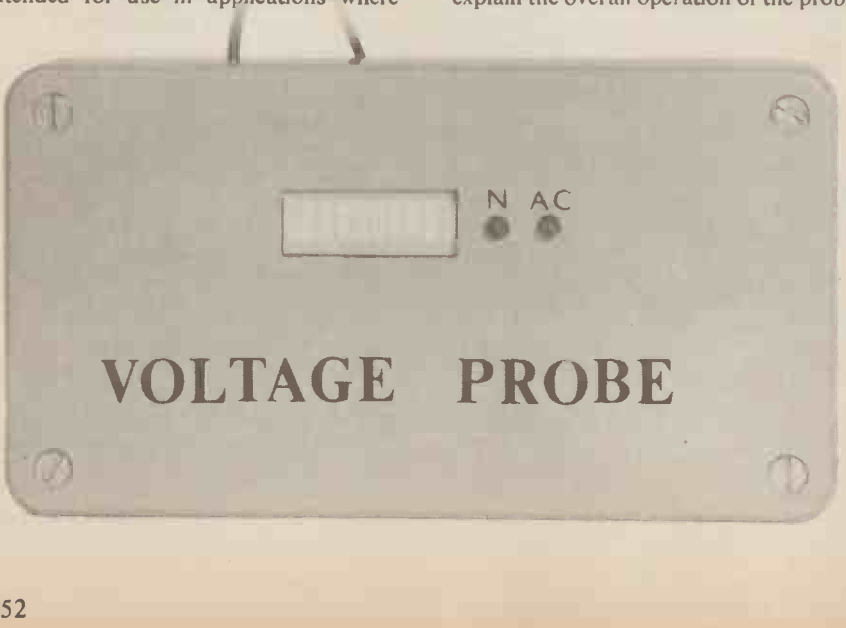
In addition to the rectifier, the input signal is applied to a voltage comparator. This activates the polarity indicator l.e.d. if the input is negative of the earth rail. The output of the comparator connects to a rectifier circuit which drives another l.e.d., and with a d.c. input no current is fed to this l.e.d. However, with an a.c. input it is pulsed on at the input frequency, and assuming this frequency is a few tens of hertz or more it will appear to light up continuously.

The voltage comparator and precision rectifier stages require a negative supply rail. Rather than use two batteries to power the unit the negative rail is derived from the positive supply using an oscillator feeding into a rectifier and smoothing circuit.

THE CIRCUIT

Refer to Fig. 2 for the full circuit diagram of the Voltage Probe.

The voltage measuring circuit has an input impedance of 10k and a full scale threshold voltage of 1·2 volts. S1 is the



range switch, and attenuator resistors R1 and R2 nominally reduce the sensitivity by factors of 10 and 100 respectively. D1 to D6 form a bipolar clipping circuit that limits the input voltage to the precision rectifier to no more than about plus and minus 1·9 volts.

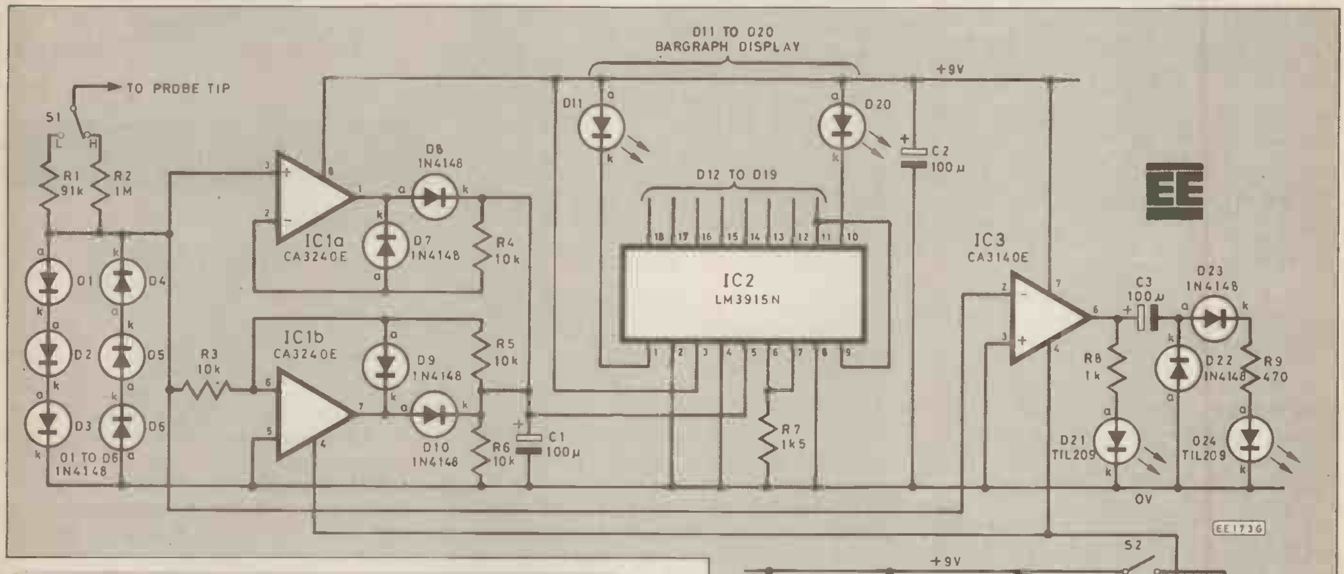
ACTIVE RECTIFIER

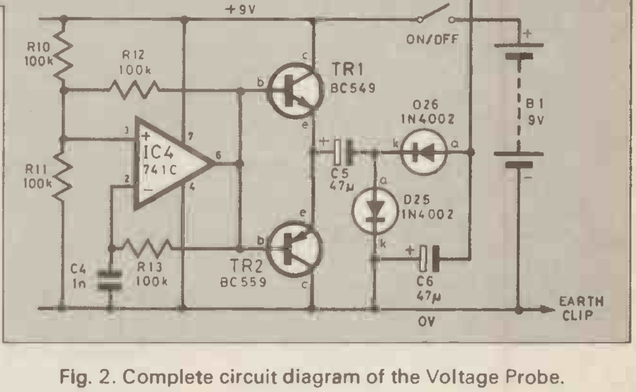
A conventional fullwave precision rectifier based on dual operational amplifier IC1 is used, and this is really two half-wave circuits connected in parallel. IC1a taken from the output of the rectifier. The effect of the negative feedback is to balance the two input voltages of the amplifier.

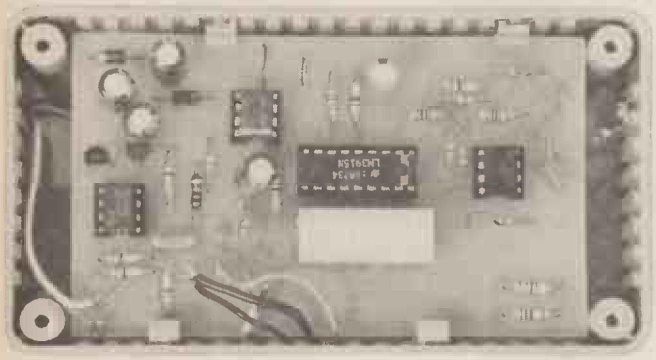
With a normal buffer stage the input signal is applied to the non-inverting input, and the feedback is taken direct from the output to the inverting input. The output therefore takes up the same potential as the input signal, and unity voltage gain buffering is obtained. In this case the feedback is taken via diode D8, but the same basic action occurs with the inverting input (and thus the output of D8)

The other section of the rectifier operates in what is essentially the same way, but the circuit is based on a unity gain inverting amplifier. A negative input signal therefore gives an identical ouput voltage that is positive in polarity, while a positive input gives a negative output that is blocked by D10.

C1 smoothes the output of the rectifier, and when using the unit with d.c. inputs this has no significant effect. It helps to give a clearer indication with a.c. signals though, and C1 then charges to the peak output voltage from the rectifier circuit.







The case lid removed revealing the circuit board, adaptors and guide rails.

Fig. 2. Complete circuit diagram of the Voltage Probe.

handles positive inputs and IC1b handles negative ones. The purpose of using an active rectifier, rather than a simple passive type such as a bridge rectifier, is that the voltage drop through a passive rectifier would give very poor accuracy in this application, especially at the lower indication levels. An active rectifier uses negative feedback to overcome the non-linearity of semiconductor diodes.

If we consider IC1a first, this is virtually an ordinary unity voltage gain, non-inverting buffer stage followed by a diode which provides the rectification. There is an important difference in that the negative feedback is not taken direct from the output of IC1a, but is instead being maintained at the same voltage as the input signal. There is a typical voltage drop of about 0·6 volts across D8, but the output of IC1a simply goes 0·6 volts more positive in order to counteract this and maintain the voltage balance at the inputs.

All this only applies if the input signal is positive. If it is negative D8 blocks any output current, and ensures that the required rectification is obtained. D7 then provides a negative feedback path and prevents the output of IC1a switching fully negative. This helps to give good high frequency performance, and the circuit will work well at frequencies of up to about 200kHz.

BARGRAPH

The bargraph driver, IC2, is an LM3915. This is the logarithmic version of the popular LM3914 bargraph driver which will probably be more familiar to most readers. Fig. 3 shows the arrangement used in the LM3914/5 integrated circuits. A series of ten voltage comparators are used to drive the l.e.d. display, with each comparator driving one l.e.d. The inverting input of each comparator is fed with the buffered input signal, while the non-inverting inputs are fed with a series of reference voltages produced by a ten stage resistor network.

In normal use the lower end of the network (pin 4) is connected to earth and the upper end (pin 6) is connected to the output of the internal 1·2 volt reference source. Each comparator has an output transistor which is switched on if the inverting input is at a higher voltage than the non-inverting input, or switched off if the comparative input levels are reversed. When switched on each output transistor switches on its l.e.d.

With zero input voltage all the output transistors will be switched off. Comparator 10 has the lowest reference voltage, and if the input potential is gradually increased the input voltage will eventually go above this reference level. The l.e.d. driven by comparator 10 is then activated. Comparator 9 has the next highest reference voltage, and when the input voltage exceeds this level the l.e.d. driven by this comparator would be activated. This process would continue until the input voltage exceeded 1·2 volts, at which point the tenth l.e.d would be switched on. This gives a true bargraph display, with the number of l.e.d.s switched on depending on the input voltage.

DOT MODE

The device contains some control logic that enables the "dot" mode to be selected instead, and in this mode no more than one l.e.d. is activated (the highest one that the input potential merits). In fact strictly speaking two l.e.d.s can be activated, since the LM3914/5 devices are designed so that in the dot mode one l.e.d. switches on before the next switches off as the transition is made from one threshold level to the next. This helps to avoid having an unstable display when the input voltage is close to a threshold level.

The 1·2 volt reference source forms part of a current generator circuit which controls the display l.e.d. current. A resistor between pins 7 and 8 is used to control this current, and the on current of each l.e.d. is about ten times the current through this resistor.

Returning to the circuit diagram, D11 to D20 are the display l.e.d.s, and in practice these are a proper bargraph display rather than ten individual l.e.d.s. R7 sets the l.e.d. current at about 8 milliamps. Pin 9 is coupled with pin 11 to set the device in the dot mode. This probably gives a slightly less clear display, but the bar mode would give an unacceptably high maximum l.e.d. current of some 80 milliamps and is not practical in this application.

IC3 is the comparator in the polarity indicator circuit, and D21 is the polarity l.e.d. C3, D22 and D23 rectify the output of IC3 and drive a.c. indicator l.e.d. D24 if an a.c. input signal is present.

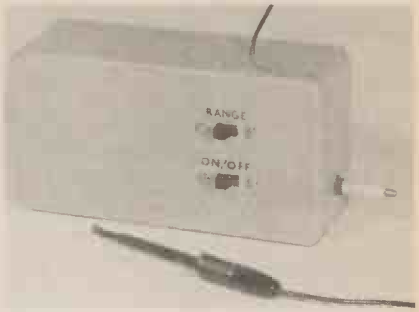
The oscillator uses IC4 in a simple relaxation oscillator circuit, and TR1 plus TR2 are a complementary emitter-follower output stage which boost the output current capability of the oscillator. C5, D25, D26 and C6 rectify and smooth the output of the oscillator to generate the negative supply rail.

The quiescent current consumption of the unit is approximately 12 milliamps, but this rises significantly when one or more l.e.d.s are activated.

CONSTRUCTION

Details of the printed circuit board and wiring are provided in Fig. 4. IC1 and IC3 are MOS devices and should therefore be fitted in (8 pin d.i.l.) integrated circuit holders, as well as observing the other anti-static handling precautions. As IC2 is not one of the cheapest of devices it is advisable to use a socket for this one as well. It is essential to use a socket for the bargraph display as the holder is needed to raise the display to a suitable height above the surface of the board. IC2 and the display require 18- and 20-pin sockets respectively.

Although the components are quite densely packed in parts of the board, con-



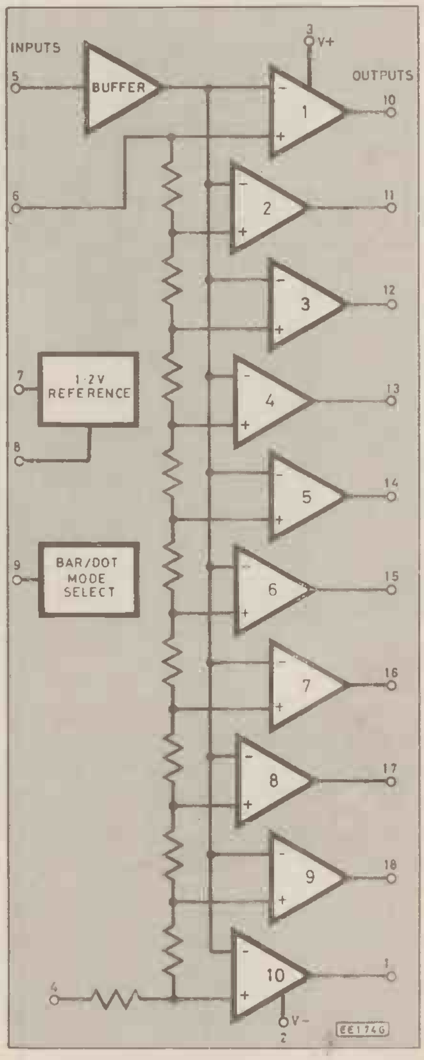


Fig. 3. Block diagram and pinning details of the LM3915N bargraph display integrated circuit.

COMPONENTS

Resistors

R1	91k 0·4W 1%
R2	1M 0·4W 1%
R3,5	10k 0·4W 1% (2 off)
R4,6	10k (2 off)
R7	1k5
R8	1k
R9	470
R10,11,12,13	100k (4 off)

All $\frac{1}{4}$W carbon 5% tolerance unless specified otherwise

Capacitors

C1,2,3	100µ 10V radial elect (3 off)
C4	1n carbonate
C5,6	47µ 16V radial elect (2 off)

Semiconductors

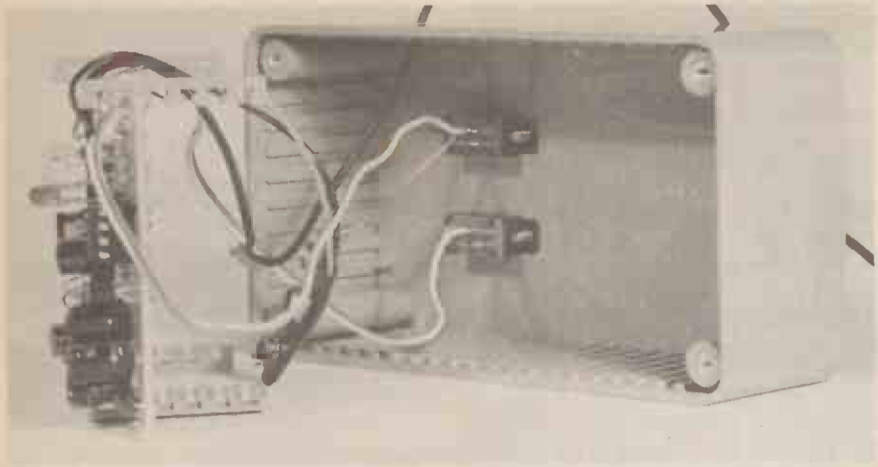
IC1	CA3240E
IC2	LM3915N
IC3	CA3140E
IC4	741C
TR1	BC549
TR2	BC559
D1 to 10, 22,23	1N4148 (12 off)
D11 to 20	10 l.e.d. bargraph display
D21,24	TIL209 (2 off)
D25,26	1N4002 (2 off)

Miscellaneous

S1,2	d.p.d.t. miniature slider switches (2 off)
B1	9 volt (PP3 size)

Plastic case about 120 × 65 × 40mm with four p.c.b. guide rail adaptors
25mm M3 screw and M3 fixing nut
20 pin d.i.l. i.c. holder
18 pin d.i.l. i.c. holder
Three 8 pin d.i.l. i.c. holders
Test prod (clip-on type) and lead
Battery connector
Printed circuit board: single-sided 100 × 62mm, *EE PCB Service*, code 8505-04

Approx. cost
Guidance only **£14.50**



Circuit board slotted in the locating "pillars" prior to inserting in the case guide rails.

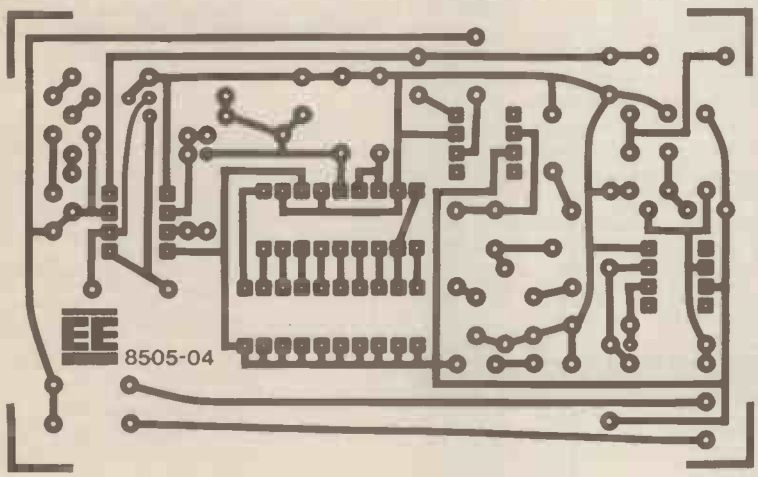
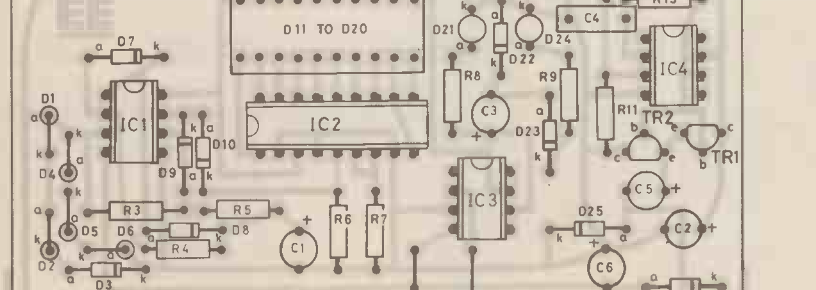


Fig. 4. Actual-size master pattern for the Voltage Probe. The component layout on the board topside and wiring to S1,S2,B1 and probe is shown below. This board is available from the EE PCB Service; order code 8505–04.

See Shop Talk page 256



struction of the board should not be too difficult provided a soldering iron having a miniature bit is used, and the components are physically small types. In particular the capacitors must be printed circuit mounting types having a body length of no more than about 10 millimetres. L.e.d.s D21 and D24 are fitted on the board, and they should be mounted so that they protrude about 5 millimetres above the bargraph display.

CASE DETAILS

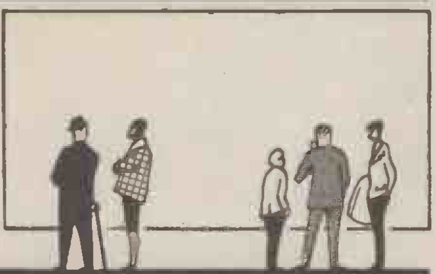
A plastic case having approximate outside dimensions of 120 × 65 × 40 millimetres is used as the housing for this project. This is reasonably compact but is not so small that construction of the unit becomes excessively intricate and difficult. The printed circuit board is specifically designed to fit into this case, and it would be difficult to fit the unit into an alternative case without redesigning the printed circuit board. The case has moulded printed circuit guide rails, but the board is fitted to these via adaptors which may be supplied with the case, or might have to be purchased separately (depending on where the case is bought). The board is mounted well towards the top of the case, component side uppermost.

The lid of the case is drilled with two holes about 3·2mm to take D21 and D24. A rectangular cutout about 25 × 10 millimetres is also needed, and this acts as a display window. These must obviously be positioned accurately so that they properly match up with the l.e.d.s and display when the lid of the case is fitted in place. Probably the easiest way of making the rectangular cutout is to drill a hole about 8 millimetres in diameter and then file this out to the correct size using a miniature flat tapered file.

S1 and S2 are mounted on the rear panel of the case, and miniature slider switches are probably the neatest type to use in this application. A small exit hole for the lead to the earthing clip is drilled at any convenient point in the case. A probe tip of some kind is needed, and this can just consist of an M3 screw about 25 millimetres or more in length. This is mounted on the front panel of the case, and it is fitted with a soldertag on the inside of the case so that a connection can be easily made to it. A neater finish can be achieved by filing a round tip onto the screw, and by using a piece of PVC sleeving to insulate all but the tip.

When the completed unit is switched on it is likely that none of the l.e.d.s will light, although the polarity l.e.d. might do so since input might drift either side of the earth rail under no-input conditions. Connecting the unit to a few known voltages and trying both polarities in the case of d.c. sources, should confirm that it is functioning properly. When using the unit to gauge fairly high voltages, such as the mains supply, normal precautions to avoid electric shocks must, of course, be taken. □

SHOP TALK



BY MIKE ABBOTT

Aerosols!

This month, in our *Fault Finding* series we look at aerosols (among other things), so we have produced the accompanying chart as a guide to which vendors stock which aerosols.

The table is a generic guide to sprays, taking no account of specific brand names. The fire extinguishers are described as the types for use in kitchens and caravans. The Electrovalue extinguisher contains 'arctons', and both aerosols featured in this guide are suitable for use on electrical fires once the power has been shut off.

Did you know that silicones travel? Thanks to investigations conducted by Electrolube in conjunction with British Telecom, evidence now exists to show that individual silicones, as used in household spray polishes, detatch themselves and travel along surfaces over quite surprising distances. Once mobilised, they can get onto electrical contacts where arcing turns them into silicon carbide crystals. Result? Premature contact failure! The compass of their mischief is greatly increased when they are airborne, so the moral of the story is: don't be too gung-ho with sprays containing silicones in the vicinity of open electrical contacts, such as relays and switches (sealed reed switches are safe). Even after the spray has settled silicones can travel.

In response to this discovery Electrolube produced a 'non-silicone' heat-sink paste, and is also looking at a formula for non-silicone polish. But alas it seems that glass and plastics just do not shine quite the same without those silicones. And as an Electrolube spokeswoman pointed out, even when people are made aware of the danger they prefer to take the risk, and go for a good shine. What do you clean your telephone with?

CONSTRUCTIONAL PROJECTS

Auto-Phaser

The *Auto-Phaser* comprises components available from general suppliers, such as **Magenta** and **Cricklewood**. A mechanically robust switch should be chosen for S1. A suitable case is available in grey ABS plastic from **Magenta** (code ABS2), or in diecast alloy from **Maplin Electronics** (type M5005).

Amstrad Amplifier

The Amstrad Amplifiers should present no buying difficulties. Different cases to the ones specified may be used, although in the smaller unit the p.c.b. is designed to slide in laterally. The mains switch on the larger unit need not be rotary, but a suitable rotary type can be purchased from **Cricklewood Electronics** (type RTYM). The **Maplin** 6VA transformer WB06G is ideal for T1, and the same supplier stocks dual log. 10k potentiometers (FX09K).

Voltage Probe

The ten-stage bargraph display used in the *Voltage Probe* is available from Maplin, order code BY65V (red) or YG33L (green). There should be no problem obtaining components; suitable d.p.d.t. slide switches are found in the **Verospeed** catalogue.

On Spec

The BPX65 photodiode featured in *On Spec* is available from **Watford Electronics** and costs £3.68. The 590KH temperature sensor is an RS Components device (No. 308 809), and may be obtained through **Ace Mailtronix Ltd., 26 Castle Rd., Wakefield, West Yorkshire WF2 7LZ.** The VMOS f.e.t. VN66AF is available from **Rapid Electronics** and **Cirkit** for around £1.25

Caravan Indicator Control

The Caravan Indicator Control should not cause the constructor any component buying problems as there are no specialised parts involved.

Aerosol	Cirkit	Electro-value	Green-weld	Maplin	Magenta	Marco Trading	Vero-speed
Antistatic (long term protection)		√				√	√
Antistatic Dissipation Spray (water based)				√			
Antistatic VDU Cleaner (harmless to antiglare coatings)				√			
Contact Cleaner Lubricant (switch cleaner)	√	√	√	√		√	√
Contact Lubricant (high quality version)			√	√	√		√
Cleaner (p.c.b. flux remover)				√			√
Cleaner (video tape head)		√		√		√	√
Cleaner (tape drive equipment)				√			
Cleaner (Ultraclene is extra powerful, but will damage certain plastics)							√
Contact Grease (extra adhesive for vertical surfaces)							√
Conformal Coating (industry standard p.c.b. coating)							√
Dry-Film Lubricant (colourless, non oily, ideal release agent)							√
Electronic Cleaning/Degreasing Solvent (okay plastics/tape heads)	√		√	√			√
Freezer	√	√	√	√	√	√	√
Foaming Cleaner (antistatic)	√	√	√	√		√	√
Fire Extinguisher (suitable electrical fires once power off)		√				√	
Graphite		√					
Lacquer (clear)	√	√		√	√	√	√
Moisture Repellent	√	√					√
Oil (WD40 type)				√			
Oil (clear, light, non-stain)				√			√
Polish				√		√	
Silicone Compound (prevents arcing/leakage, and seals)	√	√		√		√	√
Spray Duster (compressed inert gas)		√		√			
Silicone Lubricant (all materials)			√				

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Name__________

Address__________

Town__________ County__________ Age_____

Educational Qualifications__________

a regular feature for the Spectrum Owner...

by Mike Tooley BA

LAST MONTH we showed how a simple input interface for the Spectrum could be built using only three commonly available TTL gates. This month we shall turn our attention to some practical applications of the interface in the field of monitoring light and temperature levels.

Sensors

Light levels can be easily sensed using a simple photodiode/VMOS f.e.t. arrangement similar to that shown in Fig. 1a. Almost any type of photodiode can be used in this circuit; however, it should be noted that, as with most silicon photodetectors, the spectral response peaks in the infra-red region and thus such circuits may not appear to be particularly sensitive under low levels of room lighting.

In any event, a pre-set resistor, VR1, is provided as a means of adjusting the threshold of the sensor (i.e. the level of light at which the circuit changes the logical state of its output). The circuit can thus only differentiate between "light" and "dark"—its state being detected by simply reading the status of the appropriate input port.

In applications where only a single sensor is required, the output of the sensor may be connected to any one of the input channels of the input interface. In such cases, the remaining channels are simply left unconnected (in which case they will all revert to logic 1). A simple test routine for printing the status of a sensor connected to channel D is shown below:

```
100 REM Indicates whether a photosensor connected
105 REM to channel D is in light or darkness
110 PAUSE 10
120 LET d=IN 255
130 IF d=255 THEN PRINT AT 0,0; "Dark   "
140 IF d=254 THEN PRINT AT 0,0; "Light"
150 GO TO 100
```

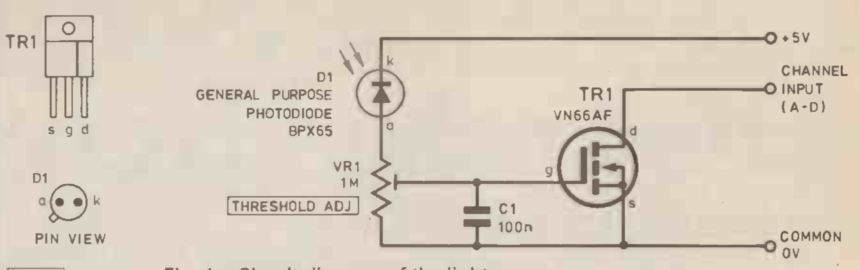


Fig. 1a. Circuit diagram of the light sensor.

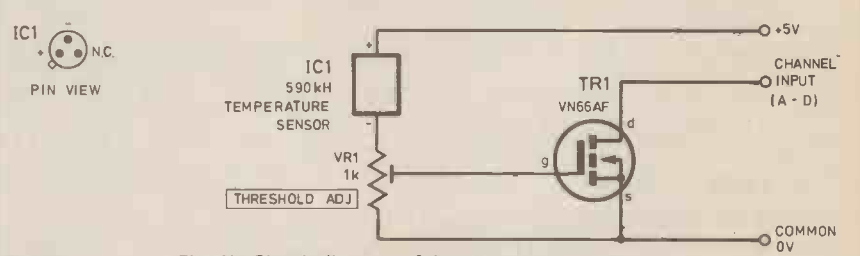


Fig. 1b. Circuit diagram of the temperature sensor.

To provide an audible warning of darkness, line 130 should be modified as follows:

```
130 IF d=255 THEN PRINT AT 0,0; "Dark   ": BEEP 1,25
```

If it is necessary to provide several levels of light discrimination (e.g. "daylight", "twilight" and "darkness") it is, of course, possible to have more than one sensor, each connected to a different interface input channel. The threshold level of each circuit may then be adjusted for an appropriate level of illumination whilst the status of the input lines can be read and interpreted as a particular range of illumination.

A simple temperature sensing arrangement is shown in Fig. 1b. Here, a two terminal semiconductor temperature sensor is used to replace the photodetector of Fig. 1a. Note, however, that the value of the threshold adjusting potentiometer, VR1, should be changed from 1Mohm to 1kohm. Furthermore, the gate decoupling capacitor is no longer required.

Like its light sensing counterpart, this circuit can only discriminate between two levels of input (in this case "hot" and "cold"). Later we shall show how an analogue-to-digital converter interface can provide a somewhat more sophisticated means of measuring, displaying and recording both temperature and light levels.

The Spectrum Signal Generator

To round of this month's instalment of *On Spec*, we are going to show how the Spectrum can, with some very simple software, be used as a programmable signal generator with an accuracy of typically better than 0·15 per cent. This provides a square wave output having a typical rise time of less than 1 microsecond over the range 10Hz to 10kHz in steps of 1Hz.

The frequency and number of output cycles must both be entered from the keyboard and these parameters are displayed together with the duration whilst the output signal is generated. Thereafter, the user is given the option of restarting with new parameters, repeating the same signal again, or exiting from the program.

The output signal is derived from the cassette port (marked "MIC") and

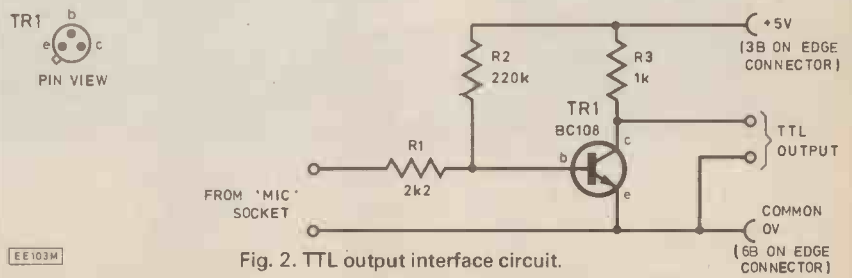


Fig. 2. TTL output interface circuit.

Signal generator program listing for use with 16k or 48k Spectrum.

```
10 REM Signal generator
20 REM Everyday Electronics - April 1985
30:
40 REM Set up machine code
50:
60 CLEAR 32499: POKE 23658,8
70 DATA 237,91,244,126,42,246,126,205,181,3,201
80 FOR i=32504 TO 32514
90 READ xi
100 POKE i,xi
110 NEXT i
120:
130 REM Input prompts and calculations
140:
150 BORDER 1: CLS
160 PRINT AT 6,8; BRIGHT 1;"Signal Generator"
170 PRINT AT 17,6; FLASH 1;"Input desired values"
180 PRINT AT 18,6; FLASH 1;"followed by <ENTER> "
190 INPUT TAB 6;"Frequency ? ";frequency
200 IF frequency <10 OR frequency>10000 THEN  BEEP .5,-20: GO TO 190
210 INPUT TAB 6;"Number of cycles ? ";nocycles
220 IF nocycles<1 OR nocycles>65535 THEN  BEEP .5,-20: GO TO 210
230 LET tc=(1/frequency)-.000068
240 LET tn=(3500000*tc)/8
250 LET th=INT (tn/256)
260 LET tl=tn-(th*256)
270 LET dh=INT ((nocycles-1)/256)
280 LET dl=(nocycles-1)-(dh*256)
290:
300 REM Display parameters and call machine code routine
310:
320 PAPER 4: CLS
330 PRINT AT 4,2;"Frequency = ";frequency;" Hz"
340 PRINT AT 5,2;"Number of cycles = ";nocycles
350 PRINT AT 6,2;"Duration = ";(nocycles/frequency);" seconds"
360 POKE 32500,dl: POKE 32501,dh
370 POKE 32502,tl: POKE 32503,th
380 RANDOMIZE USR 32504
390 PRINT AT 18,4; FLASH 1;"Press any key to continue"
400 PAUSE 0
410:
420 REM Exit/again/re-start routine
430:
440 PAPER 5: CLS
450 PRINT AT 4,8;"<A> = again"
460 PRINT AT 5,8;"<R> = restart"
470 PRINT AT 6,8;"<E> = exit"
480 PRINT AT 18,8; FLASH 1;"Key your choice"
490 PAUSE 0
500 LET r$=INKEY$
510 IF r$="A" THEN  GO TO 320
520 IF r$="R" THEN  GO TO 130
530 IF r$="E" THEN  NEW
540 GO TO 500
```

All contributions to *On Spec* should be sent to the following address and not to the Editorial Offices:

Mike Tooley,
Department of Technology,
Brooklands Technical College,
Heath Road, WEYBRIDGE,
Surrey, KT13 8TT

appears a.c.-coupled as a square wave of approximately 3V p-p. This should be adequate for many purposes (including equipment calibration), it being simply necessary to connect the output to a 10k potentiometer in order to provide a means of adjustment of the output level. The output signal can also be heard from the Spectrum's own internal loudspeaker.

For driving TTL circuitry, the simple interface shown in Fig. 2 may be employed. This not only improves the shape of the square wave produced but also provides a fully TTL-compatible output of approximately 5V p-p. The transistor may conveniently derive its supply from the regulated 5V d.c. rail available at the expansion connector provided at the rear of the Spectrum.

The complete listing of our signal generator program is given, and this should be reasonably self-explanatory. However, the following points should be noted:

Line 60
First protects the area of memory in which the machine code module is placed and then forces upper case input from the keyboard.

Lines 70–110
Loads the machine code from the data statement of line 70.

Lines 150–220
Displays the title and then prompts the user for the required input parameters. Out of range inputs are detected and an audible warning is issued before the user is prompted again.

Lines 230–280
Calculates values to be "poked" into reserved memory for later use by the machine code module.

Lines 320–380
Displays the current parameters used by the program before calling the user routine. It should be noted that this routine, in turn, calls a routine which is resident in the Spectrum's ROM.

Lines 390 and 400
Awaits a key depression from the user before clearing the screen and re-displaying the menu.

Lines 440–540
Displays a menu inviting the user to select one of three options: providing the same signal again, restarting with new parameters, or exiting the program. This last option clears the program and variables from memory.

NEXT MONTH: A simple four-channel output interface—see you then!

AUTO PHASE

R.A.PENFOLD

PHASE CONTROLLED BY AMPLITUDE

MOST phasers have either a foot pedal so that the effect can be controlled manually, or use an oscillator to provide a cyclic phasing effect. This unit does not use either of these methods, but instead uses an envelope following technique, so that the phasing effect varies in sympathy with volume of the processed signal. This gives an interesting variation on the more common phasing effects.

The unit was designed primarily for use with a synthesiser, but it should operate properly with practically any electric or electronic instrument. However, phasing effects are always most effective with a signal that contains a broad spectrum of frequencies, such as pulse and sawtooth waveforms, or a "fuzzed" guitar. It can be adjusted to accommodate a wide range of input signal levels. See block diagram of Fig. 1.

OPERATION

The phasing effect is generated using a notch filter, or multiple notch filter, with the notch frequency or frequencies swept up and down the audio spectrum. There are two basic, and similar, methods commonly used to produce this effect. One is to use a delay line, with the delayed and non-delayed signals being mixed at the output of the circuit. The delay results in signals at some frequencies being in-phase, so that they add together to produce a strong output from the mixer, while at other frequencies they are out-of-phase, and have a cancelling effect on one another. If the signals are balanced at the mixer, at some frequencies the two signals will precisely cancel out one another to produce the required deep notches of attenuation. The slight peaks in the response caused by the in-phase signals adding together are not of great importance, and do not contribute significantly to the effect. Of course, the notches must be swept up and down in frequency, and this is achieved by varying the delay time (easily done with practical delay lines).

This system provides excellent results, but has the disadvantage of the relatively high cost of the delay line, plus the problems that are inherent in circuits of this type. Most phasers therefore use a slightly simplified arrangement where the delay line is replaced with a series of phase shift circuits. The circuit featured here is in this second category, and Fig. 1 shows the block diagram of the unit.

The buffer stage at the input is needed to ensure that the instrument connected to the input is loaded by a suitably high impedance, and that the subsequent stages of the phaser are fed from an adequately low source impedance. The two phase shifters each provide a phase shift that varies from 180 degrees at low frequencies to zero at high frequencies. The effect of the two in series is to provide a total phase shift that varies from 0 to 360 degrees. Therefore, at a certain frequency the phase shift will be 180 degrees, and the circuit will invert the input signal. The mixer at the output combines the phase shifted and unprocessed signals, and at the frequency where the 180 degree phase shift is produced the two signals cancel one another out so that a notch is produced in the frequency response of the circuit.

For this system to operate properly it is essential to be able to vary the frequency at which the 180 degree phase shift occurs, and in practice the phase shifters are voltage controlled circuits so that the notch frequency can be varied by means of a control voltage. Two phase shifters provide just one notch, but more notches can be produced by using more phase shifters (two per notch are required). Phasers normally have two or three notches, but with the envelope following type of phaser featured here there was found to be little advantage in using more than one notch, and the final design is therefore of the single notch variety.

In order to produce the envelope following action some of the input signal is first amplified, and then fed to a rectifier and smoothing circuit. This gives a d.c. control voltage which is roughly proportional to the input signal level, and this is used as the control voltage for the phase shifters. The circuit is arranged so that the frequency of the notch rises and falls in sympathy with the amplitude of the input signal. This gives a better effect than the alternative of having the notch frequency fall as the input level rises.

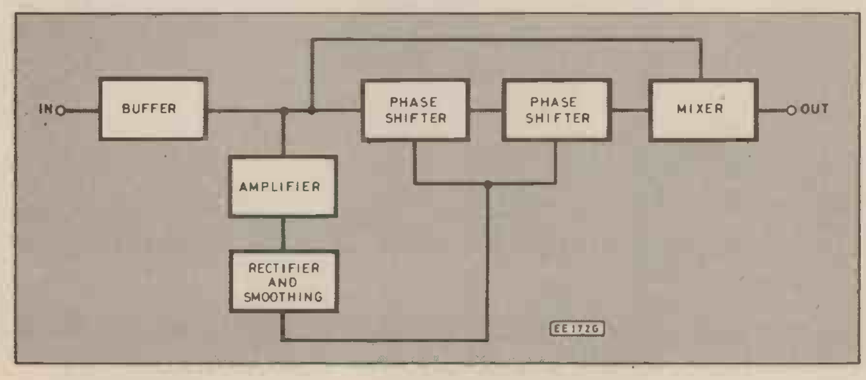


Fig. 1. Block diagram. Once switched on, phasing is controlled exclusively by signal amplitude.

PHASE SHIFTER

The basic circuit of a phase shifter is shown in Fig. 2. At low frequencies C1 has a very high impedance, and can be ignored. The circuit then operates as a standard inverting mode operational amplifier stage with R1 and R2 setting the closed loop voltage gain, and R3 biasing the non-inverting input. The voltage gain is equal to R2 divided by R1, and in this application these two resistors are made equal in value so that the circuit has unity voltage gain.

At high frequencies the impedance of C1 is negligible in comparison to the resistance of R3, and the input signal is coupled straight through to the non-inverting input of the operational amplifier, which consequently operates in the non-inverting mode. Normally, the voltage gain in this mode would be equal to R1 plus R2, divided by R2, or two times if R1 and R2 have the same value. However, the left-hand end of R1 would normally be connected to earth rather than the input signal, and this modified arrangement results in the circuit having unity voltage gain.

The circuit thus always has unity voltage gain, but gives a phase shift which varies from 180 degrees at low frequencies through to zero at high frequencies. Somewhere between these two extremes a 90 degree phase shift is obtained, which gives the required 180 degree phase shift from two of these circuits connected in series. The frequency at which the 90 degree shift occurs depends upon the relative values of C1 and R3, and this frequency can be varied by altering the value of either of these. In practice, it is much easier to vary the value of R3, which is replaced by a field effect transistor connected as a voltage controlled resistor.

THE CIRCUIT

The full circuit diagram of the *Auto Phase* unit is shown in Fig. 3.

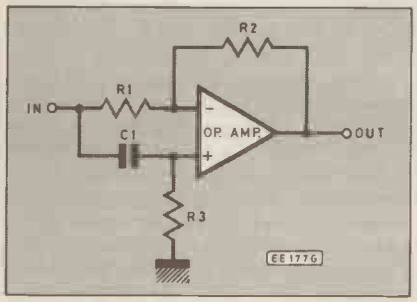
The circuit is powered from a single 9 volt supply, but R1, R2 and C2 are used to give a centre tapping on the supply lines. IC1a is the input buffer stage, and this is a conventional operational amplifier non-inverting, unity voltage gain amplifier. R3 biases the non-inverting input of IC1a and sets the input impedance of the circuit at 100k.

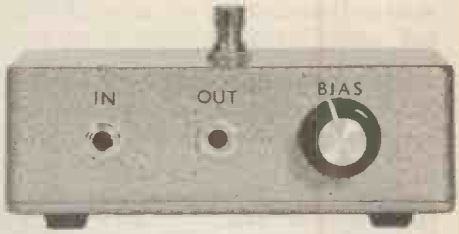
IC1b and IC2a are used as the basis of the two phase shifters, and these use precisely the same configuration as the one described earlier. The field effect transistors used here as the voltage controlled resistors are n channel m.o.s.f.e.ts from a CMOS 4007UBE device. This contains two complementary pairs plus an inverter, but in this case it is only the n channel m.o.s.f.e.t. of each complementary pair that is utilized, and the other parts of the device are ignored. These transistors are enhancement types, which means that they are normally switched off, and a forward bias is needed to bring them into conduction. This is the opposite of junction gate field effect transistors (such as the popular 2N3819, etc.), which are depletion mode devices. These are normally in the on state, and require a reverse gate bias in order to switch them off. In this application, enhancement mode f.e.ts are slightly easier to use, and of more importance, they give more predictable results. R6 and R9 are needed to maintain a small bias to the non-inverting inputs of IC1b and IC2a when the m.o.s.f.e.ts are switched off.

The mixer stage uses IC2b as a standard operational amplifier summing mode mixer. VR1 is adjusted to balance the two input signals to the mixer so that a deep notch and the strongest possible effect are obtained. S1 can be used to switch out the phase shifted signal. The unit then acts as a simple buffer amplifier, and the phasing effect is switched off. In practice, S1 is a foot-operated switch so that the effect can be switched in and out while playing.

Some of the output from IC1a is coupled to variable attenuator VR3, and then to a high gain common emitter amplifier built around TR1. The output from TR1 is coupled by C9 to the rectifier and smoothing circuit. This has circuit values which give quite fast attack and decay times so that the filter accurately follows rises and falls in the input signal level. The positive d.c. signal produced by the rectifier/smoothing circuit is coupled direct to the gates of the two m.o.s.f.e.ts. VR2 is adjusted so that under quiescent conditions the bias voltage fed to the m.o.s.f.e.ts is just below the turn-on threshold so that the minimum filter frequency is obtained. The output from the smoothing circuit adds to this voltage so that the filter is swept up and down in frequency as the input signal rises and falls in volume, giving the required auto-phase effect. In practice, if desired, VR2 can be adjusted for a somewhat higher voltage so that the filter only operates over higher audio frequencies.

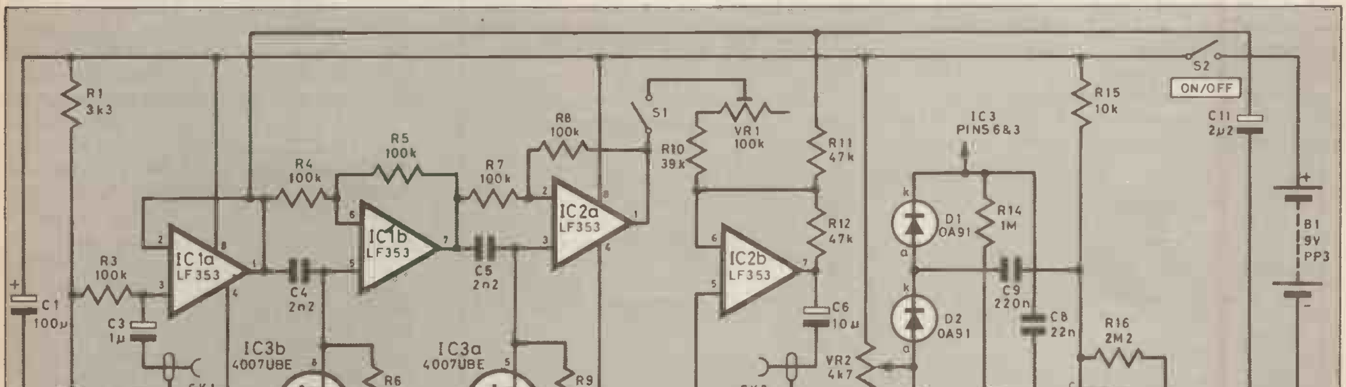
Fig. 2. Typical phasing circuit.





SET A MOBILE NOTCH LOOSE AMONG YOUR HARMONICS

Fig. 3. Circuit diagram. The inputs to IC3 (pins 3 and 6) are connected to each other and to R14.



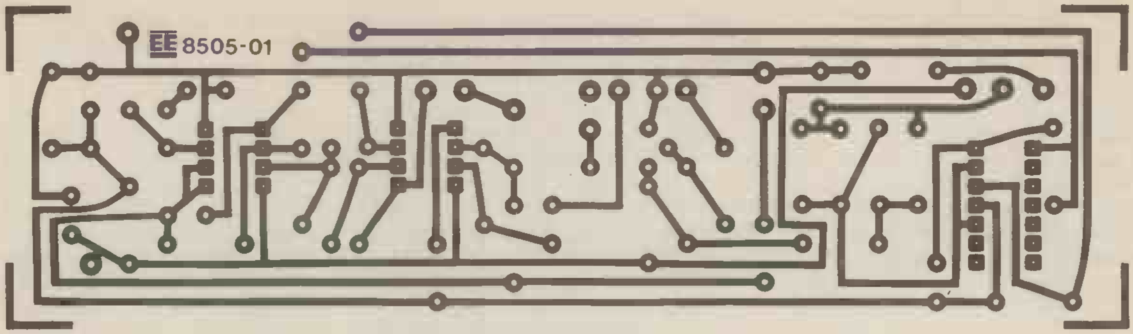


Fig. 4. P.c.b. layout.

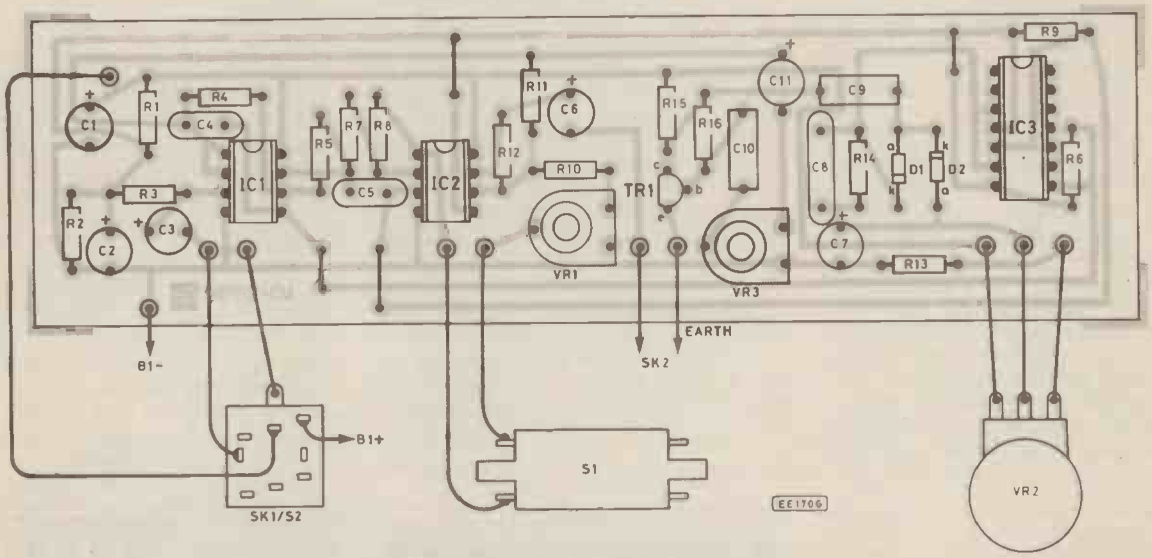


Fig. 5. Component layout of the Auto Phaser.

COMPONENTS

Approx. cost Guidance only **£12**

See **Shop Talk** page 256

Resistors

R1,2	3k3 (2 off)
R3,4,5,7,8	100k (5 off)
R6,9,14	1M (3 off)
R10	39k
R11,12	47k (2 off)
R13	4k7
R15	10k
R16	2M2

All 0·25W 5% carbon film

Potentiometers

VR1	100k 0·1W horizontal preset
VR2	4k7 lin. pot
VR3	22k 0·1W horizontal preset

Capacitors

C1,2,7	100µF 10V radial elect (3 off)
C3	1µF 63V radial elect
C4,5	2n2 mylar
C6	10uF 25V radial elect
C8	22nF polyester
C9,10	220nF carbonate
C11	2µ2 63V radial elect

Semiconductors

IC1,2	LF353 (2 off)
IC3	4007BE
TR1	BC549
D1,2	OA91 (2 off)

Miscellaneous

SK1	Standard jack with DPDT contacts
SK2	Standard jack
S1	Heavy duty push button switch
S2	Part of SK1
B1	9 volt (PP3 size)

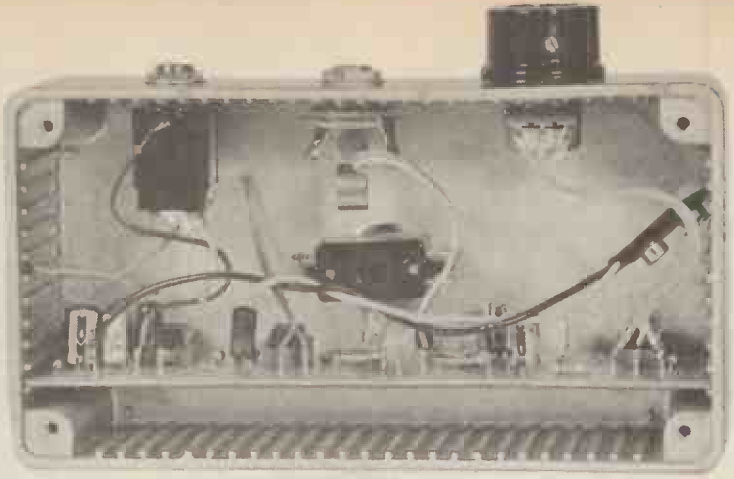
Printed circuit board, control knob, diecast aluminium box about 150 × 80 × 50mm, two 8 pin d.i.l. sockets, 14 pin d.i.l. socket, PP3 battery connector, cabinet feet, Veropins, wire, solder

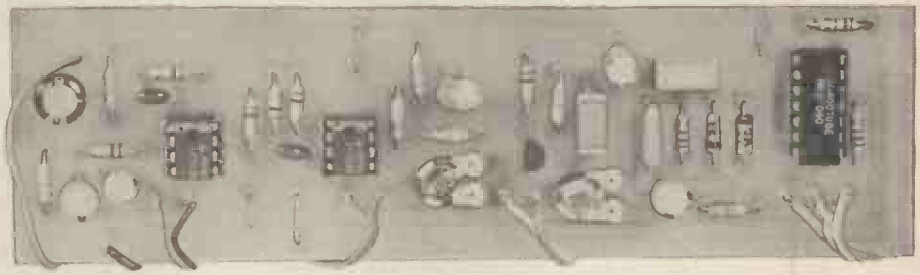
CONSTRUCTION

A diecast aluminium box measuring 150 by 80 by 50mm will comfortably accommodate all the components, and is suitably tough for this application. VR2 and the two sockets are mounted on the front panel, with S1 fitted on the lid of the case. S1 is a heavy-duty push-button type suitable for foot operation. S2 is a pair of make contacts on SK1 (which actually has d.p.d.t. contacts), so that the unit is automatically switched on and off when the jack plug is inserted in and removed from the input socket. This is a common way of providing on/off switching in musical effects units, but a separate on/off switch can, of course, be used if preferred.

Details of the printed circuit board and wiring are shown in Fig. 5. This is fairly easy to construct, but bear in mind that IC3 is a CMOS device. It should, therefore, be mounted in a (14-pin d.i.l.) i.c. socket, and the normal m.o.s. handling precautions should be taken. Do not overlook the four link wires. D1 and D2 are germanium diodes, and as such are more easily damaged by heat than the more familiar silicon devices. When connecting these, complete each soldered joint as rapidly as possible so that overheating and damage to these components is avoided. Pins are fitted to the board at the places where leads from off-board components will eventually be connected.

The completed printed circuit board fits into the set of guide rails nearest the rear of the case, with the component side facing forward. The point-to-point wiring is then added, using ordinary multi-strand, p.v.c. insulated connecting wire.





IN USE

It is essential for the three potentiometers to be set correctly if the unit is to function properly. VR1 should be set at almost minimum value (adjusted almost fully clockwise), and the unit should then give a reasonably deep notch and a strong effect. When the other two potentiometers have been adjusted properly, VR1 can be adjusted to optimise the effect.

With VR3 fully backed off (adjusted fully anti-clockwise) it should be possible to manually control the filter frequency using VR2. Set VR2 to place the notch at a fairly low audio frequency. Playing an instrument connected to the input of the unit, and then slowly advancing VR3 should gradually introduce the auto-phase effect. It is essential that VR3 is not advanced too far, or the sweeping of the filter will only occur at the very beginning and end of each note, giving an effect that will probably be barely noticeable. The filter should only just be fully swept by a signal which achieves full volume at its peak level. When using an instrument that has a high output level, VR3 will need to be almost fully backed-off. The unit will operate with lower level signals, such as the output from a low output guitar pick-up, with VR3 well advanced. □

THE MULTIMETER is without doubt the most versatile and commonly used piece of test equipment available and, for the hobbyist, it usually represents the first major investment in serious electronic testing or construction.

There are hundreds of models available with a massive choice of specifications, prices and formats, so to help you through the 'multimeter jungle', we have compiled this guide. Obviously it is not a comprehensive coverage of all the models available but at least it will put you on the right road.

Before looking at specific models, we will take a look at various aspects, advantages and disadvantages of the different types and try to explain the meaning of manufacturers' specifications.

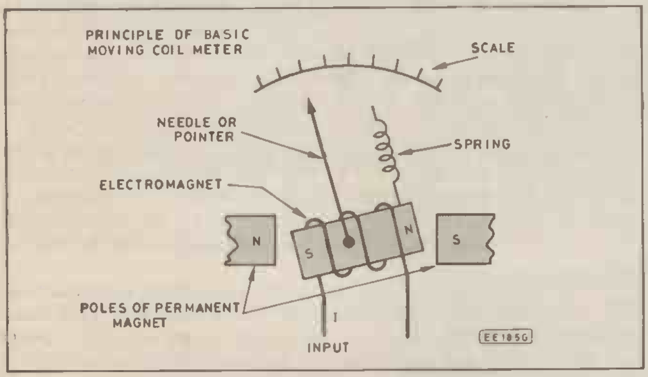


Fig. 1. The basic moving coil mechanism.

Modern multimeters, whatever their shape or size, all work on much the same principle. Whether electro-mechanical or electronic, digital or analogue, the heart of any meter is a voltage or current sensing device. This device together with a range selection circuit can be used to offer a wide range of measurements.

TYPES OF METER AVAILABLE

Moving coil meters are still very common today despite increasing competition from low cost digital electronic meters. Indeed many engineers and technicians still prefer and 'trust' the traditional instruments which have been around for years.

The heart of the meter is a d'Arsonval movement or galvanometer which is an electromechanical device consisting of a coil of wire wrapped around an iron core, and mounted between the poles of a permanent magnet. A needle or pointer is attached to the coil, which is pivoted and free to rotate. Subsequently, when an electric current is passed through the coil, the coil will rotate causing the needle to be displaced; the displacement being proportional to the current. (See Fig. 1.)

With a suitable scale placed adjacent to the pointer, the meter becomes an effective current meter and with modifications can be made to read a wide variety of ranges.

The forerunner of the modern electronic multimeter was the vacuum tube voltmeter (VTVM) which was essentially a valve amplifier circuit used to drive a moving coil meter. Of course in modern multimeters valves are replaced by transistors and integrated circuits to perform the sensing and amplifying function. Additionally analogue to digital converters are employed to drive alphanumeric digital displays rather than traditional moving coils. (See Fig. 2.)

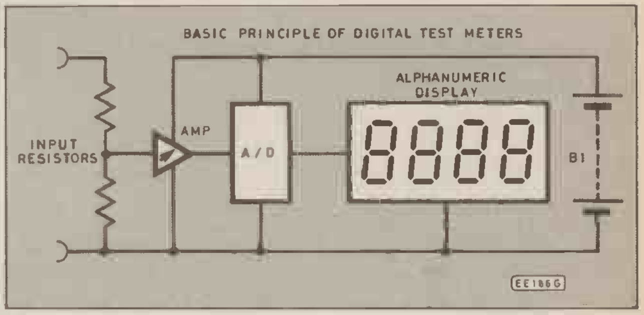


Fig. 2. Basic elements of a digital multimeter.

SHUNTS AND MULTIPLIERS

As we have said, the basic meter can be expanded by the introduction of additional circuitry. Suppose for example a device will give a maximum reading when it detects a current flow of 1mA. In the case of the moving coil device a maximum reading occurs when the needle is deflected to its furthest position, full scale deflection (f.s.d.); in the case of a digital display (say four digits) then it would read 9999. Now if we want to measure a current of 10mA f.s.d., then a resistor is connected in parallel with the meter, the value of resistor being one ninth that of the meter. By application of Ohms law it can be seen that only one tenth of the total current would pass through the coil, whilst most of the current would pass through the SHUNT, as shown in Fig. 3.

To take voltage readings (Fig. 4) a series resistor can be connected in the meter circuit. Using the same example as before, we require only 1mA to give f.s.d. Thus if we, for example, wish to measure a voltage up to 10V, then by using Ohms law we can see that the series resistor (multiplier) should be:—

$$10V/10mA=1000\Omega$$

Because the resistance of the meter coil is negligible compared with that of the multiplier it can be ignored for these simple calculations, however in practical designs it must be accounted for.

For resistance measurements an independent power source is required which usually takes the form of one or more batteries. This is connected in series with the meter and the resistance to be measured completes the circuit. Obviously the current flow will be inversely proportional to the resistance and thus the resistance can be measured using a suitable scale. (See Fig. 5.)

Using these principles, a large number of resistance voltage and current measurements can be made with the aid of a switch and resistor

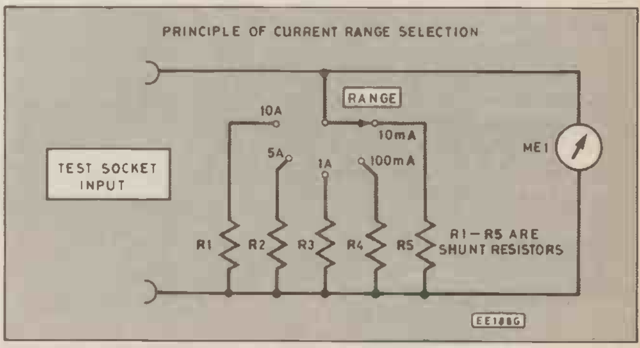


Fig. 3. Simple current measuring circuit.

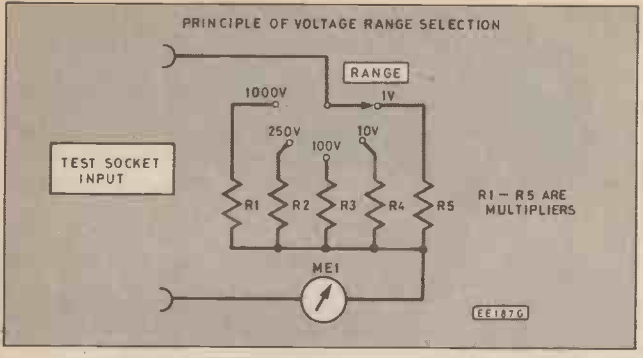


Fig. 4. Simple voltage measuring circuit.

network. For electronic multimeters different ranges are achieved using a combination of this type of network and an electronic circuit to provide amplification or attenuation of the measured signal.

SENSITIVITY

Now that we have established the very basic principles of how multimeters work, we can start to look more deeply at manufacturers' specifications. One of the most important of these being the sensitivity or input impedance.

The sensitivity of a moving coil meter is given in terms of ohms per volt. In simple terms this figure refers to the resistance of the multiplier required to give an f.s.d. of one volt. Suppose the sensitivity is 1000 ohms per volt then to measure on a scale of 100 volts f.s.d., the input impedance would be 100k ohms.

It is desirable for the sensitivity of a meter to be very high to prevent a loading effect on the circuit under test. For example if we use a meter with a sensitivity of 10k ohms per volt to measure a voltage across a resistance of 1M ohm, then the actual meter reading will be incorrect.

Referring to Fig. 6 it can be seen that when the meter is connected in parallel with the 1M ohm resistor, then the effective resistance becomes less than 100k ohms. This will cause more current to be drawn from the circuit which in turn will cause a greater volt drop across Rx. From this it can be seen that the error caused by the loading effect will be decreased by an increase of sensitivity.

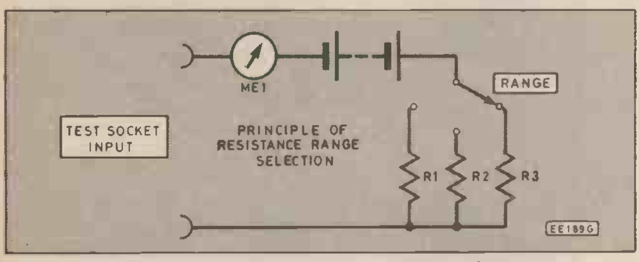


Fig. 5. Resistance measuring principles.

With normal moving coil meters the input impedance obviously varies depending on the scale. The higher the f.s.d., the higher the input impedance. However, with the electronic multimeters, the input impedance is often constant throughout the range, due to the nature of the input circuitry, which is usually a high impedance f.e.t. device.

Moving coil multimeters have a sensitivity of between about 1k ohm per volt to 100k ohms per volt whereas an electronic multimeter can have an input impedance of 10M ohm throughout the range.

Current measurements are also affected by sensitivity. It is desirable that the resistance of the meter be as small as possible when measuring current. If the resistance is high then a volt drop will be introduced into the circuit and the current will be limited by the meter resistance, and once again incorrect readings will be the result. If a meter has a large sensitivity then it also implies that the resistance when measuring current will be low.

METER SCALES AND DISPLAYS

As was mentioned earlier many engineers and technicians still prefer moving coil displays. With these types it is possible to see fluctuations in voltage readings whereas in the case of digital displays a fluctuating voltage may appear as a number of random voltages. This depends on the type of sampling circuit used in the meter and the frequency of the signal being measured.

The main advantage of digital displays is in the ease of reading and understanding the display. Digital meters usually have auto polarity sensing (it tells you when the test leads are the wrong way round), and a clear numerical reading together with the units indication. Most multi-range, moving coil instruments have several scales only one of which is relevant on a particular range. On top of this they have to be read from the correct angle or a parallax error will be caused. Also some of the scales on moving coil meters are not linear such as the resistance or decibel range.

PROTECTION

Protection of the electronics or the moving coil is very important as they can be easily damaged by excess voltages or currents. For this reason many meters have overload protection of some kind, such as fused inputs, 'crowbar' or circuit breaker protection. These protection facilities are usually specified as maximum voltage or current ratings. Some meters have polarity reversal protection which is very useful as it is very easy to connect the leads the wrong way round.

As well as protecting the meter it is important to protect the user. As some meters are capable of testing thousands of volts or many amps, it is essential that good quality test leads are supplied with adequate insulation. The range selection switches and the casing should also be well insulated.

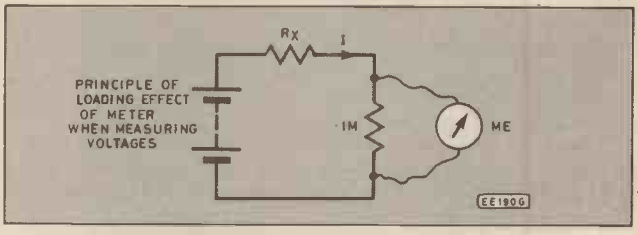


Fig. 6. Loading effects of the meter.

CHOOSING A MULTIMETER

It would be impossible to describe every aspect of multimeters as it is such a vast subject and innovations are being introduced all the time. Many of the new models have features such as auto-ranging, capacitance inductance and decibel ranges, as well as a host of other 'goodies'. This is all well and good but if all you need is a basic multimeter then many of these functions may be surplus to requirements.

Like any other major purchase, you must first decide what your requirements and priorities are. If you need a meter to assist fault finding on car electrics then a resistance and low sensitivity low voltage scale is probably all you need. On the other hand for TV servicing you may need a high voltage and low current scale and sensitivity may be important.

Whilst bearing in mind the above points cost is likely to be an important factor. This is where this buyers' guide can really help. Each meter illustrated is accompanied by a brief description including the types of ranges and the input impedance. When these factors have been compared together with the price then it may help you to come to an acceptable compromise between performance and price. It could also save you a few pounds into the bargain.

PLEASE NOTE

We would like to point out that readers buying from the guide are not protected by the Mail Order Protection Scheme unless the company concerned have advertised the product in a display advertisement in this issue.

This guide is an aid to the purchaser and makes no recommendations.

Model: TD 20. **Ranges:** 2V–500V a.c./d.c., 2kΩ–2MΩ. (9 ranges). **Impedance:** 11MΩ. **Special Features:** Continuity buzzer. **Price:** £42 + VAT. **Supplier:** *House of Instruments, Raynham Rd., Bishop's Stortford, Herts. (0279 55155).*

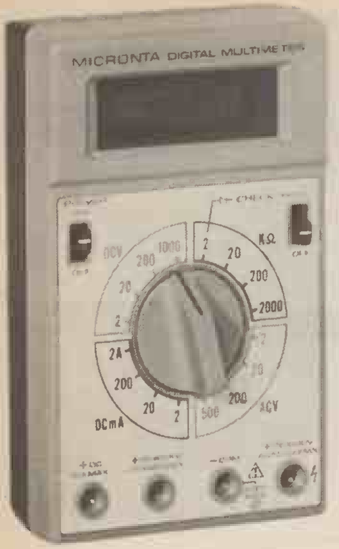
Model: BBC MA5D. 300mV–1kV a.c./d.c., 300μA–20A a.c./d.c., 3Ω–20MΩ. (26 ranges). **Impedance:** 10MΩ. **Special Features:** Capacitance and decibel ranges. Built-in battery charger. **Price:** £320 + VAT. **Supplier:** *House of Instruments, Raynham Rd, Bishop's Stortford, Herts. (0279 55155).*

MULTIMETERS buyer's guide MULTIMETERS

Model: Fluke 73, 75, 77. **Ranges:** 320mV–100V d.c., 3·2V–750V a.c., 10A a.c./d.c., 320Ω–320MΩ. (10 ranges). **Impedance:** 10MΩ. **Special Features:** Diode and continuity tester. **Price:** 73–£65.00, 75–£75.00, 77–£95.00. **Supplier:** *Fluke (GB) Ltd., Colonial Way, Watford, Herts. (0923 40511).*

Model: Hung Chang HM101. **Ranges:** 10V–1kV a.c./d.c., 100mA d.c., 1MΩ. (12 ranges). **Model:** Hung Chang HM102. **Ranges:** 250mV–1kV d.c., 10V–1kV a.c., 50μA–500A, 6MΩ. (14 ranges). **Impedance:** Not known. **Price:** £14 + VAT. **Supplier:** *Cirkit Holdings PLC, Park Lane, Broxbourne, Herts. (0992 444111).*

Model: Keithley 175. **Ranges:** 200mV–1kV d.c., 200mV–750V a.c., 200μA–10A a.c./d.c., 200Ω–20MΩ. (27 ranges). **Impedance:** 10MΩ. **Special Features:** Autoranging, μP operated with memory (100 readings). IEEE bus. **Price:** £449 + VAT. **Supplier:** *Keithley Instruments Ltd., 1 Boulton Rd., Reading, Berkshire, RG2 0NL. (0734 861287).*



Model: Micronta. **Ranges:** 2V–1kV a.c./d.c., 2mA–2A a.c./d.c., 20MΩ. (16 ranges). **Impedance:** Not known. **Special Features:** Diode test. **Price:** £44.95. **Supplier:** *Tandy (stockists).*

Model: Keithley 179A. **Ranges:** 200mV–1·2kV d.c., 200mV–1kV a.c., 200µA–20A a.c./d.c. 20MΩ. (26 ranges). **Impedance:** 10MΩ. **Special Features:** Autoranging. **Price:** £385 + VAT. **Supplier:** *Keithley Instruments Ltd, 1 Boulton Rd., Reading, Berks. (0734 861287).*

Model: TM11. **Ranges:** 150µV–500V d.c., 50µV–500V a.c., 150pA–500mA d.c., 50pA–500mA a.c., 1kΩ–10GΩ. **Impedance:** 100MΩ. **Special Features:** dB scale and 30 optional ranges. **Price:** £175 + VAT. **Supplier:** *Levell Electronics Ltd., Moxon St., Barnet, Herts., EN5 5SD. (01-440 8686).*

Model: Hitachi VR3525. **Ranges:** 200mV–1kV d.c., 2V–750V a.c., 200µA–10A a.c./d.c., 200Ω–20MΩ. (20 ranges). **Impedance:** 10MΩ. **Special Features:** Autoranging. Diode test. Continuity buzzer. Temp. −20° to 700°C. **Price:** £120.75. **Supplier:** *Reltech Instruments, New Rd., St. Ives, Huntingdon, Cambridgeshire. PE17 4BG. (0480 63570).*

Model: Metex 3500. **Ranges:** 200mV–1kV d.c., 200mV–700V a.c., 200µA–10A a.c./d.c., 200Ω–20MΩ. (28 ranges). **Impedance:** 10MΩ. **Special Features:** Diode test facility and zero check. **Price:** £37.09 + VAT. **Supplier:** *House of Instruments, Raynham Rd, Bishop's Stortford, Herts. (0279 55155).*

Model: Fluke 8026B. **Ranges:** 200mV–1kV d.c., 200mV–750V a.c., 2mA–2A a.c./d.c. (19 ranges). **Impedance:** Not known. **Special Features:** Diode test. Conductance; 2mS–200nS. **Price:** £207. **Supplier:** *Electroplan Ltd., PO Box 19, Orchard Rd., Royston, Herts., SG8 5HH. (0763 41171).*

Model: Pantec Zip. **Ranges:** 2V–500V a.c./d.c., 2kΩ–2MΩ. (8 ranges). **Special Features:** Auto-ranging and direct probe entry. **Price:** £49 + VAT. **Supplier:** *Pantec, Carlo Gavazzi (UK) Ltd., 162-164 Upper Richmond Rd., Putney, London. (01-785 9022).*

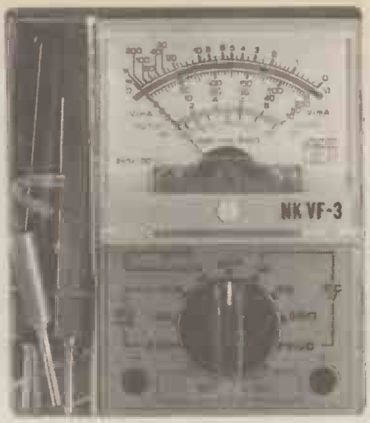
Model: Microtest 80. **Ranges:** 100mV–1kV d.c., 1·5V–1kV a.c., 50µA–5A d.c., 250µA–2·5A a.c., 500Ω–5MΩ. (30 ranges). **Special Features:** Capacitance and Decibel ranges. **Price:** £27 + VAT. **Supplier:** *Maplin Electronics.*

PLEASE NOTE:

Whilst every effort has been made to ensure that the information given in this guide is correct, we cannot be responsible for any price changes. Also specifications are subject to change without notice.

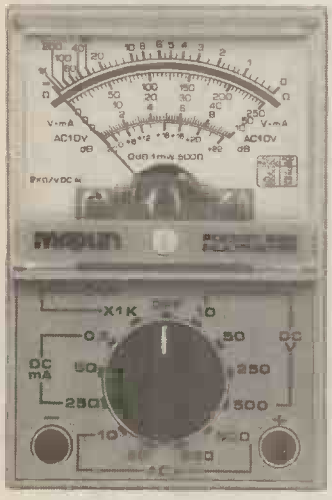
Where specifications have been listed, the number of ranges have been given together with the smallest and greatest full scale deflection readings available for each range. This information together with some special features mentioned should provide a rough guide to each instrument's capability.

MULTIMETERS buyer's guide MULTIMETERS



Model: NK VF–3. **Ranges:** 10–500V a.c./d.c., 0·5mA–250mA d.c., 1MΩ. (16 ranges). **Impedance:** 2kΩ/V a.c./d.c. **Price:** £7.95 + VAT. **Supplier:** *Harris Electronics (London), 138 Grays Inn Road, WC1X 8AX. (01-837 7937).*

Model: BBC M2012. **Ranges:** 200mV–650V a.c./d.c., 2mA–2A a.c./d.c., 2kΩ–2MΩ. (23 ranges). **Supplier:** *House of Instruments. (0279 55155).*



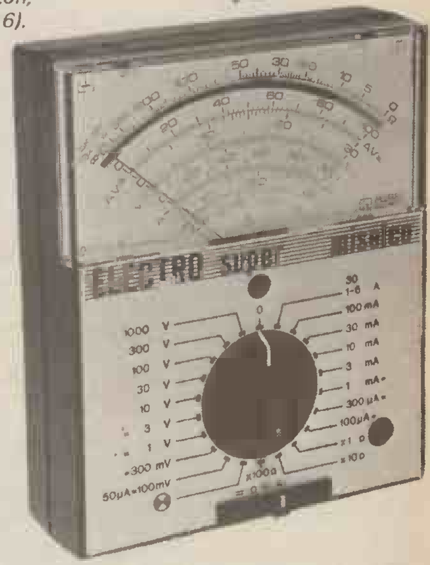
Model: Maplin Pocket Multimeter. **Ranges:** 10V–500V a.c./d.c., 0·5mA–250mA d.c., 1MΩ. (16 ranges). **Impedance:** 2kΩ/V a.c./d.c. **Price:** £6.95. **Supplier:** *Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex, SS6 8LR. (0702 554155).*

Model: AVO 1000. **Ranges:** 300mV–1000V d.c., 10V–1000V a.c., 50μA–6A d.c., 10mA-6A a.c., 1Ω–10MΩ. (23 ranges). **Impedance:** 20kΩ/V a.c., 2kΩ/V a.c. **Special Features:** Continuity buzzer. **Price:** £49.50 + VAT. **Supplier:** *House of Instruments, Raynham Rd., Bishop's Stortford, Herts. (0279 55155).*

Model: ISI DM3350. **Ranges:** 1kV d.c., 600V a.c., 10A a.c./d.c., 2MΩ. (15 ranges). **Special Features:** Autoranging. Continuity buzzer. **Price:** £49.35 + VAT. **Supplier:** *Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Rd., Sutton, Surrey, SM1 4RS. (01-643 1126).*

Model: Beckman T90. **Ranges:** 200mV–1kV d.c., 200mV–600V a.c., 200μA–2A d.c., 200Ω–20MΩ. (18 ranges). **Impedance:** 10MΩ. **Special Features:** Diode test. **Price:** £59 + VAT. **Supplier:** *Beckman Instruments Ltd., Mylen House, 11 Wagon Lane, Sheldon, Birmingham, B26 3DV. (021 742 7761).*

Model: ALT/AI KD305. **Ranges:** 2V–1kV d.c., 2V–750V a.c., 2mA–10A d.c., 200Ω–20MΩ. (14 ranges). **Impedance:** 10MΩ. **Price:** £31.50 + VAT. **Supplier:** *Semiconductor Supplies International Ltd., Dawson House, 128/130 Carshalton Rd., Sutton, Surrey, SM1 4RS (01-643 1126).*



Model: Miselco Electro Super. **Ranges:** 100mV–1kV a.c./d.c., 100μA–6A a.c./d.c., 1MΩ. (20 ranges). **Impedance:** 20kΩ/V a.c./d.c. **Special Features:** dB scale. **Price:** £41 + VAT. **Supplier:** *Alcon Instruments Ltd., 19 Mulberry Walk, London, SW3 6DZ. (01-352 1897).*

Model: Anders AMM301. **Ranges:** 60mV–300V d.c., 6V–600V a.c., 30µA–600mA d.c., 2MΩ. (20 ranges). **Impedance:** 30kΩ/V a.c./d.c. **Special Features:** dB scale. **Price:** £25.50. **Supplier:** *Anders Electronics Ltd., 48-56 Bayham Place, Bayham Street, London, NW1 OEV. (01-387 9092).*

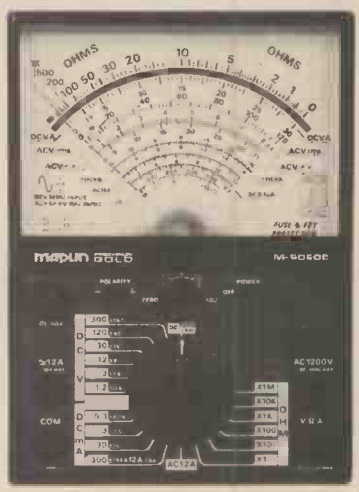
Model: Avometer DA116. **Ranges:** 200mV–1000V a.c./d.c., 200µA–10A a.c./d.c., 200Ω–20MΩ. (31 ranges). **Impedance:** 10MΩ. **Special Features:** Diode test facility. **Price:** £152.10 + VAT. **Supplier:** *House of Instruments, Raynham Rd., Bishop's Stortford, Herts. (0279 55155).*

Model: M–2020S. **Ranges:** 100mV–1kV d.c., 10V–1kV a.c., 10µA–10A d.c., 2kΩ–20MΩ. (27 ranges). **Impedance:** 20kΩ/V d.c., 8kΩ/V a.c. **Special Features:** Transistor tester. **Price:** £19.95 + VAT. **Supplier:** *Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex, SS6 8LR. (0702 554155).*

Model: DME 1400. **Ranges:** 200mV–1kV a.c./d.c., 200mA–1A a.c./d.c., 200Ω–20MΩ. **Supplier:** *House of Instruments, Raynham Rd, Bishop's Stortford, Herts. (0279 55155).*

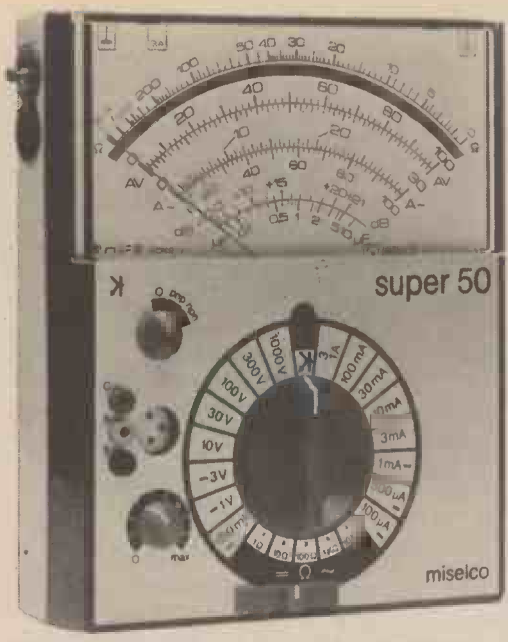
Model: ALT/AI KD55C. **Ranges:** 200mV–1kV d.c., 200mV–750V a.c., 200µA–10A a.c./d.c., 200Ω–20MΩ. (22 ranges). **Impedance:** 10MΩ. **Special Features:** Overload protection. **Price:** £44.10 + VAT. **Supplier:** *Semiconductor Supplies International, Dawson House, 128/130 Carshalton Rd., Sutton, Surrey. (01-643 1126).*

Model: Avometer Eight, Mk. 6. **Ranges:** 100mV–1kV d.c., 3V–1kV a.c., 50µA–10A d.c., 10mA–10A a.c., 200Ω–200MΩ. (31 ranges). **Impedance:** 20kΩ/V d.c. **Special Features:** Decibel and insulation resistance scales. **Price:** £138.70 + VAT. **Supplier:** *House of Instruments.*



Model: M–5050E. **Ranges:** 0·3V–1200V d.c., 3V–1200V a.c., 0·1µA–12A d.c., 12A a.c., 1–1GΩ. (53 ranges). **Impedance:** 10MΩ. **Special Features:** Polarity reversal switch. **Price:** £34.95 + VAT. **Supplier:** *Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex, SS6 8LR. (0702 554155).*

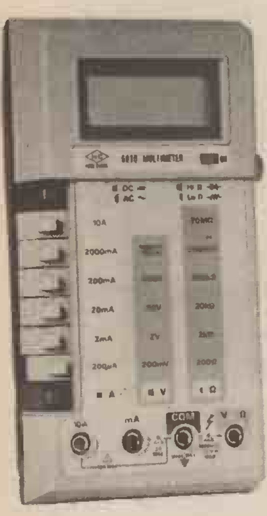
Model: Pantec PAN 2001. **Ranges:** 100µV–1kV a.c./d.c., 100mA–10A a.c./d.c., 0·1Ω–20MΩ. (17 ranges). **Impedance:** 10MΩ. **Special Features:** Capacitance 1pF–20µF., Squarewave generator 15Hz–15kHz, Temp. –50°C to 150°C. **Price:** £99 + VAT. **Supplier:** *Electronic & Computer Workshop Ltd., 171 Bloomfield Rd., Chelmsford, Essex, CM1 1RY. (0245 262149).*



Model: Miselco Super 50. **Ranges:** 150mV–1kV a.c./d.c., 20µA–3A d.c., 3mA–3A a.c., 1Ω–50MΩ. (34 ranges). **Impedance:** 50kΩ/V a.c./d.c. **Special Features:** dB –10 to + 61 (5 ranges). Diode test. **Price:** £54.45 + VAT. **Supplier:** *Alcon Instruments Ltd., 19 Mulberry Walk, London, SW3 6DZ. (01-352 1897).*

Model: Pantec Explorer. **Ranges:** 3V–1kV d.c., 15V–1kV a.c., 3A–30A d.c./a.c., 5KΩ–500KΩ. (13 ranges). **Impedance:** 5kΩ/V d.c., 1kΩ/V a.c. **Special Features:** Metal detector. Phase detector. **Price:** £58 + VAT. **Supplier:** *B.K. Electronics, Unit 5, Comet Way, Southend-on-Sea, Essex. (0702 527572).*

Model: Pantec Challenger. **Ranges:** 0·25V–1kV d.c., 5V–1kV a.c., 25µA–10A d.c.,0·5A–10A a.c., 500Ω–5MΩ. (26 ranges). **Impedance:** 40kΩ/V a.c./d.c. **Special Features:** Shock proof case. Diode test. **Price:** £49 + VAT. **Supplier:** *B.K. Electronics, Unit 5, Comet Way, Southend-on-Sea, Essex. (0702 527572).*



Model: Hung Chang HC7030. **Ranges:** 100µV–1kV a.c./d.c., 0·1µA–10A a.c./d.c., 200Ω–20MΩ. (17 ranges). **Impedance:** Not known. **Special Features:** Diode test. Overload protection. **Price:** £49.95. **Supplier:** *Cirkit Holdings PLC, Park Lane, Broxbourne, Herts. (0992 444111).*

Model: Soar ME–531. **Ranges:** 200mW–1kV d.c., 2V–1kV a.c., 200mA–10A a.c./d.c., 200Ω–2MΩ (18 ranges). **Impedance:** Not known. **Special Features:** Autoranging. Continuity buzzer. Diode test. **Price:** £63.95. **Supplier:** *Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex, SS6 8LR. (0702 554155).*

Model: Hitachi VR3510. **Ranges:** 200mV–1kV d.c., 200mV–600V a.c., 200µA–10A a.c./d.c., 200Ω–20MΩ. (20 ranges). **Impedance:** Not known. **Special Features:** Continuity buzzer. Autoranging. Diode test. **Price:** £155.25. **Supplier:** *Reltech Instruments, New Rd., St. Ives, Huntingdon, Cambridge, PE17 4BG. (0480 63570).*

Model: ALT/AI KD25C. **Ranges:** 1kV d.c., 500V a.c., 200mA d.c., 2MΩ. (12 ranges). **Price:** £27.60. **Supplier:** *Semiconductor Supplies International Ltd., Davison House, 128/130 Carshalton Rd., Sutton, Surrey, SM1 4RS. (01-643 1126).*

Model: Trio DL–705. **Ranges:** 1mV–1kV a.c./d.c., 10µA–200mA a.c./d.c., 20MΩ. **Impedance:** Not known. **Special Features:** Semi-autoranging. Hi-lo option. **Price:** £123.91. **Supplier:** *Supercat Electronics Ltd., PO Box 201, St. Albans, Herts. (0727 62171).*

Model: HC 5010. **Ranges:** 200mV–100V d.c., 200mV–750V a.c., 20μA–10A a.c./d.c., 20Ω–20MΩ. (31 ranges). **Impedance:** 10MΩ. **Special Features:** Selectable test voltage. **Price:** £36.50 + VAT. **Supplier:** *Armon Electronics, Heron House, 109 Wembley Hill Rd., Middx., HA9 8AG. (01-902 4321).*

Model: Beckman HD 100. **Ranges:** 200mV–1·5kV d.c., 200mV–1kV a.c., 200μA–2A a.c./d.c., 200Ω–20MΩ. (21 ranges). **Impedance:** 22MΩ a.c./d.c. **Special Features:** Folding stand. **Price:** £129 + VAT. **Supplier:** *STC Instrument Services, Edinburgh Way, Harlow, Essex, CM20 2DF.*

Model: M–5010. **Ranges:** 200mV–1kV d.c., 200mV–750V a.c., 20μA–10A a.c./d.c., 20Ω–20MΩ. (31 ranges). **Impedance:** 10MΩ. **Special Features:** Diode test facility. **Price:** £42.50 + VAT. **Supplier:** *Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex, SS6 8LR. (0702 554155).*

Model: ALT/AI KD615. **Ranges:** 200mV–1kV d.c., 200mV–750V a.c., 200μA–10A d.c., 200Ω–20MΩ. (18 ranges). **Impedance:** 10MΩ. **Special Features:** Diode test. Overload protection. **Price:** £38.85 + VAT. **Supplier:** *Semiconductor Supplies International, Dawson House, 128/130 Carshalton Rd., Sutton, Surrey. (01-643 1126).*

Model: YN 360TR. **Ranges:** 250mV–1kV d.c., 10V–1KV a.c., 50μA–250mA d.c., 2kΩ–200kΩ. (19 ranges). **Impedance:** 20kΩ/V. **Special Features:** Fuse and diode protection, hfe range. **Price:** £17.98 inc. VAT. **Supplier:** *Magenta Electronics Ltd, 135 Hunter St., Burton-on-Trent, Staffs, DE14 2ST. (0283 65435).*

MULTIMETERS buyer's guide MULTIMETERS

Model: M–102BZ. **Ranges:** 2·5V–1kV d.c., 10V–1kV a.c., 5mA–10A d.c., 10kΩ–1MΩ. (23 ranges). **Impedance:** 20kΩ/V d.c., 8kΩ/V a.c. **Special Features:** Continuity buzzer. **Price:** £14.95 + VAT. **Supplier:** *Maplin Electronic Supplies, PO Box 3, Rayleigh, Essex, SS6 8LR. (0702 554155).*

JAPANESE DEVELOPMENT GOES FLAT

THE Japanese have long been threatening to hit us with a revolutionary flat television/video screen that may be hung on the wall or even form part of the wall and be added to the "all mod cons" list circulated by house agents when offering a desirable property for sale!

This concept of the future has moved a step nearer with the announcement from Matsushita Electric Industrial of a new flat colour "panel" for all forms of media presentations and promotions.

The panel has been successfully used to develop a prototype of a truly "flat-screen" colour TV, featuring a diagonal 10-inch screen and a depth of only 9·9cm. The new set was put through its paces at *Tsukuba Expo '85 Show*, Japan, during March.

The colour panel features a square, completely flat screen, which, it is claimed, reproduces distortion-free images across the entire display area. Applications envisaged include office automation display and electronic services, such as; teletex, videotex, direct satellite broadcasts, high definition TV and cable/pay TV.

The new colour panel was developed using Matsushita's Matrix Drive and Deflection System. The screen consists of 3000 picture cells arranged in a matrix; 200 units horizontally and 15 vertically. Each picture cell is scanned by one electron beam which excites phosphor stripes. The prototype TV provides a resolution of 270 TV lines, a contrast ratio of more than 50, and a brightness of over 70fL.

How It Works

The newly-developed Matrix Drive and Deflection System produces 3000 controlled beams by forming a matrix of 15 filament cathodes and 200 electron beam control electrodes which cross cathodes at right angles. Each beam is horizontally deflected in six steps (two sets of R.G.B.) and vertically deflected in 32 steps (including the interlace) to form images consisting of 192,000 elements on the display panel. A complete picture is formed through the line-at-a-time method.

This deflection method also reduces the number of electrode terminals required to approximately one-seventh of the number used in the conventional matrix driving method.

Focusing

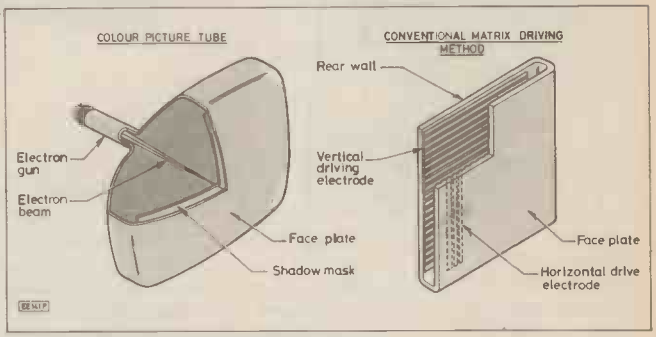
The system's lack of the shadow mask found in conventional colour picture tubes necessitates a fine electron beam of the same width as a phosphor stripe. They found the optimum electrode structure using the three-dimensional simulation technology previously developed by the company.

Separation of the horizontal and vertical lens systems to provide individual control of their focusings, has, it is claimed, resulted in improved resolution and colour reproduction. Of special importance to uniform display was the development of a cementing technology which evenly and alternately adheres 0·1mm grid electrodes with insulating plates.

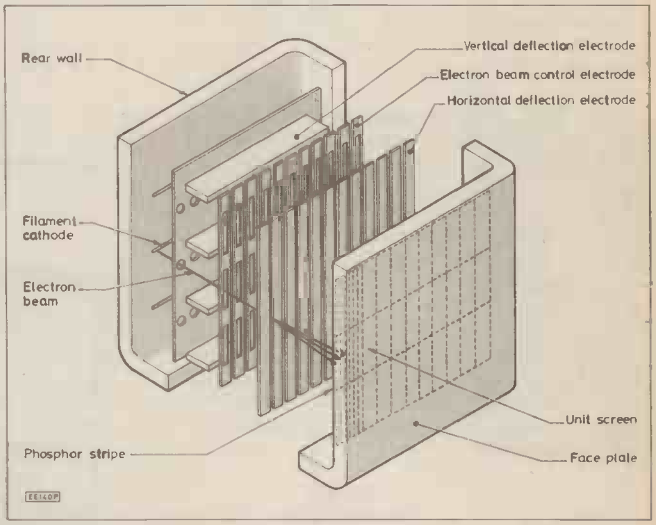
Digital Technology

Signal processing and driving are performed digitally and picture brightness is controlled by varying the pulse width which drives electron beams, thereby generating 64 steps in the gray scale. Colour reproduction is performed by digitizing the picture signal and alternately driving red, green and blue signals. Resolution is markedly improved by giving time differences in sampling each.

The use of a microcomputer for fine adjustment of the diameter and position of electron beams on the phosphor screen results in uniform brightness and high colour reproduction.



Conventional matrix driving method



Matsushita matrix drive and deflection system

Specifications . . .

	Colour Flat Panel	Flat Colour TV
Screen size:	200mm × 150mm	10 inch diagonal
Dimensions:	282mm (W) × 222mm (H) × 65mm (D)	370mm (W) × 355mm (H) × 99mm (D)
Weight:	7·5kg	14kg
Power consumption:	7 watts	70 watts
Brightness:	70fL	70fL
Resolution:	picture element pitch of 0·5mm	270 TV lines
Contrast:	More than 50	Gray scale: 64

The Amstrad CPC464 home computer has been voted *"Computer of the Year"* by the Computer Traders Association.

The award was made, at the *LET Show* trade exhibition, based on an independent poll of computer retailers.

Money Matters

Total sales in the 12 months ended 31 December 1984 of £110·8 million ($144·9M) was achieved by INMOS International plc. This is almost three times the level achieved in 1983. The company enjoyed its first profitable year producing profits of £14·4M ($18·8M) against a loss of £13·5M in 1983.

In his statement accompanying their financial report, Mr. Harold Mourgue, Chairman of INMOS said:

"In 1984 INMOS invested over £28 million ($32 million). The company plans substantial further investment in 1985. While much of the money is generated by INMOS operations, the board of Thorn EMI has indicated that it is prepared to commit the finance needed to ensure the company's continuing success . . ."

"We are therefore confident that INMOS will continue to grow and is significantly well placed to take advantage of a market recovery."

BUSINESS LINK

The first small-dish transatlantic business satellite link exclusively for multi-national companies, provided by British Telecom International (BTI), has enabled the giant Massey-Ferguson group to establish its world-wide communications centre in the UK.

The key to the operation is BTI's SatStream North America small-dish satellite service using an Intelsat V satellite for high-speed computer traffic between Britain and North America.

The link allows dealers throughout Canada and the United States to place computerised orders via their own terminals for parts and machinery direct to the British factories.

Planning to make it an annual Spring Fair, the West of Scotland Amateur Radio Society is organising The Glasgow Amateur Radio Exhibition for 11 May at the Cardonald College, Glasgow.

More information may be obtained from the organising committee chairman, Tom Hughes GM3EDZ or Ian McGarvie GM4JDU.

QUALITY FILM

A new film has been launched by the DTI's National Quality Campaign to promote the benefit of independent certification and thereby improve the quality and international competitiveness of UK industry.

In the film, "Getting Certified", business broadcaster and journalist, Brian Widlake talks to four key men who are concerned with quality systems. They describe the benefits of independent, third-party certification, as proof of a company's ability to manufacture to an agreed standard.

The 24 minute film is available on Free loan to industry and training and educational establishments from the Department of Trade and Industry. It can be obtained in 16mm film and video cassettes (VHS, Beta or U-matic format).

Anyone wishing to borrow the film should write, stating the format required, to: *Standards and Quality Policy Unit, Department of Trade and Industry, Room 323, Ashdown House, 123 Victoria Street, London, SW1E 6RB.*

The Right Honourable James Prior, M.P., Chairman of GEC and former Secretary of State for Northern Ireland, will officially open the first "British Electronics Week" at Olympia, London, on Tuesday, 30 April 1985.

METER TAKE OFF

A major Ministry of Defence contract for the supply of handheld digital multimeters to the RAF has been won by Beckman Industrial.

The meters being supplied are standard heavy duty HD110 models which conform to NATO standards without modification. They were selected following a thorough evaluation of several manufacturers' products by the Electrical Engineering Wing of the RAF Test Systems Flight.

Evan Steadman, Chairman of the Evan Steadman Communications Group and organiser of the "All Electronics/ECIF Show", has been named *"Best exhibition organiser of 1984"* in a worldwide readers' poll organised by the magazine *Conference & Exhibitions International.*

Copyright Levy

The problem of unauthorised home taping of copyright material is discussed and possible solutions proposed in a HMSO document entitled "The Recording and Rental of Audio and Video Copyright Material" published by the Department of Trade and Industry. The Green Paper, which supplements one issued in 1981, also discusses the related issues of recording of broadcasts for educational purposes and the rental of pre-recorded copyright material.

"We have considered in detail the several hundred responses to that document (1981) and we intend to bring forward as soon as possible a comprehensive set of proposals for the reform of copyright and related laws," said Geoffrey Pattie, MP, Minister of State for Industry and Information Technology.

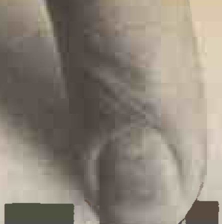
"On the issues of home and educational recording and on rental, the Government considers that a further opportunity for public comment is needed before a final decision can be taken."

The new Green Paper proposes that a levy be imposed on the sale of blank audio and video tape intended for domestic users who would in return be free to make, for personal use, video recording in general and audio recording of music. The size of levy to be subject to negotiation between beneficiaries and manufacturers/importers and to be statutorily limited to say 10 per cent of the retail price of audio tape and say 5 per cent of video tape. Audio tapes of less than 35 minutes total playing time to be exempt.

No realistic alternative to a levy scheme is seen, but there will be exemptions for certain categories of non-infringing user, for example the visually handicapped. It concludes that copyright owners are entitled to payment for the home taping of their material and that a levy is the only practicable way to providing such payment.

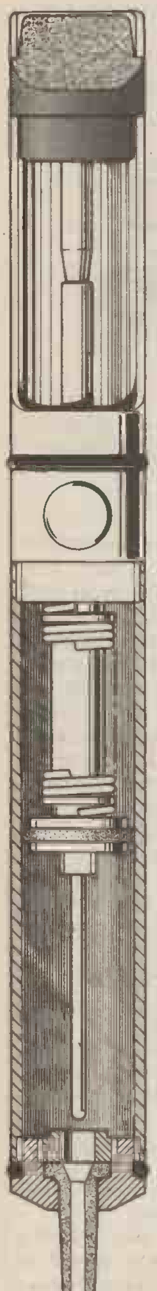
This latest document invites comments on the acceptability of a levy as a solution to the difficult problems posed by home taping. This is probably the last chance for readers to make their views known as all comments must be in by 30 April 1984. Proposals should be addressed to:

Industrial Property and Copyright Department, Department of Trade and Industry, State House, 66–71 High Holborn, London, WC1R 4TP.



FAULT FINDING

E. A. Rule Part 7



DURING this series, a number of servicing aids have been mentioned which can save time when locating a fault, and/or help clear the fault once found. The initial cost of these aids can be quickly recovered making them a good investment.

AEROSOL SPRAYS

Some of the most useful are in aerosol spray form—a few general words about aerosol sprays may be helpful.

First, they should always be used in a vertical position. The expected shelf life is around two years with correct storage conditions, which are normally within the temperature range of 10°C to 40°C with absolute limits of 0°C and 50°C. Most service workshops or home construction locations will meet these conditions, but extra care is needed if your workshop is a shed outside, for example, as temperatures here could well exceed the limits. Aerosols must not be exposed to direct sunlight and *never* placed near a naked flame or high temperature object. The contents are highly pressurised and excessive heat can cause an explosion.

When using aerosol sprays be careful not to use the spray near to your eyes and remember that the spray can 'bounce' back from a surface or component. Always read the instructions and follow them; like so many things, aerosols are very safe when used correctly but if misused can be dangerous.

FREEZER SPRAY

Another useful aerosol is the freezer spray, which provides a means of cooling components down to as low as minus 56°C in a very short time (frost can be seen on components in many cases). This rapid cooling will often show up a faulty component or help locate a cracked printed circuit board track. As the component or printed track is cooled it will contract and intermittent contacts will often be revealed because this contraction will part the connection. It can also be used as a heat shunt to maintain a low temperature near heat sensitive components while soldering their connections. Usage of the aerosol is similar to the switch cleaner with a small spout to localise the spray.

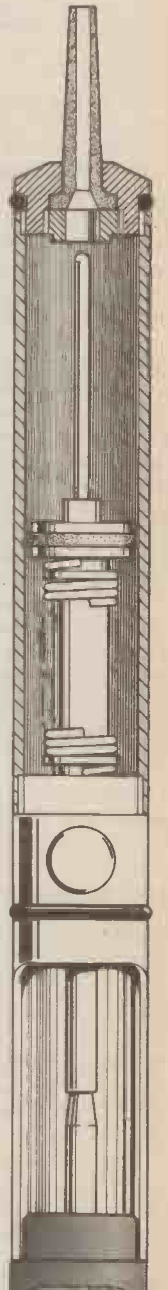
While on the subject of aerosols, although not a service aid as such, a fire extinguisher type is available which is designed to be used on *small* electrical fires. These extinguishers contain liquified BCF gas, it is non-corrosive and harmless to electrical/electronic components.

CONTACT CLEANER

One of the most useful aerosol sprays is the switch cleaner and this one is found in almost every service department. It contains a contact cleaner and a lubricant, this combination will clean off tarnish and corrosion from switch contacts and leave a thin film of lubricant to protect against further corrosion. This film of lubricant also helps maintain a low contact resistance which will reduce contact arcing or burning of switch contacts, prolonging their life. The solvent is inert and can be used on most surfaces safely. Some aerosols have a short flexible spout fitted which enables the spray to be directed onto a small area and avoids waste.

DE-SOLDERING

A useful aid to removing components from a printed circuit board without damage is the de-soldering tool. There are a number of different types available, but perhaps the most popular are the ones that use suction to remove the solder. These are very effective and can be used with one hand while holding the soldering iron in the other. Basically, this device works like a bicycle pump in reverse mode. Instead of pushing the plunger (to force air out of the nozzle), the plunger is pulled (by a spring) so as to suck air up the nozzle; see illustrations. In practice, the tool is primed by pressing the plunger down into the main body against the spring. Then, while melting the solder with the soldering iron, the nozzle of the solder sucker is placed over the connection to be unsoldered and when the solder is molten the release button pressed. This releases the suction plunger and sucks the solder from the joint into the body of the solder sucker, leaving the connection completely free of solder after which the component can be removed without damage. After a period of use the nozzle can be unscrewed and the surplus solder cleaned out. These solder suckers can be used over and over again. The author is still using the same one after sixteen years, having periodically replaced the nozzle. With some of the multi-pin i.c.s, a solder sucker is the only way which will enable damage-free removal.



MAG TAPE CLEANER

A video head cleaning fluid was mentioned last month regarding cleaning cassette recorder heads, etc. But the same fluid can also be used to degrease drive belts or idler wheels. Cleaning these with this fluid can give them a new lease of life and often a replacement will not be required. It is important to keep the container top screwed down tightly as these fluids evaporate very, very quickly.

TWO FOR THE ROAD

An epoxy cement is another useful service aid. This adhesive can be used for most repair jobs, such as broken knobs, front panels, etc. It is important that the surfaces to be repaired are clean and free from grease and also with some plastics the surface should be roughened. Not all plastics can be repaired using epoxy cements, but it is effective in most cases. In one situation the use of such an adhesive proved to be the only suitable method to fix a multi-track professional recording head onto its mounting bracket; a method, I hasten to add, which was recommended by the manufacturers.

Last but not least is heat sink compound. Whenever a power semiconductor is changed it is important that a fresh application of a heat sink compound is applied between the semiconductor and heat sink. These compounds are normally a zinc oxide filled silicon and provide a good thermal conductor between semiconductor and heat sink, they also add extra electrical insulation when used with the normal (mica) washers.

There are many more service aids available and a look through a good components catalogue should reveal those most useful in your particular situation.

For a wide range of aerosol-aid stockists see *Shoptalk* page 256.

FROM EXPERIENCE

Recently a cassette recorder was brought into the workshop with the complaint that the tape speed was too fast. Examination showed that the transistor used to stabilise the motor supply had become short circuited. A replacement was fitted but the tape speed was now very erratic; a careful check of other components did not reveal any fault, but the output voltage was unstable. The actual cause was traced to an original manufacturing fault. During manufacture, a part of the printed circuit track was omitted—the test department had bridged this gap with solder! When the transistor was removed using the solder sucker tool, the solder bridge also was inadvertently removed, without even realising it was there in the first place. Only careful checking of the circuit against the manual revealed this one.

A common complaint received is that of noisy controls, mainly volume controls, but sometimes other types as well. The cause could be due to a leaky coupling capacitor allowing a small voltage to appear across the control, and this should be checked out, but often it is simply due to wear of the control track causing small particles of carbon dust to get between the wiper blade and track. Sometimes an application of the switch cleaner spray will effect a cure, but in the author's experience this may only effect a cure for a short time. The author has used a cure now for a number of years which is very effective, even with really bad controls. This is to use penetrating oil, such as *Three-in-one*. It is applied in very small quantities to the defective track and the control then operated a number of times. This application of penetrating oil direct to the track is almost 100 per cent effective, and careful tests over a number of years have not revealed any side effects. However, if used on the slider type of control it can make the mechanical operation feel rough, so it must be used very sparingly. Also keep the oil well away from other components.

This is the final part of this series on fault finding, and although limited to basic procedures the series should prove helpful. The photograph shows the equipment used by the author, and although it may look impressive, in fact most of the time the multimeter is the busiest piece of equipment—*see page 264*. □

FOR YOUR ENTERTAINMENT

BY BARRY FOX

Lasers Light the Way

The STC Laboratories out at Harlow get edgy when people talk about the company as being part of ITT. It was, until 1982, but then STC (Standard Telecommunications) hived off on its own with ITT owning just 24 per cent.

The original work on fibre optics was done at STL in Harlow in the 60s, by Hong Kong scientist Charles Kao. At that time it was all just mathematical prediction. He said that light could be channelled down a fibre of very pure glass.

Now STL has 800 scientists, of which a quarter work on fibre optics. Some of their laboratory experiments point where fibre optics will be leading towards the end of the century.

In a nutshell, the trend is towards longer light wavelengths, in the infra red band. This will open up all kinds of possibilities because in many applications it will no longer be necessary to convert light into electricity before carrying it to a processing system.

Today's optic fibres are made of silica glass. At certain fixed wavelengths there are "windows" in which light travels through it most efficiently. There is a window at the 1·3 micron wavelength and most of today's telecommunications use this. There is another window at 1·6 microns and this is where the next generation of systems will work.

Today's fibres are approaching their theoretical best with a loss of 0·1dB per kilometre. But if the wavelength is longer, as for infra-red light, the silica glass just absorbs it. So new glasses are needed. The best bet so far is a glass made from zirconium fluoride which has a theoretical absorption of as little as 0·01dB per kilometre. This opens the door to a submarine cable, a thousand kilometres long, without any booster repeaters along the route.

It looks likely that fluoride glass will be able to carry light of between 2 and 12 microns wavelength. This enables optic communication, for instance from a gas sensor or heat sensing camera. Light signals from the sensor could pass along an oil pipeline or through the wings of a military aircraft. At the moment the light must be converted to electricity.

Doctors use infra-red laser light, usually at 10·6 micron wavelength, for surgery. At the moment they need an articulated arm with mirrors to get it round corners. With fluoride glass it might be possible to pump watts, or even tens of watts, down a flexible fibre.

This wavelength incidentally is generated by the carbon dioxide lasers used for cutting steel. But in this case kilowatts of power are used and it is unlikely that this can ever be channelled down a fibre without frying it.

Of course nothing is for nothing. Fluoride glass transmits long wavelength infra-red because it has heavy atoms which can be thought of as weakly sprung. Unfortunately this makes the glass difficult to draw into fibre. It melts at around 300°C instead of 2,000 degrees for silica, and crystallizes easily which means that it is fragile.

Fluoride glass is also very susceptible to water. If any gets into the glass it absorbs the light. The fundamental peak of water absorption is 2·9 microns. The other water absorption peaks which plague silica glass are weak harmonic overtones. So the worst risk of water absorption is in the infra-red band.

Fluoride glass has to be made in chambers where the air is so dry that only a few parts per million of water is able to get at the raw chemicals. Other odd mixes, for instance involving arsenic, in the chalcogenide group, may turn out to work well at the much longer wavelengths over 10 microns.

Laser Sandwich

The light launched into a fibre usually comes from a laser. These aren't bulky gas lasers any more, they are solid state chips. A speck of active material, for instance gallium arsenide for wavelengths of around 0·85 microns or gallium indium arsenide phosphide for wavelengths of around 1·3 microns, is sandwiched between tiny reflectors in an integrated circuit.

Early solid state lasers had a short life, largely because they drew a high current and got hot. STL reckons it now has the world's lowest threshold current laser, for the 1·3 micron wavelength. The active light-emitting part measures just 1 micron in length and is 0·2 microns thick. As a reference, a human hair is 50 microns thick.

The chip starts to lase at a current threshold of 4·6 milliamps. So it runs very cool. Estimated working life is around 25 years which makes it safe to install in submarine cables. Obviously you can't send out a man with a screwdriver to replace lasers under the Atlantic.

Another new trick is to tune the laser output very tightly, because this means that the light pulses sent down a fibre do not spread. Before the chip lases, it emits a broad band of light, around 100 nanometres wide. It is now acting as an l.e.d. When it lases, through oscillation of the light between the reflectors, the bandwidth drops to a few hundred MHz which is under one nanometre. But there are still spikey lines in the spectrum, caused by standing waves in the resonant chamber between the mirrors.

Optical Grating

The aim is to tune out all these lines except one. This is now done by building an optical grating into the laser chip. The grating ridges are one wavelength long and act as extra resonant chambers.

The grating works like a very sharp filter that kills off all but a single frequency in the laser output. So all the light travelling down the fibre is of exactly the same wavelength and frequency. So it travels at one speed and all arrives at the same time. So digital pulses do not spread and introduce errors into the signal.

Think for a moment about the difficulties of making such a grating, with a ridge spacing of 250 nanometres. The only way to do it is with an electron beam masking machine, which draws direct onto the silicon wafer with an accuracy down to 0·1 microns. This compares with an accuracy of one or two microns for the chips made with conventional photo lithographic techniques.

It will take several hours to trace each wafer by direct electron beam writing. But each wafer can produce up to 1,000 chips and even if only half these are usable it's worthwhile because telecommunication lasers of this type sell at thousands of pounds each.

Electron Analysis

Finally, have you ever thought how you can check the electrical performance and continuity of a chip with circuit lines drawn down to a spacing of one or two microns, or even less? Early chips were tested with a mechanical probe. This is now impractical. The probe damages the chip.

One technique used at the STL Labs is to put power through the chip circuit and look at it under an infra-red microscope. Any faults show up as hot spots, because the fault areas generate more heat than the rest of the chip.

Another way is to put the chip inside an electron microscope and look at it while current is running through. Negative voltages show up as light tracks on the microscope picture and positive voltage shows up as dark tracks.

This is fine for d.c. but what about high frequency operations? Simple when you know how. The electron beam is switched on and off at the same frequency as the operating voltage, like a pop group strobe. That way it artificially freezes the dynamic performance of the chip. Magnification can be up to 100,000 times.

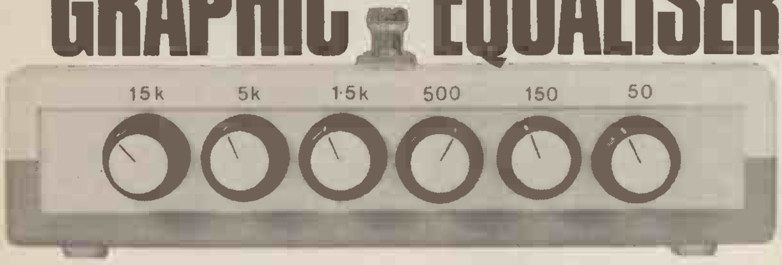
Electron beams can also be used to analyse the physical and chemical structure of the chip surface. When the beam hits the chip it produces X-rays and secondary electrons which have an energy pattern which is characteristic of the material which released them.

Computer software can give a direct readout of the material under the beam, down to a one micron spot. So if a chip doesn't work a lab technician with an electron microscope can look for a break in the voltage pattern and then do a spot analysis of that tiny area to identify any chemical blemish.

This group of hair-thin strands of glass fibre cables are capable of carrying thousands of simultaneous telephone calls and digital information down each cable.

JUNE FEATURES...

GRAPHIC EQUALISER



This low cost unit is an ideal add-on for electric guitars, providing a wide range of musical effects. The unit incorporates six graphic equaliser channels with centre frequencies between 50Hz and 15kHz.

COMPUTERISED SHUTTER TIMER

Use your microcomputer as a piece of photographic test equipment. This is a simple and inexpensive camera tester, yet will do what normally requires costly apparatus.

ELECTRONIC DOORBELL

A doorbell with the ringing sound of a conventional electromechanical device, but taking advantage of the reliability and compactness of electronic techniques.

Plus... Monostables - Bistables - Astables

EVERYDAY ELECTRONICS and computer PROJECTS

JUNE 1985 ISSUE ON SALE FRIDAY, MAY 17

DOWN TO EARTH

BY GEORGE HYLTON

THE DATA SHEET on an operational amplifier says that it will source 10mA and sink 15mA. Please explain.

Another case of jargon! "To source" is shorthand for "to act as the source of current". "To sink" means "to absorb current".

CURRENT

Some simple examples (Fig. 1) illustrate the point. At (a) the boxed-in part is a source of current, which it supplies to a load RL. The current rises when RL is reduced, and its upper limit, when RL = 0, is fixed by the internal resistance (100Ω) at 30mA. So 3V in series with 100Ω can source 30mA.

A current sink (b) can be just a resistance. If it's 100Ω as shown, then it can absorb up to 30mA when driven by 3V through a load RL which may fall to zero.

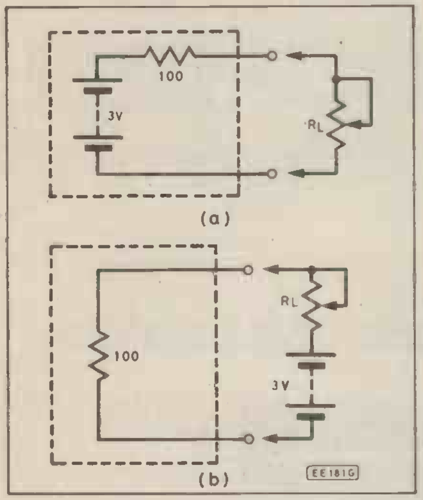


Fig. 1: in drawing (a), the current source is represented by a 3V battery with a 100 ohm internal resistance in series. In drawing (b), the 100 ohm load resistance is "sinking" up to 30mA via load resistor RL, which is variable.

Obviously the amount of current which a circuit can source or sink must depend on the voltage available for driving it. In practical cases the voltage is often fixed by some other consideration. In logic circuits, for example, it may be fixed by a design requirement at, say, 5V.

In any case, the driving voltage can't be increased beyond a certain point, because any increase in current entails an increase in power dissipation. Every component or device has its safe dissipation limit, beyond which overheating may damage it. For this reason, sourcing and sinking ratings imply safety. A circuit which is forced to source or sink more current that its rating may overheat.

OPERATING AMPLIFIER CURRENTS

"Source" and "sink" are really no more than brief terms for the ability of a circuit to deal with outward and inward current flows. But the terms have a certain handiness which guarantees their survival.

In the case of an operational amplifier with split d.c. supplies (Fig. 2) the circuit either sources current through the load RL, or sinks it. The current really comes from the battery, of course. But if we take the battery for granted, the operational amplifier is seen to source or sink currents via RL and "earth".

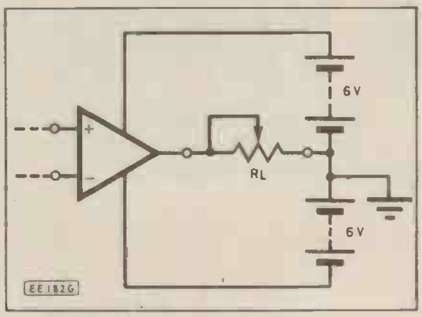


Fig. 2. The operational amplifier has a "split" supply, which means that the chip has both a positive and a negative power supply connection. In terms of sourcing and sinking current, the current flow (from the battery) can be considered as flowing from, or into, the operational amplifier, respectively.

RL may not be a physical resistor. It could be, for instance, the resistance of the operating coil of a relay. In this case, since a relay will only operate reliably when its coil passes enough current, the source or sink current rating can be very relevant. Quite often the two ratings differ. This can affect the way the operational amplifier is used.

Suppose, for example, that RL is a relay coil whose operating current is 25mA. If the operational amplifier will source 20mA but sink 30mA then in this case the relay must be connected so that is is operated by the "sink" current.

An operational amplifier is arranged in Fig. 3 to switch on one of two l.e.d.s, one green, the other red. If the green l.e.d. needs more current than the red (for equal brilliance) it may be necessary to pay attention to the source and sink ratings, and connect the l.e.d.s accordingly.

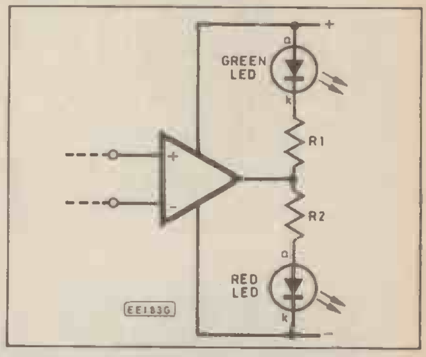


Fig. 3. When different l.e.d.s are connected in circuit, their current ratings will determine which l.e.d. is "sourced" current by the op-amp, and through which the op-amp "sinks" current.

If the current-sinking rating is the greater, then the arrangement shown may have to be used. (In many cases, of course, both sourcing and sinking capacities will be more than adequate, so either arrangement of l.e.d.s would do).

SINKING ALONE

Many circuits can either source current, or sink it, but not both. Some integrated circuits have "open-collector" outputs; i.e., their last stage is a transistor with no collector load resistance. The user adds his own (see Fig. 4). If it takes the form of a relay or lamp you have to ensure that the current-sinking ability is adequate. Suppose, for example, a 6V, 300mW lamp has to be lit by a voltage comparator i.c. with open collector output. If the comparator will sink 100mA, is this enough?

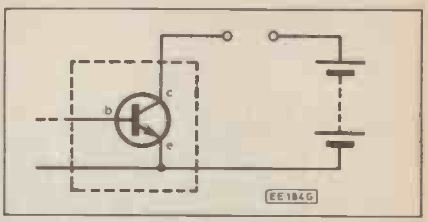


Fig. 4. The output stage of an integrated circuit which is "open-collector".

Since power (wattage) is the product of voltage across, and current flow through any device, it is easy to work out the current that the lamp will draw. We have 0·3 (watts) = 6 (volts) x I (amps) Hence $I = \frac{0{\cdot}3}{6} = 0{\cdot}05$A, or 50mA. The comparator is capable of sinking 100mA, so it can be used.

However, the designer must ensure that the supply voltage is correct for the job.

If a 6V supply is used, then the bulb needs the whole voltage, leaving nothing across the comparator output. If, when sinking 50mA, the comparator's output voltage is 3V, then the supply voltage will have to be increased in order to have enough for lamp and comparator output in series.

COUNTER INTELLIGENCE

BY PAUL YOUNG

Computer Weather

As much as I admire computers, and realise that life today would probably be intolerable without them, I still cannot resist a quiet smirk of satisfaction when one of them finishes up with egg on its monitor. This is most likely an age old instinct going back to the days when we were all savages and worshipped idols. Every now and again we would knock them down and chop them up, just to keep them in their place, so to speak.

This happened recently, I refer of course to the computers, not the idols. During the terrible spell of cold weather the BBC weather man explained they now had a wonderful new computer system, with which they could pinpoint any part of the country and tell us exactly what was going to happen. He then proceeded to tell those of us who lived in the South East, that next day we could expect an easterly blizzard and heavy snow, we were depressed but not surprised. To our relief and delight, the next day was sunny with a south westerly wind.

Perhaps it is a bit hard to blame the computer, because weather is less predictable than the fair sex. Fronts bringing rain occlude before they reach you, and a "Low" which should have moved South East, shoots off in a North Easterly direction, causing the opposite of what was forecast, tantalizing isn't it?

Common Market Shock

Something I have often wanted but doesn't exist, is a small neat two-way flex connecter. The nearest thing to it was the old Bulgin range of "Domina" plugs and sockets.

Someone will no doubt howl that you must have an earth connection. My contention is, that if you are connecting a plastic clock, or a glass or porcelain table lamp or one of those appliances where the works are completely isolated there is no point. There must be countless occasions when you want to move a lamp around and you don't want a long lead, nor do you want a clumsy thirteen amp plug on the end.

Even if someone produced one, I have no doubt the bureaucrats in Brussels would jump on it. I well remember how they outlawed the Bulgin P70 series, because it was possible to unscrew the back with the mains on. They were all ignominiously derated to twelve volts d.c. despite the fact they had been in use for probably fifty years without harming anyone

What is so safe about the continental system, with its two pin plugs and no earth? This was understandable when they were using 110 volts, but now it is a standard 220/240 volts a.c.

I put this question to an electrical friend of mine. What happens if the metal part of the appliance becomes "Live" and you touch it? He explained that the current flowed via your body back to the switch box, which tripped a relay and switched off the power. He added, that of course you may be dead by then. It was not very reassuring. Was he having me on?

Pirate Radio

I was sorry to learn that "Radio Jackie" had been closed down. They have been broadcasting for three or four years and were at one time customers of mine, buying high voltage capacitors for their transmiters. I remember at the time asking one of the partners how they got away with it and he told me that as they were practically non profit making, and carried out a large amount of work for charity, the Law kindly turned a blind eye.

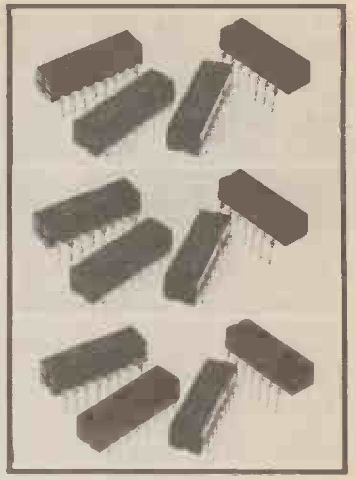
From what I read about these events, I get the impression that the regulations governing these matters needs revising, to bring it into line with current needs. I remember many years ago, that popular witty saga of the *Wireless World* "Free Grid" bringing up the same point. He said according to the Act, it was illegal for one person to convey Information to another by other means than the written or spoken word or telephonic communication.

In his usual humorous way, he added, that as far as he could see, it was an Indictable offence to wink at a pretty girl. I hope he was joking.

DIGITAL ELECTRONICS

D.W. CRABTREE B Sc Tech Eng (CEI)

PART EIGHT



In the previous article in this series, we discussed microprocessor systems, their design and some of the decoding and memory mapping techniques that they employ.

In this, the final article of the series, we shall discuss the ways of using the information produced by the microprocessor (or by any other device).

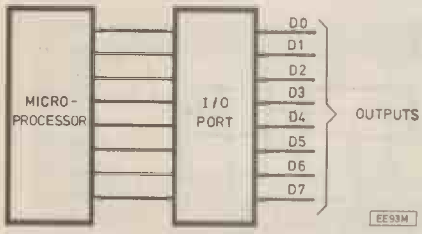
USE OF DATA

The data to which we now refer is the 8-bit (or 4-bit, 16-bit or 32-bit, dependent upon the type of system used) words produced by, say, a microprocessor system on the data lines. We shall not be discussing the application of these words within the system itself, since this is merely repeating what we have discussed earlier. We are, however, concerned with the use of controlling other devices using our data.

Some devices use the words directly from the data lines, whilst other devices require interface circuits connected either, via input/output ports or direct to the data lines. When devices are connected direct to the data lines it is generally necessary to provide decoding circuits in order to ensure that those devices are only "called" when required. Since we have already discussed decoding techniques in the previous article, there is no need for further explanation.

We shall only consider those devices which use a single bit of information, since, if they use more than one bit, the method is more than likely, simply repeated.

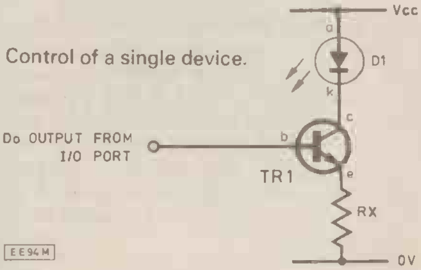
Suppose we are using an input/output port, which, although having the ability, as its name suggests, to either input or output information, is set to output data at the port only. This setting would be carried out using software control. We have, therefore, 8 bits of information being output from the system as shown in the diagram.



An 8-bit output port.

Now, we will assume that each of the 8 output lines contain information to control seperate devices of some kind, which is quite likely and quite practical. The existence or not of data on the 8 lines is controlled by software commands, with, say, a "1" on the line being a request for the device to operate, whilst a "0" on the line is an instruction for the device not to operate. If devices are connected separately to the output lines, as we have suggested above, then we can operate none, one, or as many of the devices as we like, each independently of another, using program control. Hence we need only consider one of the lines, say output Do, as shown below.

Control of a single device.

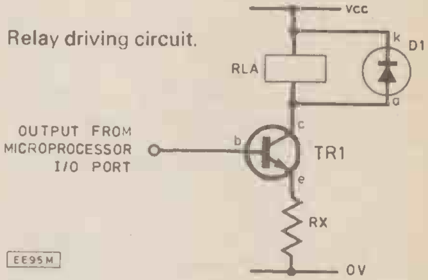


Now, suppose that only device that we need to operate is an l.e.d., that is we need to indicate whether or not our output line has a bit at logic 1. If it has, then we light the l.e.d., if not, the l.e.d. is not lit. Let us use the circuit shown, which is simply an l.e.d. driving circuit.

The output from the I/O port is fed into the transistor base. If the output is low, then the transistor will be switched off. If the output goes high, however, the transistor switches on and D1 is allowed to light, with the resistor Rx being the current limiting resistor for the device.

Although the circuit is an analogue type, since a transistor is being used, which can be in any state between on and off, it should be remembered that here only a high or low signal is available from the I/O port, with in-between states not permitted, therefore the transistor driving circuit will similarly only be working in either a high or a low state of conduction. In-between states will not exist.

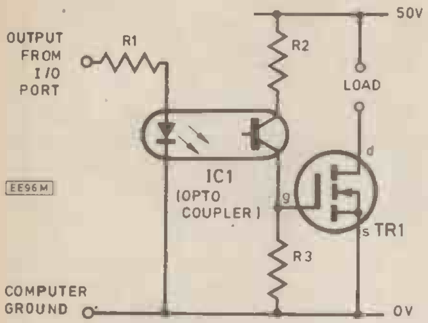
Relay driving circuit.



Note also that the "Vcc" and "ground" connections shown on the circuit diagram may be the same as those used for the microprocessor system supply. Alternatively, another supply may be used for these functions, as long as the "ground" connection is attached to the microprocessor ground as a common.

Now, suppose we wanted to operate, say, a relay instead of an l.e.d.. Then this is no problem, since we only have to put the relay in place of the l.e.d., with one or two other points considered. Firstly, the Vcc supply used should be a separate supply to that used by the microprocessor, but the ground connections should be made common as previously discussed. (The supply for the relay will probably need to be of a higher voltage anyway.) Secondly, since the relay is an inductive load to the circuit, a diode should be connected across the coil to protect the circuit from back e.m.f's when switching takes place. Thirdly, the value of the resistor, to limit the current, and the type of transistor used, should both be carefully chosen. The circuit becomes that shown above.

If the devices to be operated involved the use of higher voltage supplies, say 50 volts d.c., then it may be necessary to use some other switching device, such as a VMOS device, which has the advantage of literally being able to dissipate many watts from only 1μA gate input. Shown opposite is a typical use of a VMOS, N-channel, device, as a drive to a 50V d.c. circuit.

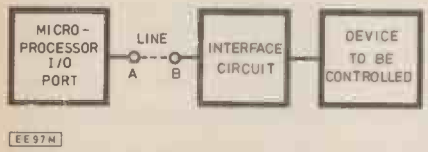


High voltage driving circuit.

Here, the output from the microprocessor I/O port is fed via a current-limiting resistor, R1, to an opto-coupler which provides isolation between the TTL voltage levels and the higher voltage supply. Resistors, R2 and R3 provide a voltage-divider chain for the N-channel VMOS component, which drives the load as shown.

Above we have considered circuits which require d.c. supplies for the devices to be operated. If a.c. supplies are required, the triacs or other a.c. components should be considered as the driving device.

We have now adequately provided background information to enable further research into interface circuits to be undertaken. Let us now consider the diagram below.



The basic interfacing format.

In our discussions above we have only considered the situation where the link between A and B, shown above, is a small distance. Then there is no problem here and the I/O port and the interface circuitry can be considered to be adjacent.

Now, however, suppose that the device to be operated is at some greater distance from the microprocessor I/O port, which is quite possibly the case when a remote control of the device is required. Suppose also that, instead of just one device being required to be operated, there are several controls to be sent to the remote location.

This gives us a problem, since, if we are working at TTL logic levels of 5 volts and 0 volts, then due to losses derived though cable resistances and/or wire resistances, there is a grave probability that the "high" levels output from the system cannot clearly be defined as "high" at the remote end of the system and malfunctions of the system would probably result.

We must therefore have some system which we can use to accept the outputs from the microprocessor I/O port and transmit to the remote end for control of the devices there. This system performs the task of data transfer and the type of system utilised is dependent upon several factors:

DATA FORMAT—Is the data available in parallel or serial form? In the example above, the outputs from the I/O port will be in parallel form.

DISTANCE OF THE TRANSMISSION—Over very great distances, amplification may be required.

REQUIRED SPEED OF THE TRANSMISSION—Called the Data Rate, this need only be considered when overall speed of operation of a system is seen to be critical.

REQUIRED LEVEL OF INTEGRITY—This is the accuracy required by the system in transmitting data without any error in level detection at the remote end. Codes can be injected into the system to create a high level of integrity.

SIGNAL TO NOISE PROBLEMS—Any system suffers from electrical noise and, really, the greater the distance the data is to be transmitted, the greater the amount of noise picked up. We can, however, consider an ideal noise-free system here.

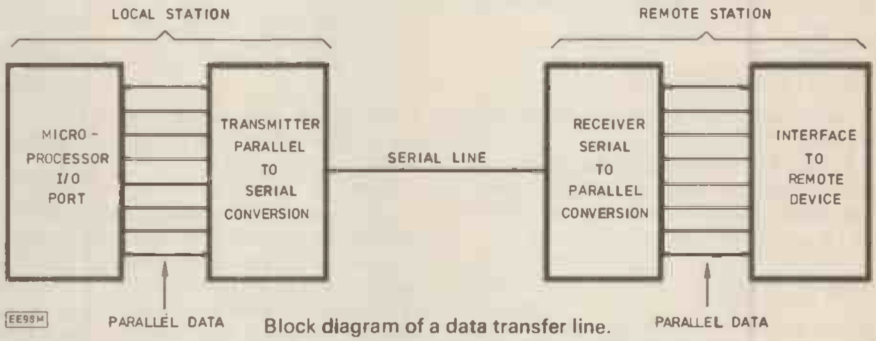
CHANNEL CAPACITY AVAILABLE—The transmission system used must have a limit to the number of channels available for transmission of data and this limit must be greater than the actual number of data channels required, or at least equal to that number. (In this latter case, there would be no allowance for any further channels to be added at a later date).

TYPE (of transmission channel used).

DATA ENCODING—Data can be encoded for transmission, this being generally essential, in some cases.

Generally, serial transmission of data is used for remote systems since only 2 wires (or a single fibre-optic link) would be required, hence a saving in cabling results. This system of transmission is shown below, in the block diagram.

It is seen, therefore, that we have a transmitter and a receiver at the local and remote ends respectively, with a parallel-to-serial and a serial-to-parallel conversion of data at the respective ends. Therefore, considering 8-bits of information produced at the microprocessor, bit 0 is transmitted first, followed by bit 1, bit 2, etc., until bit 7 has been transmitted, at which time bit 0 will be retransmitted and the cycle, or "scan" repeats. At the receiving end, the remote end, bit 0 will at first be received, then bit 1, etc.

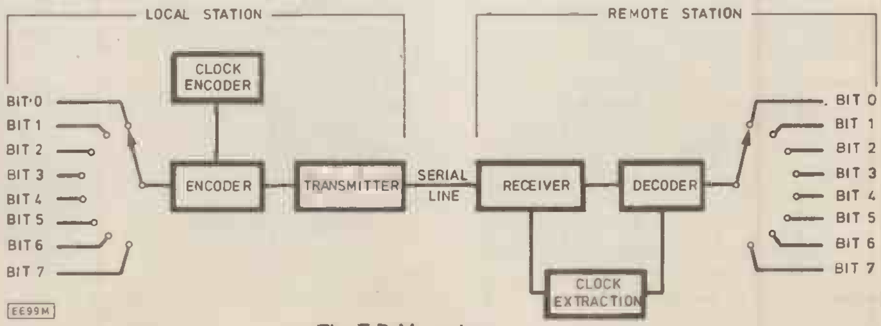


Block diagram of a data transfer line.

To ensure correct operation a coding system is added to the transmitted data which is detected at the receiving end and this is used to ensure that the transmitter and the receiver are in phase so that bit 0 transmitted is detected as bit 0 and not as bit 4 say.

TIME DIVISION MULTIPLEX

The basic type of transmission system is the T.D.M. or Time Division Multiplex system and gives operation similar to that described above. The name is derived from the task of splitting, or sharing, of a certain length of time between bits of information transmitted. In the simplest example, if 10 functions are to be transmitted in a time of 1 second then each function occupies 1/10th. second timespan. In practice, we are probably considering say, thousands of functions being tranmitted in a 1/2 second timespan. Consider the diagram below, which shows the basic principle of the T.D.M. system.



The T.D.M. system.

Here, the 8 bits in our example are connected to a sequence switching system that takes each bit in turn and connects that bit to an encoder which gives a unique code for each bit. The encoded bit is then passed to the transmitter which puts the information out onto the serial link. At the receiver the information is decoded and the bit is output to the device relevant to that bit. Clock information is encoded at the transmitter end and extracted at the receiver end to ensure phases are the same at the two ends.

DATA TRANSMISSION INTEGRITY

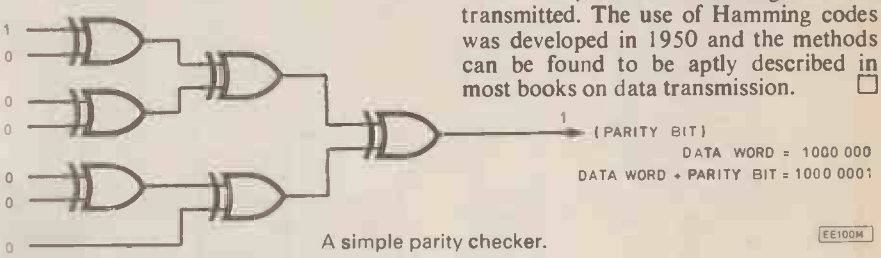
As previously mentioned, it is essential to check that the data transmitted is accurately received. Parity checking is one method used to prove integrity.

PARITY CHECKING

Here we have a means of checking whether any one bit of a transmitted word is received in error. To do this, we always make sure that either an even number of bits (even parity) or an odd number of bits (odd parity) is transmitted.

A parity bit is generated at the transmitter and transmitted with the data. Let us consider even parity. Suppose we have the 7-bit word 1011101 to be transmitted. Then in this word there are 5 high bits. We must add a 1 to this to give an even number of high bits. This 1 to be added is the parity bit. Hence our word transmitted becomes 10111011. At the transmitter we have a parity generator and at the receiver we have a parity detector. Therefore, at the receiver we detect that the parity bit is 1 and, knowing that we are working with an even parity system, we know that, including the parity bit, there must be an even number of bits received that are "high". In this example, six "highs" are received so we know that the received word is correct. If only five "high" bits had been received then we would have detected an error and the word would have been rejected.

Referring to the diagram below, a parity generator simply detects the number of 1's input and either gives a "1" or a "0" at the output, for even parity, to be used as the parity bit.



A simple parity checker.

It is seen that the parity generator is a collection of EX-OR gates connected simply as shown. The parity receiver is similarly simply constructed.

The only disadvantage to parity checking is that, if an even number of bit errors occur, or indeed more that one bit error, then the parity check will not detect it, but the chance of two or more bit errors in an 8-bit word is very unlikely. For example:

7-bit word 1000110
7-bit word + parity transmitted 10001101
7-bit word + parity received ... 10010101
receiver thinks 7-bit word is 1001010
...... wrong, but parity check does not discover any errors.

HAMMING CODES

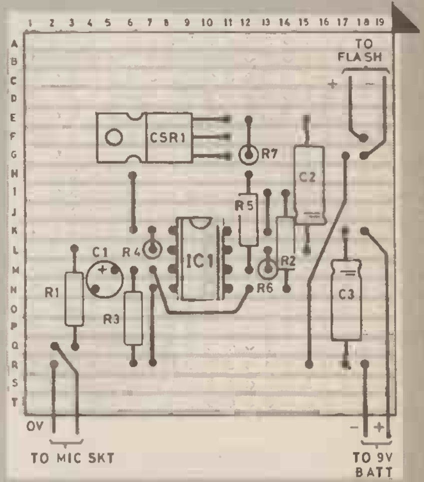
These are codes used for the detection and automatic correction of a single-bit error in a digital word. It is a repeated parity-checking procedure that checks the parity of one group of bits in the word, followed by another group, etc. By allowing overlapping of the groups, the actual position of the error can be detected and a correct bit generated. Instead of transmitting just 1 parity bit with, say, a 7-bit word, several Hamming bits are transmitted. The use of Hamming codes was developed in 1950 and the methods can be found to be aptly described in most books on data transmission. □

The above article concludes this series entitled Digital Electronics. In the series, I have tried to give an introduction to this subject for those who have little or no understanding of it. It would be impossible to go into very great detail on a widespread subject such as this in a short series of articles, such as this has been, however, we do hope that the series has been constructive and has provided a basis for further research into the subject.

PLEASE TAKE NOTE

Sound Operated Flash *(September 1984)*

The stripboard and component layout on page 575 was incorrect and should be constructed as shown in the diagram opposite.

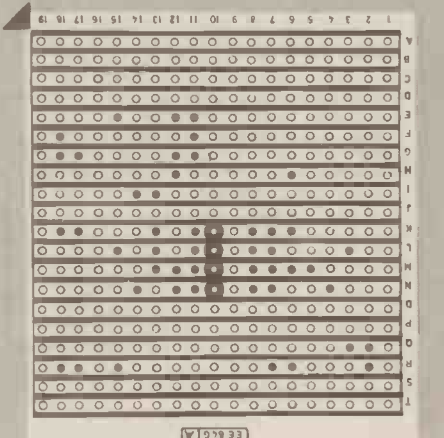


Headlight Activated Switch *(March 1985)*

The earth lead to the light in Fig. 2 on page 137 should be common to the Mains In Earth, and *not* to the neutral as shown. Also, D3 cathode resistor (R12, 470) is not shown.

In Fig. 3, there should be a link between rows *F* and *G*, column 20.

The wiring diagram, Fig. 5, should show row *N* connected to earth, and row *B* connected to JK1 input. They are transposed as published.



Motorcycle Codelock—Circuit Exchange *(February 1985)*

Page 121. On the circuit diagram diode D1 is not an l.e.d.

In the last paragraph:
Line one; IC1c should read IC2a.
Line five: IC1d should read IC2b.
Line seven; IC1d should read IC2a.

Digital Electronics—Part 5 *(February 1985)*

Pages 114 and 115. The two circuit diagrams of the Binary-Up and Binary-Down counters are transposed. Diagram EE60M should be in the place of EE58M and vice-versa.

BAKERS DOZEN PARCELS

All the parcels listed below are brand new components. Price per parcel is £1.00, but if you order 12 you get one extra free.

1 – 5 13 amp ring main junction boxes
2 – 5 13 amp ring main spur boxes
3 – 25 13 amp fuses for ring mains
4 – 5 surface mounting switches suitable insulated for mains voltage
5 – 3 flush electrical switches intermediate type, will also replace 1 0r 2 way switches
6 – 5 in flex line switches
7 – 4 in flex line switches with neons
8 – 2 80 watt brass cased elements
9 – 2 mains transformers with 6v 1a secondaries
10 – 2 mains transformers with 12v ½a secondaries
11 – 1 extension speaker cabinet for 6½" speaker
12 – 5 octal bases for relays or valves
13 – 12 glass reed switches
14 – 4 OCP 70 photo transistors
15 – 25 assorted gemanium transistors OC45 etc
16 – 4 tpae heads, 2 record, 2 erase
17 – 2 ultra sonic transmitters and 2 ditto receivers
18 – 2 15000 mfd computer grade electrolics
19 – 2 light dependent resistors similar ORP12
20 – 5 diff micro switches
21 – 2 mains interference suppressors
22 – 2 25 watt crossover units
23 – 1 40 watt 3 way crossover unit
24 – 250 various screws and self tappers
25 – 1 of each wafer switches – 6p 2 way; 4p 3 way; 2p 6 way; 1p 12 way
26 – 2 tape deck counters
27 – 1 6 digit counter 12v
28 – 1 6 digit counter mains voltage
29 – 1 BOAC In flight stereo unit (second hand)
30 – 2 Nicad battery chargers
31 – 1 key switch with key
32 – 2 humidity switches
33 – 2 aerosol cans of ICI Dry Lubricant
34 – 96 x 1 metre lengths colour-coded connecting wires
35 – 4 battery operated model motors
36 – 2 air spaced 2 gang tuning condensors
37 – 2 solid diaelectric 2 gang tuning condensors
38 – 10 compression trimmers
39 – Long and Medium wave tuner kit
40 – 4 x 465 KC IF transformers
41 – 8 Rocker Switches 10 amp Mains SPST
42 – 6 Rocker Switches 10 amp Mains SPDT
43 – 5 Rocker Switches 10 amp SP DT Centre Off
44 – 4 Rocker Switches 10 amp DPDT
45 – 1 24 hour time switch mains operated
46 – 1 6 hour clockwork timeswitch
47 – 2 lever switches 4 pole changeover up and ditto down
48 – 2 6v operated reed switch relays
49 – 10 neon valves – make good night lights
50 – 2 x 12v DC or 24V AC 4C0 relays
51 – 1 x 12v 2C 0 very sensitive relay
52 – 1 x 12v 4C 0 relay
53 – 2 mains operated relays 3 x 8 amp changeovers (secondhand)
54 – 10 rows of 32 gold plated IC sockets (total 320 sockets)
55 – 1 locking mechanism with 2 keys)
56 – Miniature Uniselector with circuit for electric jigsaw puzzle
57 – 5 Dolls' House switches
58 – 2 telephone hand sets incorporating ear piece & mike (s/hand)
59 – 2 flat solenoids – ideal to make current transformer etc.
60 – 5 ferrite rods 4" x 5/16" diameter aerials
61 – 4 ferrite slab aerials with L & M wave coils
62 – 4 200 earpieces
63 – 1 Mullard Thyristor trigger module
64 – 10 assorted knobs ¼ spindles

With most items quantity buyers get good discounts and save on postage costs.

SOUND TO LIGHT UNIT

Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is £14.95 in kit form or £25.00 assembled and tested.

MINI MONO AMP on p.c.b., size 4"x2" (app.)

Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of £1.15 each, or 10 for £10.00.

The AMSTRAD Stereo Tuner.

This ready assembled unit is the ideal tuner for a music centre or an amplifier, it can also be quickly made into a personal stereo radio – easy to carry about and which will give you superb reception.

Other uses are as a "get you to sleep radio", you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music Instead.

Some of the features are: long wave band 115 – 270 KHz, medium wave band 525 – 1650KHz, FM band 87 – 108MHz, mono, stereo & AFC switchable, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands. All made up on very compact board

Offered at a fraction of its cost: **only £6.00** + £1.50 post + insurance.

25w SPEAKER SYSTEMS By Amstrad

25 watt RMS loading 8" woofer, 4" tweeter with crossover. £12.00 per pair + £4 post. New and unused but cabinets slightly damaged hence this low price, carry our normal guarantee.

CAR STARTER/CHARGER KIT Flat Battery! Don't worry you will start your car in a few minutes with this unit – 250 watt transformer 20 amp rectifiers, case and all parts with data £16.50 or without case £15.00. post paid.

4/5A BATTERY CHARGER Transformer and rectifier £3.95 & £1 post, 3 kits £12 post paid.

PRESTEL UNITS

These are brand new and we understand tested, came with manufacturer's guarantee now void as the manufacturer no longer trades. These originally sold for over £150. We offer them complete, except for 7 plug in i.c.'s and price is only £14.95 (less than the value of the modem included).

STABILISED POWER SUPPLY (Mains Input)

By LAMDA (USA) – Ideal for computer add-ons, d.c. output. Regulated for line volts and load current. Voltage regulation .1% with input variations up to 20% – load regulation 1% from no load to full load – or full load to no load. Complete in heavy duty case – Models available 5v - 9A £23. 12v - 1.5A £13.25. 15v - 1.2A £13.25. 24v - 2A £23.

25A ELECTRICAL PROGRAMMER

Learn in your sleep: Have radio playing and kettle boiling as you wake – switch on lights to ward off intruders – have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. Independent 60 minute memory jogger. A beautiful unit at £2.50.

THIS MONTH'S SNIP

TOP OF THE POPS LIGHTING if you use our disco switch

These have 12 x 10 amp changeover switches each rated at 10 amps so a whole street could easily be lit with one. Switches adjustable and could be set to give a running light, random flashes, etc etc. 230 volts main operation. Brand new, made by Honeywell. Offered at approximately one third of cost.

ONLY £6.90

COMPUTER DESKS

Again available Computer desks – size approx 4' x 2' x 2'6" high formica covered, cost over £100 each. Our price only from £9.50 – you must collect – hundreds supplied to schools.

FROZEN PIPES. Can be avoided by winding our heating cable around them – 15 mtrs connected to mains costs only about 10p per week to run. Hundreds of other uses as it is waterproof and very flexible. Resistance 60 ohms/metre. Price 28p/metre or 15m for £3.95

FLEXIBLE EXTENSION LEAD twin rubber 5mm Ideal grass cutter etc. 250 metre coil £25.00. 50 metre coil £6.75.

50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, 90% are unused componants.

YOURS FOR ONLY £11.50 plus £3.00 post.

REVERSIBLE MOTOR WITH CONTROL GEAR

Made by the famous Framco Company this is a very robust motor size approximately 7½" long, 3½" dia. 3/8" shaft Tremendously powerful motor, almost impossible to stop. Ideal for operating stage curtains, sliding doors, ventilators etc., even garage doors if adequately counter-balanced. We offer the motor complete with control gear as follows:

- 1 Framco motor with gear box
- 1 manual reversing & on/off switch
- 1 push to start switch
- 2 limit stop switches
- 1 circuit diag. of connections

£19.50 plus postage £2.50

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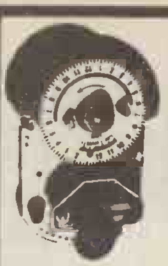
Established 30 YEARS

PRICES: All prices include VAT.

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £12 add 60p service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted day or night. Haywards Heath (0444) 454563. Bulk orders: phone for quote. Shop open 9.00 – 5.30, Mon to Fri, not Saturday.



VENNER TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only £2.95. without case, metal case - £2.95, adaptor kit to convert this into a normal 24hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is £2.30. Ex-Electricity Board. Guaranteed 12 months.

EXTRACTOR FANS – MAINS OPERATED

Woods extractor.
5" – £5.75, Post £1.25.
6" – £6.95, Post £1.25.
5" Plannair extractor £6.50. Post £1.25.
4"x4" Muffin 115v. £4.50. 230v. £5.75. Post 75p.
All the above ex-computer, those below are unused.
4" x 4" £8.50. Post 75p.
9" American made £11.50. post £2.00.
Tangential Blower 10x3 air outlet, dual speed £4.60. Post £1.50.

TANGENTIAL BLOW HEATER

by British Solartron, as used in best blow heaters. 3Kw £6.95 complete with 'cold' 'half' and 'full' heat switch, safety cut out and connection diagram.

Please add post £1.50 for 1 or 3 for £20 post paid

2.5 Kw KIT Still available: £4.95 + £1.50 post. or have 3 for £16 post paid

ROCKER SWITCHES Standard size fit 11.5 x 28 mm cut out. Single pole on/off – 15p each 1000 for £75. Single pole changeover 20p each – 1000 for £100. Single pole changeover with centre off – 25p each – 1000 for £125. Single pole on/off with neon – 36p – 1000 for £180.

ROCKER SWITCH DP/DT 15 amp 250 volts suitable for motor reversing etc. – 46p – 100 for £34.50, 1000 for £230.

MICRO SWITCHES V3 type all 250 10 amp SpST 20p 1000 – £100 Spdt 30p 1000 – £150, very low tongue Spdt 40p 1000 for £200.

EX-G.P.O. TELEPHONES

Black heavy type	£5.50.
Lightweight 746 type	£7.50.
Ex-G.P.O. plug	£1.00.
Ex-G.P.O. socket	£1.00.

WALL MOUNTING ROOM THERMOSTAT

By Danfoss has a really pretty two tone grey case with circular white scale and dial. Setting temperature from 0 – 30 c – 13 amp 250v contacts. Price £4.60. – 10 for £40.

BLEEPERS 6 or 12v battery or transformer operated, ideal for using in alarm circuits but particularly suitable for car and motor cycle alarms. These give a loud shrill note. Price 69p. 1000 for £345. Jap made.

MINIATURE WAFER SWITCHES

2 pole, 2 way – 4 pole, 2 way – 3 pole, 3 way – 4 pole, 3 way – 2 pole, 4 way – 3 pole, 4 way – 2 pole, 6 way – 1 pole, 12 way.
All at 25p each or 10 for £2.00

12 volt MOTOR BY SMITHS

Made for use in cars, etc. these are very powerful and easily reversible. Size 3½" long by 3" dia. They have a good length of ¼" spindle – Price £3.45.
Ditto, but double ended £4.25.

MAINS MOTORS

We have very large stocks of motors from 2 watts to ¼ hp. Most at a price well below cost, let us know your requirements.

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder – a complete mains operated kit, case included.

£11.95 plus £2.00 post.

OTHER POPULAR PROJECTS

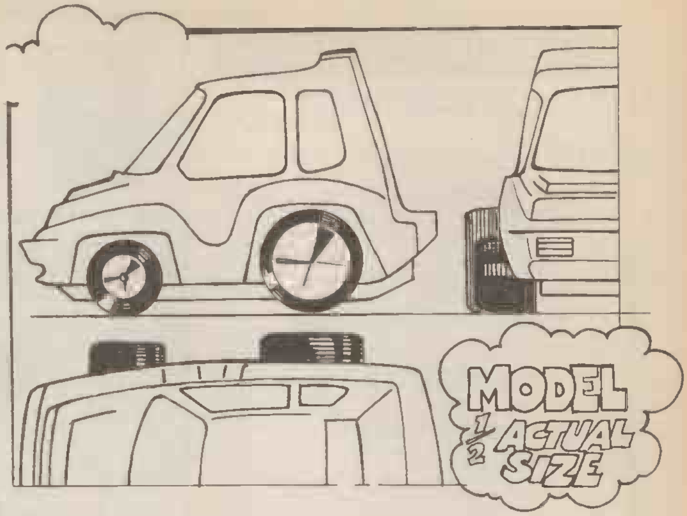
R C Bridge Kit	£9.95
3 Channel Sound to Light – with fully prepared metal case	£14.95
Big Ear, listen through walls	£9.50
Silent sentinel Ultra Sonic Transmitter and receiver	£9.50
Car Light 'left on' alarm	£3.50
Secret switch – fools friends and enemies alike	£1.95
3 – 30v Variable Power Supply	£13.80
2 Short & Medium wave Crystal Radio	£3.99
3v to 16v Mains Power Supply Kit	£1.95
Radio stethoscope – fault finding aid	£4.80
Mug stop – emits piercing squark	£2.50
Morse Trainer – complete with key	£2.99
Drill control kit	£3.95
Interrupted beam kit	£2.50
Transmitter surveillance kit	£2.30
Radio Mike	£6.90
F M receiver kit – for surveillance or normal F M	£3.50
Insulation Tester – electronic megger	£7.95
Battery shaver or fluorescent from 12v	£6.90
Matchbox Radio – receives Medium Wave	£2.95
40 watt amp – hifi 20hz – 20kHz	£9.50
115 Watt Amplifier 5Hz 25kHz	£13.50
Power supply for 115 watt amps	£8.50

FUNTRONICS WITH RADIO CONTROL

PART 2

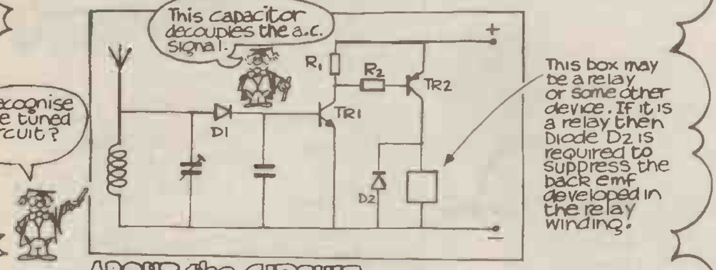
PART 2 (OF 3 PARTS) WILL LOOK AT THE RECEIVER (RX FOR SHORT)

COMPLETE COMPONENT LISTS WILL BE GIVEN IN PART 3



DIODE CARRIER RECEIVER

This circuit is ideal for getting into a R.C. model quickly. It's very simple & cheap but has a short range.

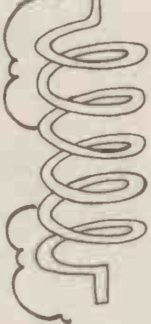


ABOUT the CIRCUIT

Normally (ie. without signal) TR1 doesn't conduct nor does TR2

SIGNAL ARRIVES. D1 provides positive bias for NPN transistor TR1. Collector current passes through R1 moving the base of the PNP transistor TR2 to negative thus allowing TR2 to pass current. R2 limits base current

INDUCTANCE



The simplest type of tuning coil is an OPEN winding of solid wire.

N = number of turns, L = Length, R = Radius

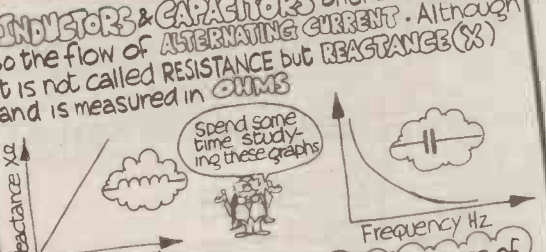
$$L\,(\text{inductance}) = \frac{R^2 \times N^2}{9R \times 10L}$$

The above formala will give L (inductance) but note there are 3 variables and you must assume 2 values to find the 3rd.

PROF

To FULLY understand the RECEIVER (...and Transmitter) we must give close examination to the INDUCTOR & CAPACITOR. Let's have a look at the INDUCTOR & CAPACITOR together...

INDUCTORS & CAPACITORS offer a resistance to the flow of ALTERNATING CURRENT. Although it is not called RESISTANCE but REACTANCE (X) and is measured in OHMS



The reactance of an inductor INCREASES with frequency

The formula for this property is...

$X_L = 2\pi f L$

L is inductance in HENRIES

f is frequency in Hz

The reactance of a capacitor DECREASES with frequency

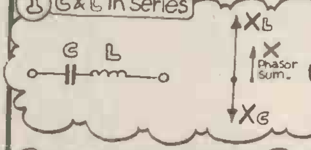
The formula for this property is...

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

C is Capacitance in FARADS

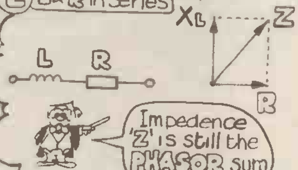
It may be clear by now that INDUCTIVE & CAPACITIVE reactance are in ANTI-PHASE i.e. they have a phase difference of 180°. Let's have a look at how we arrive at the PHASOR sum of inductance capacitance... and resistance before looking at the tuned circuit.

1 C & L in series



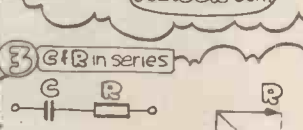
If $X_L = 80\Omega$
$X_C = 20\Omega$
then $X = X_L - X_C$
$= 80 - 20$
$X = 60\Omega$ (inductive)

2 L & R in series

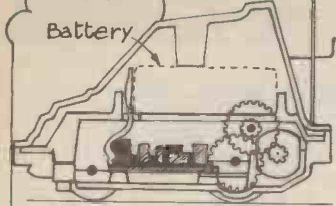


Here we must introduce IMPEDANCE (Z). Impedence is simply the TOTAL opposition to A.C. i.e. INDUCTIVE, CAPACITIVE & RESISTIVE. By applying Pythagoras we see that $Z = \sqrt{(X_L^2 + R^2)}$

3 C & R in series

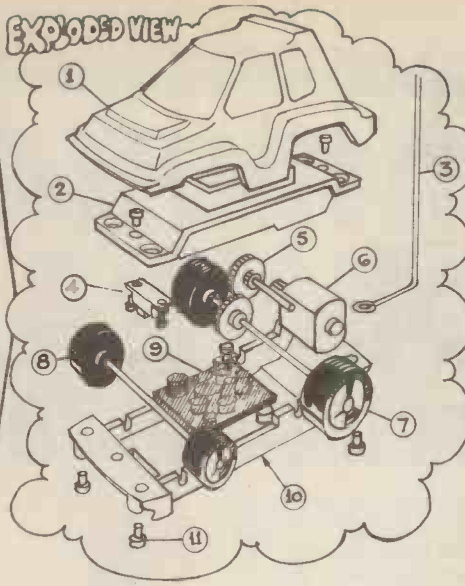


And of course when a capacitor is in series with a resistor we have $Z = \sqrt{(X_C^2 + R^2)}$



1. Body
2. Battery house
3. Aerial
4. Switch
5. Intermediate gear (mounted in item 2)
6. motor
7. Rear wheels with gear
8. front wheels
9. Circuit
10. Base
11. Screws

EXPLODED VIEW



BRAINBUSTER LINK-UP

Link-up the letters to form a chain of words related to electronics.

		L	E	C	T	R			
		E	H	P	A	O			
		L	O	G	R	D	Y		
		A	E	L	T	R	N		
		H	P	E	C	O	A		
T	C	■	E	C	N	E	M		
R	E	R	E	T	E	M	O		
O	L	E	P	H	E	S			
C	A	T	A	O	R	I	S		

Start at E and find only 3 words.

CLUE

1st word ...brain voltages...

2nd word ...produce a square law deflection...

3rd word ...ions through membrane.

COLOUR CHANNELS

This is where the super-het receiver must be used. A coloured strip flying from the transmitter clearly indicates Tx & Rx frequency so avoiding interference with other transmitters. The Superhet is used because both Tx & Rx crystals must be changed.

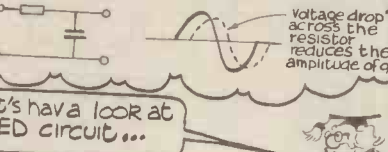
Colour	Tx	Rx
Black	26·970	26·515
Brown	26·995	26·540
Red	27·045	26·590
Orange	27·095	26·640
Yellow	27·145	26·690
Green	27·195	26·740
Blue	27·245	26·790
White	27·275	26·820

IF = 455KHz

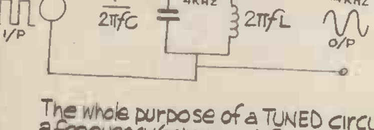
by Thakery

Solutions on page 290

Let's see what happens to an output when taken across the inductor and Capacitor in the RC & RL circuits

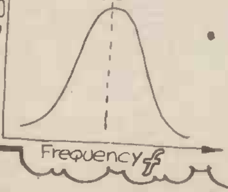


NOW, let's hava look at the TUNED circuit...



The whole purpose of a TUNED circuit is to select a frequency (or harmonic) from the input.

This occurs at the RESONANT frequency (f_o) or when...



$$\frac{1}{2\pi fC} = 2\pi fL$$

$$(2\pi f)^2 LC = 1$$

$$(2\pi f)^2 = \frac{1}{LC}$$

$$2\pi f = \frac{1}{\sqrt{LC}}$$

$$\therefore f_o = \frac{1}{2\pi\sqrt{LC}}$$

This formula will give the frequency at which the circuit will resonate

RECEIVERS Rx

1 the SUPERHET (crystal controlled)

This Reciever is popular because of its STABILITY & SENSITIVITY. It responds extremely well to the intended signal so that more than one model can be operated simultaneously and it is not TOUCHY with regard to POSITION & LENGTH of AERIAL. SUPERHET is short for SUPERHETERODYNE. The incoming signal is MIXED with a locally generated signal to produce an INTERMEDIATE frequency which is then AMPLIFIED and then DEMODULATED

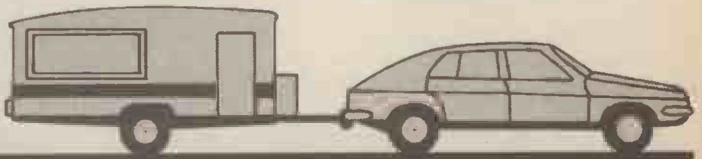
2 the SUPER REGENERATIVE

This is a much easier reciever to build than the Superhet. The single regenerative DETECTOR replaces the MIXER, OSCILLATOR, INTERMEDIATE FREQUENCY Amplifier and DETECTOR of the Superhet. Of course it has certain disadvantages. It lacks the CRYSTAL controlled stability of the Superhet oscillator is sensitive to aerial length, is relatively unselective and so can respond to other transmitters.

3 the DIODE CARRIER RECEIVER

Now this is a very simple type and operates from the UNMODULATED carrier. We'll be looking at this type for the Receiver and Transmitter...

CARAVAN INDICATOR CONTROL



T.R.de Vaux Balbirnie

WIRING the 7-pin socket for a caravan electrical system is a straightforward job. As many have found to their cost, however, it is unwise to connect the additional flashing indicator lights direct to the car system. At the very least this will cause a change in operating speed. At worst, the flasher unit will overheat and fail.

ALTERNATIVE

The usual solution is to use a "heavy duty" flasher unit to replace the standard one. Alternatively, a *relay* may be used to relieve the existing unit of the extra load.

This project is a type of relay but without moving parts—the switching action is performed by *transistors*. If carefully constructed, it should give indefinite service. The Caravan Indicator Control meets UK Vehicle Lighting Regulations and, as described, is suitable for all trailers towed by negative-earth cars. By using alternative transistors it may be made for use with positive-earth vehicles.

LAMP FAILURE

An important feature of this circuit is that a warning is given if a caravan indicator bulb fails as soon as this happens. Normally, a dashboard indicator light remains *off* until a turn is signalled—it then flashes in sympathy with the existing warning light. Should a filament fail, however, the new indicator will light immediately and glow continuously. If a spare bulb is carried, then the fault may be corrected before causing danger to other road users. Faulty wiring or poor earth connections will cause the warning light to flash intermittently.

HAZARD OPERATION

If the towing vehicle has a "hazard" system whereby all four flashing indicators can be switched on together, the Caravan Indicator Control will operate both additional lights and all six will flash together. Although the dashboard indicator lamp will not operate under these conditions the existing hazard warning light gives a reminder that the system is switched on.

CIRCUIT DESCRIPTION

The entire circuit for the Caravan Indicator Control is shown in Fig. 1. TR1 and TR3 drive power transistors TR2 and TR4 which have the caravan flashing indicator lamps, LP1 and LP2, connected in their emitter circuits. TR1 and TR2 are used for left turn signals while TR3 and TR4 are used for right ones. The appropriate transistors turn on when a small base current flows from the existing car system through R1 or R2 as appropriate. This current is so low as to have negligible effect on the flasher unit.

The rest of the circuit consisting of TR5, TR6 and associated components form a type of Exclusive-OR gate. There were problems with early circuits using integrated circuit gates and the present design is better suited to the "noisy" conditions of the car charging system. The gate is used to monitor voltage levels at the points A and B. In the following description, a voltage near to +12V is referred to as High, while near-zero voltage is called Low.

If either two Highs or two Lows are applied to the inputs of the gate (points A and B) then the warning indicator, LP3, will remain *off*. With one High and one Low input, it will switch *on*. When driving without the caravan, both inputs will be High (since they are connected to the battery positive through R3 and R4) and LP3 will be *off*. When a caravan is being towed, the low-resistance filaments of LP1 and LP2 keep both inputs Low so, again, LP3 will be *off*. When a left turn is signalled point A will pulse between High and Low states while point B remains Low so LP3 will flash. For right turns a similar situation arises with Point B pulsing between the two states and point A remaining Low.

If either LP1 or LP2 should fail, then the appropriate point A or B will go High, causing LP3 to glow continuously. In "hazard" operation, both inputs pulse between High and Low states together so LP3 will remain *off*. Faulty indicator lamp connections will cause intermittent flashing of LP3.

GATE

The gate works in the following way. Consider a left-hand turn signal—point A keeps pulsing High and turning on TR6. Current then flows through R7, LP3 and TR6. If a right turn is signalled current will flow through R8, LP3 and TR5. If TR5 and TR6 are both on or off together, then both terminals of LP3 will be at the same voltage and it will remain *off*.

Since LP3 derives current through R7 or R8, these components will become warm and must be adequately rated. Moreover, there will be 6V approximately "dropped" across the working resistor so LP3 must be a 6V lamp of the correct current rating (see components list). With

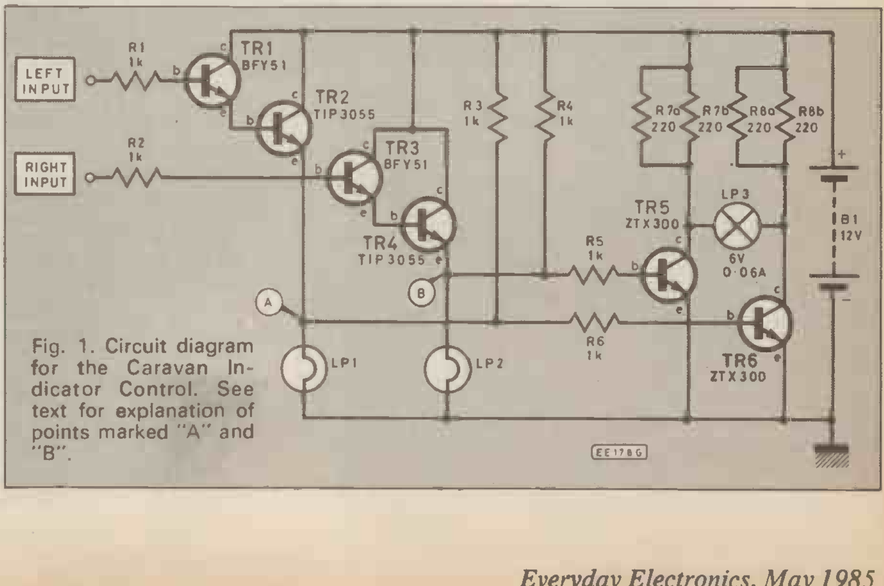


Fig. 1. Circuit diagram for the Caravan Indicator Control. See text for explanation of points marked "A" and "B".

the ignition switched *on* and no caravan in tow, both TR5 and TR6 will be *on* and current will flow through R7 and R8 continuously. The only consequence of this is that the case becomes slightly warm after a period of time.

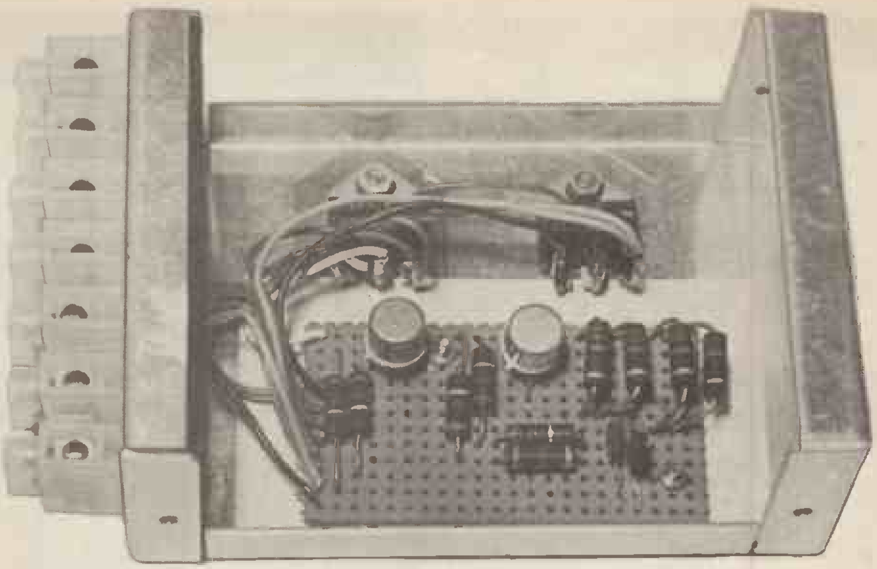
CONSTRUCTION

Note: an *aluminium* case must be used for this project—not a plastic one. Refer to Fig. 2 and construct the circuit panel using a piece of 0·1in. matrix stripboard size 12 strips by 22 holes. Drill the two fixing holes, make the breaks in the copper strips in the positions shown and follow by soldering the on-board components as indicated.

In the prototype, R7 and R8 each consisted of two off 220 ohm $\frac{1}{2}$W resistors connected in parallel. Alternatively, single 100 ohm 1W components could be used. Whichever method is employed, the resistors must be mounted well clear of the circuit panel and spaced away from one another to allow a free flow of air. When complete, the panel should be examined carefully for wiring errors and for accidental "bridging" between adjacent copper tracks. Solder connecting wires to strips A, D, E, F, G, H, I, J, K and L.

Refer to the photograph and prepare the case to accept the panel. Drill a hole next to the terminal block position and fit a rubber grommet. This is to carry the wires passing through from the inside. Drill mounting holes to correspond with those already drilled in the panel. Secure the panel and the offboard components noting that TR2 and TR4 require mounting kits so that they are *electrically isolated* from the case. A piece of thick cardboard should be placed between the underside of the panel and the case to provide insulation.

Make certain that there are no sharp protrusions which could penetrate the cardboard and cause short circuits. Check that R3 cannot short circuit to the upper panel fixing. In the prototype, the earth (battery negative) connection was made by means of a "flying lead". Alternatively, an extra terminal on the block connector could be used.



POSITIVE EARTH

Although a positive-earth prototype was not tested, there should be no problems if the alternative pnp transistors are used (see components list).

INSTALLATION

Find a suitable place for the completed project. Behind a trim panel in the rear of the car is a good choice. Refer to Fig, 2 and make the terminal block connections. Begin by wiring the dashboard indicator light connections to terminals 6 and 7

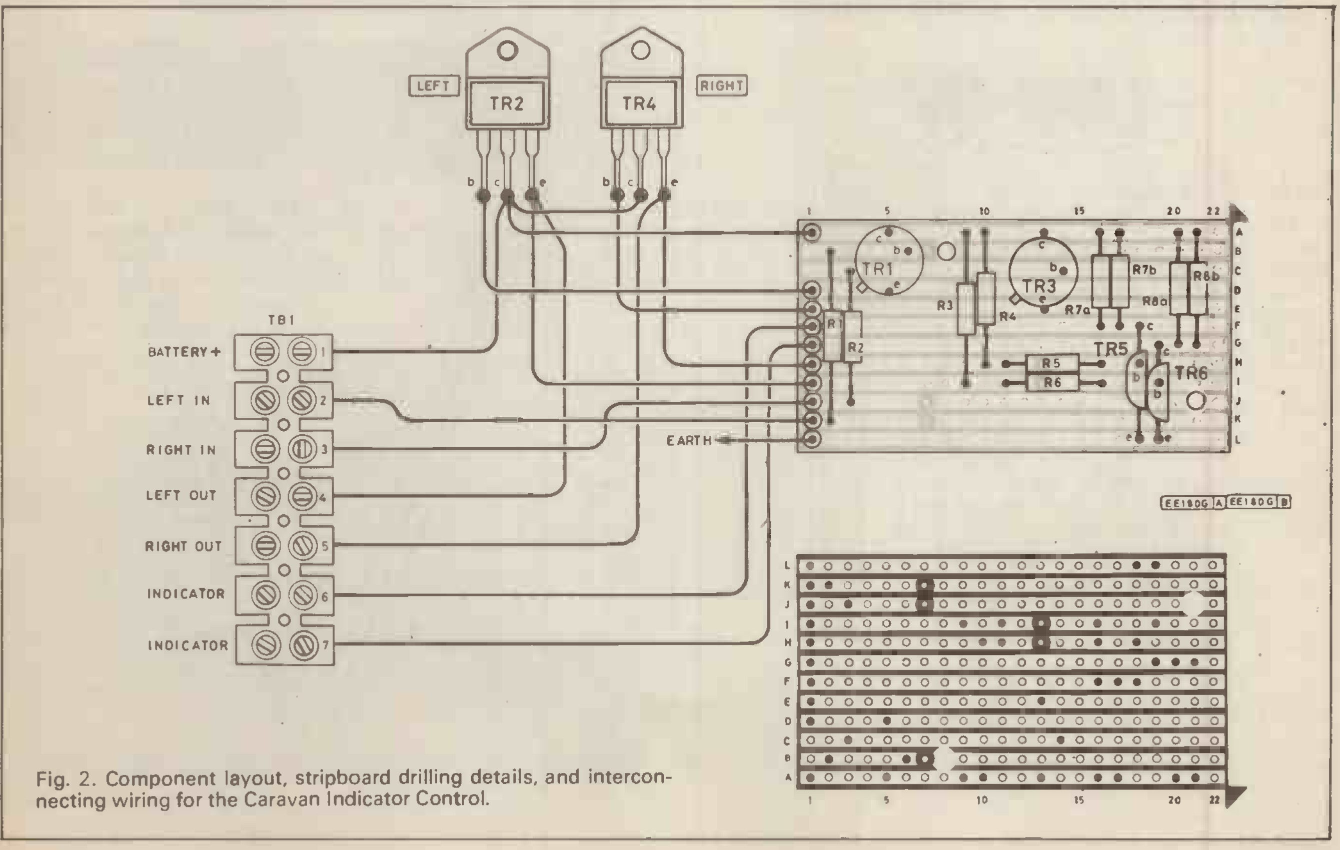


Fig. 2. Component layout, stripboard drilling details, and interconnecting wiring for the Caravan Indicator Control.

using light-duty twin wire—loudspeaker wire, for instance. Using stranded auto-type wire of 5A rating minimum connect terminals 4 and 5 respectively to the left and right-hand caravan flashing indicator circuits (pins 1 and 4 on the 7-pin socket). Connect terminals 2 and 3 respectively to the left and right-hand car direction indicator circuits using similar wire. Connectors are available from caravan accessory shops which enable this to be done without breaking the wires.

FUSE

Connect terminal 1 to a fuse which is live only when the ignition is switched on. Use a small 12-volt bulb with one terminal earthed to a metal part to find a suitable fuse. Make sure that the correct side of the fuse is used—check by removing it that the test lamp goes off. Connect the flying lead to an existing earth point or, if one cannot be found nearby, drill a small hole and use an eyelet secured with a self tapping screw.

TESTING

Connect the caravan plug to the 7-pin socket and switch the ignition on. Check that the direction indicators all work correctly with the dashboard light signalling the turns. Remove each caravan flashing indicator bulb in turn to simulate failure of the filaments—the dashboard indicator should now light continuously. Check "hazard" operation—note that the ignition must be switched on for the caravan lights to work. If all is well, the trim panel may be replaced and the unit forgotten. It should give years of reliable service, and the only time you should be aware of its presence is when the dashboard light signals a failed bulb. □

COMPONENTS

Resistors

R1–R6	1k ½W ±5% (6 off)
R7,R8	220 ½W (4 off) or 100 1W (2 off). See text.

See Shop Talk page 256

Semiconductors

TR1,TR3	BFY51 *npn* silicon (2 off)
TR2,TR4	TIP3055 *npn* silicon (2 off)
TR5,TR6	ZTX300 *npn* silicon (2 off)

NOTE: for positive-earth cars the following alternative transistors should be used.

TR1,TR3	BC461 *pnp* silicon (2 off)
TR2,TR4	TIP2955 *pnp* silicon (2 off)
TR5,TR6	ZTX500 *pnp* silicon (2 off)

Miscellaneous

AB9 aluminium box size 102 × 70 × 38mm.
0·1in. matrix stripboard size 12 strips by 22 holes.
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LIGHT PIPE

For use in those inaccessible corners, **AEG-Telefunken (UK)** have introduced a range of specially constructed l.e.d.s utilising a flexible optical guide to transmit light for distances up to 2 metres.

The "light pipe", which they claim offers the designer much more flexibility when designing equipment layouts, may be positioned on a printed circuit board and used to provide a visual front panel indication to a remote part of the equipment.

Available in standard 0·5, 1·0, 1·5 and 2·0 metre lengths, the light pipe may be cut and polished at any point in its length to suit the required application. The l.e.d. colours available include red, yellow and green.

The flexible transmission guide may also be fitted to a photosensitive detector to form one half of a matched pair for high voltage isolation applications. This would be ideal for many control and automation operations, including optical card/tape readers, counting and lighting control.

Further details may be obtained from:

AEG-Telefunken (UK) Ltd., Dept EE, 217 Bath Road, Slough, Berks SL1 4AW.

PRINTER INTERFACE

The latest addition to the range of Eprom based Copy routines from **Euroelectronics** is the ZXLPrint 111 printer interface for the Spectrum computer.

Full colour screen dumps can be carried out on Epson JX80 and Seikosha GP700 printers while four colour screen dumps for CGP115 and MCP40 are available as an option.

The ZXLPrint interface costs £34.95 and a cable—either Centronics or RS232—is available for the sum of £9.95. For further details and information on range of computer add-ons contact:

Euroelectronics, Dept EE, 26 Clarence Square, Cheltenham, Glos. GL50 2JP.

GOOD RECEPTION

The release of a new TV aerial for mobile or static use, the subject of a provisional patent application, is announced by **Maxview Aerials**. Known as the Omnimax, it is claimed to take account of the fact that vehicles on the move will change their position relative to the siting of the transmitter, thus, in some cases, affecting the reception.

As its title implies, the aerial is claimed to overcome the directional problems by providing 360 degrees coverage. This is achieved by the use of a 12/24V d.c. High Gain Amplifier (22dB) and a novel "array" arrangement.

Another feature is that it is "tuned" to cover the whole of the international u.h.f. television spectrum from 470 to 860MHz, channels 21 to 69. This makes it ideal for installing in sea craft, caravanettes and caravans when touring.

Designed for use on land or water vehicles, the Omnimax aerial sells, complete with amplifier, for the sum of £39.50 including VAT and comes complete with five metres of low-loss coaxial cable fitted with standard TV plugs at both ends. Two versions are available, for horizontal surface fixing or mast top fixing.

Further information may be obtained from:

Maxview Aerials Ltd., Dept EE, Maxview Works, Setchley, King's Lynn, Norfolk, PE33 0AT.

SHURE SOUND

At a time when there seems no end to the effects of the US dollar, it makes a welcome change to report that the world famous American **Shure** audio equipment specialists have launched a new product that slots at the lower price end of the market.

An ideal choice for the beginner whose budget cannot stretch to the headier heights of most Shure microphones, the new Shure Prologue line is an excellent "starter" mic for vocalists, musicians or audio/video hobbyists.

There are three models, all available in high or low impedance versions and retail prices including VAT start at under £25. Each model is manufactured in diecast metal and features an on/off switch, XLR connector and is furnished with a swivel adaptor.

Further details and prices for the Shure Prologue range may be obtained from:

HW International, Dept EE, Efen Grove, London, N7 8EQ.

PRINTED CIRCUIT BOARD SERVICE

Printed circuit boards for certain EE constructional projects are now available from the EE PCB Service, see list. These are fabricated in glass-fibre, and are fully drilled and roller tinned. All prices include VAT and postage and packing. Add £1 per board for overseas air-mail. Remittances should be sent to: EE PCB Service, Everyday Electronics Editorial Offices, Westover House, West Quay Road, Poole, Dorset BH15 1JG. Cheques should be crossed and made payable to IPC Magazines Ltd.

Please note that when ordering it is important to give project title as well as order code. Please print name and address in Block Caps. Do not send any other correspondence with your order.

Readers are advised to check with prices appearing in the current issue before ordering.

NOTE: Please allow 28 days for delivery. We can only supply boards listed here.

PROJECT TITLE	Order Code	Cost
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User Port Input/Output *M.I.T. Part 1*	8307-01	£4.82
User Port Control *M.I.T. Part 1*	8307-02	£5.17
— AUGUST '83 —		
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Car Intruder Alarm	8308-02	£5.15
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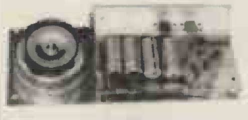

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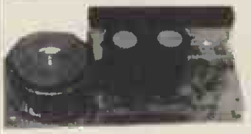

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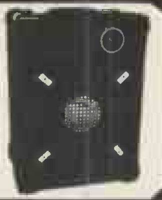

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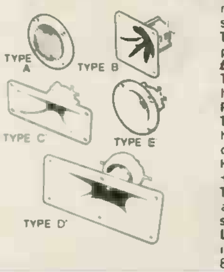

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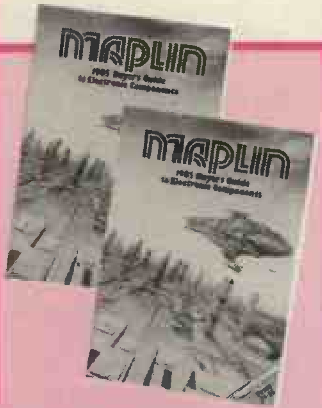

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