PRACTICAL
ELECTRONICS

Australia $1.35 New Zealand $1.60 Malaysia $4.95 IR £1.14 (inc. VAT)

AUGUST 1982

75p

Comprehensive HOME ALARM SYSTEM

* Infra-Red
* Radar
* Ultrasonic

ALSO INSIDE...

Combo AMPLIFIER

PRACTICAL
ELECTRONICS
VOLUME 18 No. 8 AUGUST 1982

CONSTRUCTIONAL PROJECTS

GENERAL FEATURES

NEWS AND COMMENT

OUR SEPTEMBER ISSUE WILL BE ON SALE FRIDAY, AUGUST 13th, 1982
(for details of contents see page 40)

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

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CR033	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

Noise Diode
Z5J 195

SCR's Thyristors

0.8A-100V	32
1A/100V	60
5A/300V	38
5A/400V	40
5A/600V	48
8A/300V	60
8A/600V	95
12A/100V	78
12A/400V	95
12A/800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

DIAC
ST2 25

BRIDGE RECTIFIERS
(plastic case)

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

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

VARICAPS

MVAM2	165
BA102	30
BB105B	40
BB106	40

TRIACS

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

SOLDERCON PINS
100 70p
500 325p

OPTO ELECTRONICS

LEDS including Clips	
TIL209 Red 3mm	11
TIL211 Green 3mm	14
TIL212 Yellow	14
TIL220 .2" Red	12
0.2" Yel, Grn, Amber	14
Rectangular LEDs with two part clip. R, G & Y	29
Rectangl. Stackable LEDS	18
Triangular LEDs R&G	18
0.2" Flashing LED Red	55
0.2" Bicolour LEDs Red/Green	65
Green/Yellow	80
0.2" Tricolour LEDs Red/Green/Yellow	85
0.2" Red High Bright	59
LD271 Infra Red (emit)	46
TIL32 Infra Red (emit)	52
SFH205 (detector)	118
TIL78 (detector)	54
TIL38	45
TIL81	82
TIL100	90
7 Segment Displays	
TIL321 .5" C.An	115
TIL322 .5" C.th	115
DL704 .3" C.Cth	99
DL707 .3" C.Anod	99
DL747 .6" C.Cathod.	180
.8" Orange C.A.	250
FND357 or 500	120
.3" Green C.A.	140
±1.3" Red or Green	150
Bargraph 10 seg. Red	225
Bargraph NSM3916	520

0.5" LIQUID CRYSTAL DISPLAYS

3½ digit	525
4 digit	650
6 digit	750

BPX25	195
IL74	45
ILD74	99
ILQ74	185
TIL111	75
TIL117	90
OCP71	120
ORP12	78
ORP61	85
2N5777	45
4N33	135

OPTO SWITCH
Reflective TIL139 170
Slotted similar to RS 186

ALUM. BOXES

3x2x1"	65
4x2¼x2"	85
4x2¾x2½"	103
4x4x2½"	120
5x4x2	105
5x2½x1½"	90
5x2½x2½"	130
5x4x1½"	99
5x4x2½"	120
6x4x2"	120
6x4x3"	150
7x5x3"	180
8x6x3"	210
10x4½x3"	240
10x7x3"	275
12x5x3"	260
12x8x3"	295

FERRIC CHLORIDE
1 lb bag Anhydrous
195p + 50p p&p

DALO ETCH RESIST
Pen + Spare tip 90p

COPPER CLAD BOARDS

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

VEROBOARDS 0.1"

	Clad	Plain
2½x3¾"	73p	52p
2½x5"	83p	—
3¾x3¾"	83p	—
3¾x5"	95p	79p
3¾x17"	325p	211p
4¾x18"	425p	—
Pkt. of 100 pins	50p	
Spot Face Cutter	118p	
Pin Insertion Tool	162p	

'VQ' Board	150
'DIP' Board	330
Vero Strip	144
S100 Board	£14

PROTO-DECs

Veroblock	375
S-Dec	350
Eurobreadboard	520
Bimboard 1	695
Superstrip SS2	£13

VERO WIRING PEN and Spool 310p
Spare Wire (Spool) 75p; Combs 6p ea.
Wire Wrapping Stakes 100 250p

SPECIAL OFFER

	1+	25+
NE555	16p	14p
2114L-3	80p	75p
2114L-2	80p	75p
2532	365p	335p
2716	215p	205p
2732	380p	355p
4116	70p	65p
4816-120ns	225p	205p
6116-150ns	390p	370p
6520/21	115p	105p
6522	320p	295p

EPSON PRINTERS
- **MX80T** 10" Tractor Feed, 9x9 matrix, 80 column, 80 CPS, Bi-directional, Centronic Interface. Baud Rate 110-9600. **£275**
- **MX80FT** Friction & Tractor Feed plus all the MX80T features **£325**
- **MX80FT/3** Has hi-resolution, bit image graphics, Subscript & Superscript, italics & underlining facility plus all the MX80FT features **£339**
- **MX100** 15½" Fr.&Tr. **£489**

ANTEX Soldering Irons

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

Buy with Access
Just phone your order through, we do the rest.

GAS & SMOKE DETECTORS
TGS812 & 813 575
Sockets 40

ULTRASONIC TRANSDUCERS
40KHz Transmitter & Receiver 325p/pair

DIL SOCKETS (TEXAS)

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

ZIF DIL SOCKET

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

DIL PLUGS (Headers)

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

RIBBON CABLE (price per foot)

Ways	Grey	Color
10	12p	22p
16	25p	40p
20	25p	40p
26	35p	52p
34	48p	60p
40	55p	70p
60	75p	115p

WATFORD'S Ultimate Monitor IC.
WE MON

A 4K Monitor Chip specially designed to produce the best from your: Superboard Series I & II, Enhanced Superboard & UK101. As reviewed by Dr. A. A. Berk In Practical Electronics, June 1981.
Price only £15.00 + 50p P&P.

IDC CONNECTORS (Speed block type)

	PCB PLUG with latch Strt. Pins	Angle Pins	Female Header Socket	PCB Pins Male Strt	Male Angle
2 x 5 way	90p	99p	85p	60p	65p
2 x 8 way	130p	150p	110p	70p	78p
2 x 10 way	145p	166p	125p	80p	92p
2 x 13 way	175p	200p	150p	95p	110p
2 x 17 way	205p	236p	169p	110p	135p
2 x 20 way	220p	250p	190p	125p	150p
2 x 25 way	235p	270p	200p	150p	175p

EURO CONNECTORS

	SOCKETS Strt.	Angle	PLUGS Strt.	Angle
DIN 41618	180p	—	—	185p
DIN 41612 2x32 way	340p	345p	295p	325p
DIN 41612 2-3x32 way	350p	385p	300p	350p
DIN 41612 3x32 way	420p	425p	320p	400p

'D' CONNECTORS: Miniature

Pins	9 way	15 way	25 way	37 way
PLUGS				
Solder	80p	110p	160p	240p
Angle	150p	210p	250p	355p
Strait	170p	160p	220p	310p
SOCKETS				
Solder	105p	160p	200p	338p
Angle	165p	215p	290p	440p
Strait	175p	200p	300p	420p
COVERS	95p	90p	100p	110p

TRANSFORMERS (mains Prim. 220-240V)
6-0-6V 100mA; 9-0-9V 75mA; 12-0-12V 75mA; 15-0-15V 75mA 98p
6VA: 2x6V-.5A; 2x9V-.4A; 2x12V-0.3A; 2x15V-.25A 220p
12VA: 2x4V5-1.3A; 2x6V-1.2A; 2x12V-.5A; 2x15V-.4A 295p
24VA: 6V-1.5A 6V-1.5A; 9V-1.2A 9V-1.2A; 12V-1A 12V-1A; 15-.8A 15-.8A; 20V-.6A 20V-.6A 330p (44p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-2A; 2x30V-0.8A 465p (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x30V-1.5A; 2x40V-1.25A; 2x50V-1A 920p (60p p&p)

Amphenol Plugs
24 way IEEE 575p
36 way Centonics Parallel 550p

EDGE CONNECTORS Two rows

	.1	.156
2x10 way	—	135p
2x15 way	—	140p
2x18 way	180p	145p
2x22 way	199p	200p
2x23 way	210p	—
2x25 way	225p	220p
2x30 way	245p	—
2x36 way	295p	—
2x40 way	315p	—
2x43 way	395p	—
2x75 way	550p	—

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

Length	14pin	16pin	24pin	40pin
24"	145p	165p	240p	380p
Double Ended Leads				
6"	185p	205p	300p	465p
12"	198p	215p	315p	490p
24"	210p	235p	345p	540p
36"	230p	250p	375p	595p

ID HEADER SOCKET Jumper Leads 24"

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

COMPUTER CORNER

- **VIC 20 MICROCOMPUTER.** Connects directly to a colour TV. 5K RAM expandable to 32K PET type graphics. **£165**
- **CASSETTE DECK** for VIC20 including a free 6 programme Cassette. **£39**
- **EPSON MX** Series Printers. Full range available. See box above for details.
- **SEIKOSHA GP100A** – Unihammer Printer, gives normal and double width characters as well as dot resolution graphics 10" Tractor feed. Parallel Interface standard. **£185**
- **SOFTY-2.** The complete microprocessor development system for Engineers & Beginners. New powerful instruction. Accepts any 24 pin 5V single rail EPROM. Supplied fully built, tested & enclosed in a black ABS case. Price including plug-in PSU & Watford's extended warranty. **£169**
- **VIDEO MONITOR** 9" fully cased. B&W. Fully guaranteed. 15MHz bandwidth value for money. **£75**
- **TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 min. **£33**
- **TEX EPROM ERASER** with the Solid-State 30 minute Electronic Timer. **£43**
- **Spare** 'UV lamp bulbs **£9**
- **5V/5A PSU** Ready built and tested **£25**
- Attractive Beige/Brown **ABS CASE** for Superboard/UK101 or Home Brew **£29**
- **Space Invaders** for Superboard **£6**
- **Full ASC11 coded keyboard type '756'** **£39**
- **4 x 4 matrix keypad** (reed switch assembly) **£4**
- **C12 COMPUTER Cassettes** in Library Cases **40p**
- **STACK-PACK** Drawers rack including 10 x C12 Computer grade Cassettes. **550p**
- **8½" Fan fold paper** (500 sheets) (no VAT) **£5**
- **9½" Fan fold paper** (500 sheets) (no VAT) **£5**
- **Teleprinter Roll** (no VAT) **£3.50**

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

VOLTAGE REGULATORS

1A	T03 +ve		−ve	
5V	7805	145p	7905	220p
12V	7812	145p	7912	220p
15V	7815	145p	7915	220p
18V	7818	150p		—
1A	**T0220 Plastic Casing**			
5V	7805	40p	7905	45p
12V	7812	40p	7912	45p
15V	7815	40p	7915	45p
18V	7818	40p	7918	45p
24V	7824	40p		
100mA	**T092 Plastic Casing**			
5V	78L05	30p	79L05	60p
6V	78L62	30p		—
8V	78L82	30p		—
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H	170	LM305H	140
LM304H	160	LM309K	135
78H05 5V/5A	550	LM317K	350
78H12 12V/5A	580	LM317P	99
78HG+5 to +24V 5A	599	LM323K	500
79HG −2.25V to −24V 5A	785	LM337T	175
		LM723	35
		T8A625B	75

SWITCHES

SLIDE 250V

1A DPDT	14
1A DPDT C/OFF	15
½A DP on/on/on	40
4 pole c/over	240

TOGGLE 2A 250V

SPST	33
DPDT	44
4 pole on off	54

PUSH BUTTON Spring loaded

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

SUB-MIN TOGGLE

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

MINIATURE Non Locking

Push to make	15p
Push break	25p

ROCKER: 5A, 250V, SPST 28p
ROCKER: (white) 10A 250V SPDT 38p
ROCKER: With neon lights red when on. 10A 250V, DPST 85p
ROCKER: (White) 10A/250V DPDT 72p
ROTARY: Make your own Multiway Switch. Shafting Assembly accommodates up to 6 wafers. 90p
Break before make Wafers. Silver contacts. 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6 pole/2 way 65p
Mains DPST Switch to fit 45p
Screen & Spacers 8p
ROTARY: (Adjustable Stop Type) 1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way 45p
ROTARY: Mains 250V AC, 4 Amp 56p
DIL SWITCHES: (SPST) 4 way 65p; 6 way 80p; 8 way 87p; 10 way 135p; (SPDT) 4 way 190p.

CRYSTALS

32 768KHz	100
100KHz	350
200KHz	295
455KHz	370
1MHz	295
1.008M	275
1 28MHz	392
1 6MHz	395
1 8MHz	395
1.8432M	200
2.0MHz	225
2.4576M	220
3 2768M	150
3.57954M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.80MHz	200
4.194304M	200
4 433619M	120
5.0MHz	160
5.185MHz	300
5 24288M	390
6.0MHz	140
6.144MHz	225
6 5536MHz	200
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8 08333M	395
8.867237M	175
9.00MHz	200
9.375MHz	350
10.0MHz	175
10 7MHz	150
10.24MHz	200
12.0MHz	290
12.528MHz	300
14.31818M	170
16.0MHz	250
18.0MHz	180
18.432M	150
19.968MHz	150
20.0MHz	325
24.0MHz	170
24.930MHz	325
26.69M	150
26 670MHz	325
27.125MHz	295
27.648M	330
27.145M	190
38.66667M	175
48.0MHz	175
100.0MHz	375
116.0MHz	300

ASTEC UHF Modulators
6MHz 280
8MHz Wide-bandwidth 425

ZX81 16K RAM PACK
Watford's 16K RAM pack for ZX81: Fully built and tested. Plugs straight on to your ZX81.
Only £17.35 (50p p&p)

BBC MICRO & UPGRADE
BBC Microcomputer Model B
£399 incl. VAT + P&P
Upgrade your BBC Micro with our upgrade and save yourself £ s s s...

- 16K MEMORY (8x4186AP) BBC1 **£18.00**
- Printer User I/O Port BBC2 **£8.20**
- SK10 with 36" Cable **£2.00**
- Complete Printer Cable 36" **£13.00**
- SK9 with 36" Cable **£3.00**
- Disc Interface Kit BBC3 **£41.00**
- Analogue I/O Kit BBC4 **£6.75**
- Serial I/O Kit BBC5 **£7.50**
- Expansion Bus Kit BBC6 **£6.50**
- SK11 with Cable 36" **£3.00**
- SK12 with Cable 36" **£3.75**
- 5 pin DIN Socket **£0.40**

FLOPPY DISC DRIVERS
- TEAC Single FD-50A uncased **£135**
- TEAC Single FD-50A cased with PSU **£180**
- TEAC Twin FD-50A cased with PSU **£335**
- TEAC Single FD-50E 80 track cased with PSU **£238**
- SIEMENS FDD 100-5 Cased, Head, Motors, track zero micro switch & motor control PCB with read, write & control electronics plus cable **£215**
- Apple II Interface Card for above avail.

WATFORD ELECTRONICS
Tel. (0923) 40588 Telex. 8956095

THE MULTI-PURPOSE TIMER HAS ARRIVED

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

FEATURES INCLUDE:-

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

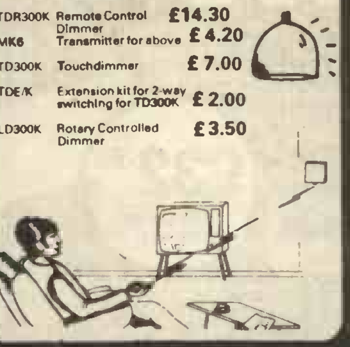
(Kit includes all components, PCB, assembly and programming instructions).

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

HOME LIGHTING KITS

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

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



MINI KITS

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

MK2 Solid State Relay
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac £2.60

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10 element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. £4.50

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

MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 mins. to 35 hrs. Longer or shorter periods may be realised by minor component changes. Max. load 1KW. £4.50

3-NOTE DOOR CHIME

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

For a detailed booklet on remote control – send us 30p & SAE today.

THE HOME CONTROL CENTRE

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

Order as XK112

£42.00

DISCO LIGHTING KITS

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

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

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

"OPEN-SESAME"

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

Only £23.75

Extra Solid State Switch Kits (XK104) and transmitters (XK105) can be supplied.

XK104 £2.40 XK105 £10.50

DVM/ULTRA SENSITIVE THERMOMETER KIT

This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (−50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week. **£15.50**

ALL PRICES EXCLUDE VAT

REMOTE CONTROL KITS

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

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

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

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

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

MK12 16-CHANNEL IR RECEIVER
For use with MK8 kit with 16 on/off outputs, which was further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Latched or momentary outputs – please specify when ordering. Includes its own mains supply. £11.95

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

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

MK17 12V d.c. IR RECEIVER
For use with MK6 or MK16. Relay output with DP3 Amp change-over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 6-13V d.c. £9.50

MK18 HIGH POWER IR TRANSMITTER
Similar to MK8 but with range of approx. 60ft. £8.20

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

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

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

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Sec Volt 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30V or 12V-0-12V or 15V-0-15V.

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

50 VOLT RANGE (Split Sec) Pri 120/240V (2×25V tapped secs) Voltages available 5, 7, 8, 10, 13, 15, 17, 20, 33, 40 or 20V-0-20V or 25-0-25V

Ref.	Amps 50V	Amps 25V	P&P	Ref.
102	0.5	1	£4.13	£1.40
103	1	2	£5.03	£1.40
104	2	4	£8.69	£1.84
105	3	6	£10.36	£1.90
106	4	8	£14.10	£2.12
107	6	12	£18.01	£2.34
118	8	16	£24.52	£2.70
119	10	20	£30.23	O.A.
109	12	24	£36.18	O.A.

MAINS ISOLATORS
Pri 0-120; 0-100-120V (120, 220, 240V) Sec 0-CT-120V twice.

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

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

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

VA	Price	P&P	Ref.
20	£7.21	£1.25	56W
75	£9.35	£1.50	64W
150	£12.10	£1.84	4W
250	£14.73	£1.60	69W
500	£22.14	£2.24	67W
1000	£33.74	£2.80	84W
2000	£60.47	O.A	95W

AUTO TRANSFORMERS
Volts out: 105, 115, 190, 200, 210, 220, 230, 240, for step up or step down.

Ref.	VA (Watts)	Price	P&P
113*	15	£2.39	£1.20
64	80	£4.85	£1.40
4	150	£6.48	£1.60
67	500	£13.30	£2.24
84	1000	£22.70	£2.80
93	1500	£28.17	O.A
95	2000	£42.14	O.A.
73	3000	£71.64	O.A.
80	4000	£93.01	O.A.
57	5000	£108.30	O.A.

*0, 115, 220, 240.

96/48/36V RANGE
Pri 0-120/240V
Sec 2 windings 0-36-48V to give 36-0-36V or 48-0-48V or 96V.

Amps 72v/96v	Amps 36v/48v	Ref.	Price	P&P
1	2	431	£8.93	£1.64
2	4	432	£14.69	£1.60
3	6	433	£17.79	£2.40
4	8	434	£22.24	£2.40
5	10	435	£32.23	£2.40
6	12	436	£40.36	O.A.
8	16	437	£44.03	O.A.

60 VOLT RANGE (2×30V tapped secs)
Pri 120/240V. Voltages available 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 or 24V-0-24V or 30V-0-30V.

Ref.	Amps 60V	Amps 30V	Price	P&P
124	0.5	1	£4.70	£1.50
126	1	2	£7.15	£1.50
127	2	4	£9.20	£1.90
125	3	6	£13.31	£2.02
123	4	8	£15.15	£2.26
40	5	10	£19.16	£2.24
120	6	12	£21.86	£2.64
121	8	16	£30.72	O.A.
122	10	20	£35.76	O.A.
189	12	24	£41.22	O.A.

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

Ref.	Amps 12V	Amps 24V	Price	P&P
213	1.0	0.5	£3.19	£1.20
71	2	1	£4.25	£1.20
18	4	2	£4.91	£1.60
85	5	2.5	£6.78	£1.50
70	6	3	£7.69	£1.40
108	8	4	£8.98	£1.64
72	10	5	£9.82	£1.80
116	12	6	£10.89	£1.90
17	16	8	£12.97	£2.12
115	20	10	£17.46	£2.44
187	30	15	£21.69	£2.64
226	60	30	£44.45	O.A.

SCREENED MINIATURES

Ref	mA	Volts	£	P&P
238	200	3-0-3	3.11	0.90
212	1A, 1A	0-6, 0-6	3.45	1.20
13	100	9-0-9	2.59	0.80
235	330, 330	0-9, 0-9	2.41	0.60
207	500, 500	0-8-9, 0-8-9	3.36	1.20
208	1A, 1A	0-8-9, 0-8-9	4.27	1.40
236	200, 200	0-15, 0-15	2.41	0.90
214	300, 300	0-20, 0-20	3.39	1.20
221	700(DC)	20-12-0-12-20	4.13	1.20
206	1A, 1A	0-15-20 (×2)	5.60	1.60
203	500, 500	0-15-27 (×2)	4.83	1.50
204	1A, 1A	0-15-27 (×2)	7.30	1.60
239	50	12-0-12	3.11	0.90
234	500	6-0-6	2.41	0.90

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171	500mA	£2.53	£0.90
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174	3A	£4.54	£1.20
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250	£16.07	O.A.
350	£19.88	O.A.
500	£24.77	O.A.
1000	£50.53	O.A.
2000	£74.79	O.A.
3000	£104.86	O.A.
6000	£207.92	O.A.

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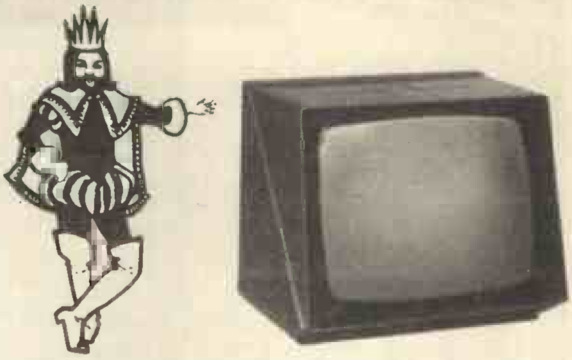

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709	25	ICL7621	180	★LM380	65	LM13600	120	★RC4136	68	TL072	50
★741	14	ICL7622	180	LM381	120	MC1310	150	RC4558	60	TL074	95
748	35	ICL8038	320	LM382	120	MC1496	68	SL480	170	TL081	45
9400CJ	350	ICL8211A	200	LM384	130	★ML922	400	SL490	250	TL082	45
AY-3-1270	840	ICM7224	785	★LM386	65	ML924	195	SN76477	250	TL084	95
AY-3-8910	600	ICM7555	80	LM387	120	ML925	210	SP8629	250	TL170	50
AY-3-8912	625	LF351	45	LM393	100	ML926	140	TBA120S	70	★UA2240	120
CA3046	60	LF353	85	LM709	25	ML927	140	TBA800	80	ULN2003	85
CA3080	65	LF356	90	LM711	40	ML928	140	TBA810	96	ULN2004	90
CA3089	215	LM10	360	LM725	350	ML929	140	TBA820	80	ZN414	100
CA3090AQ	375	LM301A	25	LM733	75	MM5387A	465	TBA950	290	ZN423	135
CA3130E	90	LM311	70	★LM741	14	NE529	225	TDA1008	320	ZN424	135
CA3140E	45	LM318	120	LM747	75	NE531	150	★TDA1022	525	ZN425E	350
CA3161E	100	LM324	40	LM1458	40	NE544	205	TDA1024	125	ZN426E	330
CA3189	290	LM334Z	100	LM2917	200	★NE555	16	TL061	40	ZN427E	650
★CA3240E	110	LM335Z	125	LM3900	45	★NE556	45	TL062	60	ZN428E	480
		LM339	50	LM3909	70	NE566	150			ZN459	285
		LM348	65	LM3911	120	★NE567	100			ZN1034E	200

CMOS

4000	10	★4017	38	4036	275	4055	95	4082	16	4502	60	4529	150
★4001	10	4018	45	4039	290	4059	480	4085	65	4503	40	4532	80
4002	12	4019	25	4040	50	4060	65	4086	60	4507	38	4534	485
4006	50	4020	50	4041	60	4063	85	4089	125	4508	150	4538	110
4007	15	4021	50	4042	45	★4066	30	★4093	30	4510	50	4543	100
4008	48	4022	50	4043	50	4067	295	4094	120	★4511	50	4549	360
4009	24	4023	16	4044	50	4068	16	4095	75	4512	50	4553	275
4010	24	4024	33	4046	60	4069	16	4097	290	4514	120	4555	35
★4011	11	4025	16	4047	60	4070	15	4098	75	4515	120	4556	35
4012	15	★4026	80	4048	40	4071	15	4099	90	4516	65	4559	390
★4013	25	4027	24	★4049	25	4072	15	40106	50	★4518	40	4560	175
4014	50	4028	50	★4050	25	4073	15	40109	100	4520	70	4584	45
4015	50	4029	60	4051	45	4075	15	40163	100	4521	130	4585	60
★4016	20	4030	30	4052	60	4076	50	40173	100	4526	70	4724	140
		4031	125	4053	50	4077	18	40175	100	4527	80		
		4034	140	4054	95	4081	14	40193	95	4528	70		

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LS00	11	LS21	12	LS76	18	LS125	26	LS161	37	LS221	54	LS365	30
LS01	11	LS22	12	LS78	18	LS126	25	LS162	37	LS240	69	LS366	30
LS02	11	LS26	14	LS83	40	LS132	42	LS163	37	LS241	69	LS367	30
LS03	12	LS27	12	LS85	52	LS136	26	LS164	43	LS242	75	LS368	35
LS04	12	LS30	12	LS86	19	LS138	32	LS165	75	LS243	75	LS373	65
LS05	13	LS32	13	LS90	28	LS139	32	LS166	75	LS244	60	LS374	65
LS08	12	LS37	15	LS92	32	LS145	70	LS170	85	LS245	70	LS375	45
LS09	12	LS38	13	LS93	28	LS147	150	LS173	65	LS247	50	LS377	70
LS10	12	LS40	13	LS95	40	LS148	85	LS174	45	LS251	35	LS378	60
LS11	12	LS42	32	LS96	95	LS151	38	LS175	45	LS257	35	LS390	55
LS12	12	LS47	38	LS107	40	LS153	40	LS190	45	LS258	35	LS393	55
LS13	22	LS48	45	LS109	21	LS154	90	LS191	45	LS259	75	LS399	175
LS14	38	LS51	14	LS112	21	LS155	30	LS192	45	LS266	22	LS541	120
LS15	12	LS55	14	LS113	23	LS156	36	LS193	45	LS273	68	LS670	150
LS20	12	LS73	18	LS114	22	LS157	30	LS195	36	LS279	35		
		LS74	18	LS122	38	LS158	30	LS196	50	LS283	40		
		LS75	22	LS123	38	LS160	37	LS197	60	LS353	88		

TTL

7400	11	7413	18	7442	32	7480	48	74107	25	74155	40	74177	45
7401	11	7414	28	7444	90	7482	65	74109	25	74155	40	74179	80
7402	11	7416	24	7446	65	7483	40	74121	25	74157	30	74180	40
7403	12	7417	24	7447	40	7485	80	74122	40	74160	60	74181	115
7404	13	7420	15	7448	45	7486	20	74123	40	74161	50	74182	60
7405	15	7421	20	7450	16	7489	180	74125	35	74162	50	74190	50
7406	24	7422	20	7451	16	7490	21	74126	35	74163	50	74191	50
7407	25	7427	22	7453	16	7491	45	74132	35	74164	50	74192	50
7408	14	7428	26	7454	16	7492	25	74141	60	74165	60	74193	45
7409	14	7430	14	7460	16	7493	25	74145	60	74167	150	74194	50
7410	14	7432	20	7472	26	7494	38	74147	90	74170	125	74195	50
7411	16	7433	25	7473	26	7495	36	74148	70	74173	60	74196	50
7412	18	7438	25	7474	20	7496	40	74150	55	74174	55	74197	50
		7437	25	7475	26	7497	95	74153	40	74175	55	74198	90
		7440	15	7476	30	74100	80	74154	55	74176	40	74199	90

TRANSISTORS

AC125	35	BC157	10	BC548	10	BFR40	23	TIP29A	40	★ZTX107	8	2N3053	23
AC126	25	BC158	10	BC549	10	BFR80	25	TIP29B	55	★ZTX108	8	2N3054	55
AC127	25	BC159	8	BC558	10	BFX29	25	TIP29C	60	ZTX109	12	2N3055	50
★AC128	20	BC160	45	BCY70	18	BFX84	25	TIP30A	45	ZTX300	14	2N3442	120
AC176	25	BC168C	10	BCY71	18	BFX85	25	TIP30B	50	ZTX301	16	★2N3702	6
AC187	22	BC169C	10	BCY72	18	BFX86	28	TIP30C	60	ZTX302	15	2N3703	9
AC188	22	BC170	8	BD115	80	BFX87	25	TIP31A	45	ZTX304	17	★2N3704	6
AD142	120	BC171	10	BD131	35	BFX88	25	TIP31C	55	ZTX341	30	2N3705	9
AD149	80	BC172	8	BD132	35	BFY50	23	TIP32A	45	ZTX500	15	2N3706	9
AD161	40	BC177	18	BD133	50	BFY51	23	TIP32C	60	ZTX501	15	2N3707	10
AD162	40	BC178	18	BD135	50	BFY52	23	TIP33A	50	ZTX502	15	2N3708	10
AF124	60	BC179	18	BD136	30	BFY53	32	TIP33C	75	ZTX503	18	2N3709	10
AF126	50	BC182	10	BD137	30	BFY55	32	TIP34A	60	ZTX504	25	2N3772	190
AF139	40	★BC182L	8	BD138	30	BFY56	32	TIP34C	85	2N697	20	2N3773	210
AF186	70	BC183	10	BD139	35	BRY39	40	TIP35A	160	2N698	40	★2N3819	18
AF239	75	BC183L	10	BD140	30	BSX20	20	TIP35C	180	2N706A	20	2N3820	40
BC107	10	BC184	10	BD204	110	BSX29	35	TIP36A	170	2N708	20	2N3823	65
BC107B	12	★BC184L	7	BD206	110	BSY95A	25	TIP36C	195	2N918	35	2N3866	90
★BC108	9	BC212	10	BD222	85	BU205	160	TIP41A	60	2N1132	22	2N3903	10
BC108B	12	BC212L	10	BF180	35	BU206	200	TIP42A	60	2N1613	30	2N3904	10
BC108C	12	BC213	10	BF182	35	BU208	170	TIP120	90	2N2218A	45	2N3905	6
★BC109	9	BC213L	10	BF184	25	MJ2955	99	TIP121	90	2N2219A	25	2N4037	45
BC109C	12	BC214	10	BF185	25	MJE340	50	TIP122	90	2N2221A	25	2N4058	10
BC114	22	★BC214L	8	BF194	12	MJE520	65	TIP141	120	2N2222A	20	2N4060	10
BC115	22	BC237	8	BF195	12	MJE521	95	TIP142	120	2N2368	25	2N4061	10
BC117	22	BC238	14	BF196	12	MJE3055	70	TIP147	120	2N2369	16	2N4062	10
BC119	35	BC308	15	BF197	12	MPF102	40	TIP2955	60	2N2484	25	2N5457	36
BC137	40	BC327	14	BF198	10	MPF104	40	TIP3055	55	★2N2646	45	2N5458	36
BC139	40	BC328	14	BF200	30	MPSA05	22	TIS43	40	2N2904	20	2N5459	30
BC140	30	BC337	14	★BF244B	22	MPSA06	25	TIS44	45	2N2904A	20	2N5485	36
BC141	30	BC338	14	BF245	30	MPSA12	30	TIS45	45	2N2905	22	2N5777	45
BC142	25	BC478	30	BF256B	45	MPSA55	30	TIS90	30	2N2905A	22	2N6027	30
BC143	25	BC479	30	BF257	32	MPSA56	30	TIS91	30	2N2906	25	40360	40
BC147	8	BC517	40	BF258	25	MPSU05	55	★VN10KM	45	2N2906A	25	40361	50
BC148	8	BC547	7	BF259	35	MPSU06	55	VN46AF	75	2N2907	25	40362	50
BC149	9			BF337	40	MPSU55	60	VN66AF	85	2N2907A	25	40408	70
						MPSU56	60	VN88AF	95	2N2926	9		

SWITCHES

Submin toggle
SPST 55p. SPDT 60p. ★DPDT 50p.
Miniature toggle
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle SPST 35p. DPDT 48p
★Miniature DPDT slide 12p.
★Push to make 12p. Push to break 22p
Rotary type adjustable stop
1P12W 2P6W 3P4W 4P3W all 55p ea.
DIL switches
4 SPST 80p. 6 SPST 80p. 8 SPST 100p

VERO

★ Verobloc 350p
Size 0·1 matrix

2·5 × 1	22p
2·5 × 3·75	75p
2·5 × 5	85p
3·75 × 5	95p
VQ board	160p

Veropins per 100
Single sided 50p
Double sided 60p
Spot face cutter 105p
per insertion tool 162p

RESISTORS

¼W 5% Carbon film E12 series 4·7Ω-10M 1p each.
½W 5% Carbon film E12 series 4·7Ω to 4M7, 2p each.
½W 1% Metal film. E24 series 10Ω-1M, 6p each.

BRIDGE RECTIFIERS

1A 50V	22	6A 100V	80
1A 400V	35	6A 400V	95
2A 200V	40	VM18 DIL	
2A 400V	45	0·9A200V	50

CABLES

20 metre pack single core connecting cable ten different colours 65p
Speaker cable 10p/m
Standard screened 16p/m
Twin screened 24p/m
2·5A 3 core mains 23p/m
10 way rainbow ribbon 65p/m
20 way rainbow ribbon 120p/m

HARDWARE

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

DIODES

BY127	12	★1N4001	3
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N4007	7
OA200	8	1N5401	15
OA202	8	1N5404	16
1N914	4	1N5406	17
★1N4148	2	400mW zener	6

BZX61 Series zeners 1·3W 4V7-39V 15p each.

ORDERING INFO

All prices exclude VAT. Please add to total order. Please add 50p carriage to all orders under £10 in value. Send cheque/PO or Access/Visa number with your order. Please note new address. Callers most welcome—we are just 10 minutes from the centre of Colchester. Telephone orders welcome with Access and Visa. Official orders welcome from colleges and schools etc. Export orders no VAT but please add carriage. All components brand new & full spec.

OPTO

★3mm red	8	★5mm red	8
★3mm green	12	★5mm green	12
★3mm yellow	12	★5mm yellow	12

Clips to suit 3p each.

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

Seven segment displays

Com athode		Com anode	
DL704 0·3"	95	DL707 0·3"	95
★FND500 0·5"	80	FND507 0·5"	90
TIL313 0·3"	105	TIL312 0·3"	105
TIL322 0·5"	115	TIL321 0·5"	115

LCD: 3½ digit 580p. 4 digit 620p.

TRIACS

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

PCB MATERIALS

Alfac transfer sheets—please state type (e.g. DIL pads etc.) 45p
Dalo etch resist pen 100p
Fibre glass board 3·75" × 8" 75p
Ferric Chloride 250ml bottle 100p

SOLDERING IRONS

Antex CS 17W Soldering iron 450p
2·3 and 4·7mm bits to suit 65p
CS 17W element 210p
Antex XS 25W Soldering iron 480p
3·3mm and 4·7mm bits to suit 65p
XS 25W element 210p
Soldering Iron Stand 250p
Solder pump desoldering tool 480p
Spare nozzle for above 70p
10 metres 22swg solder 100p

Simply phone 0206 36412 with your order

ACCESS BARCLAYCARD VISA

REGULATORS

78L05	30	79L05	65
78L12	30	79L12	65
78L15	30	79L15	65
7805	40	7905	45
7812	40	7912	45
7815	40	7915	55
LM309K	130	LM723	40
LM317K	350	LM338K	475
LM317T	120	78H05	
LM323K	350	5A 5V	550

PANEL METERS

Size 60 × 46 × 35mm

0-50μA	0-500mA
0-100μA	0-1A
0-500μA	0-50V
0-1mA	VU
0-10mA	0-300V AC
0-50mA	0-25V
0-100mA	0-30V DC
495p each	

FREE DIODES!

Yes thats right! With each order over £10 in value we give you 25 1N4148 signal diodes absolutely free of charge! Offer expires 31st July 82. Please mention this magazine when ordering.

This advertisement is only a partial listing of our enormous stocks. Please send 45p for our Short Form catalogue. Stocks include chokes, coils, aerials, Veroboxes, Multimeters etc. etc.

SCRS

TIC45	28
C106D	30
400V 8A	70
400V 12A	99

VERO WIRING PEN

Pen + spool 310
Spare spool 75
Combs 6

CRYSTALS

100KHz	290	6·0M	200
200KHz	370	6·144M	180
1MHz	300	7·0M	250
1·008M	370	8·0M	170
1·8432	300	10·0M	190
2·0M	270	12·0M	290
2·4576M	220	16·0M	240
3·276M	240	18·0M	240
3·579M	120	18·432	220
4·0M	150	19·968	300
4·194M	150	38·667	320
4·43M	125	48·0M	220
5·0M	240	116M	300

SOCKETS

	Low profile	Wire-wrap
★8 pin	7p	25p
★14pin	9p	35p
★16 pin	10p	42p
18 pin	15p	52p
20 pin	18p	60p
22 pin	20p	70p
24 pin	22p	70p
28 pin	26p	80p
40 pin	32p	98p

Soldercon pins 60p/100.

BOXES

Aluminium		Plastic	
3 × 2 × 1in	70p	With lid + screws	
4 × 3 × 1½in	85p	3 × 2 × 1in	55p
4 × 3 × 2in	100p	4½ × 3 × 1½in	88p
6 × 4 × 2in	120p	7 × 4 × 2in	160p
6 × 4 × 3in	150p		

CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	9p	9p	2·5mm	10p	10p
3 pin	12p	10p	3·5mm	9p	8p
5 pin	13p	11p	Standard	16p	20p
Phono	10p	12p	Stereo	24p	25p
1mm	12p	13p	4mm	18p	17p

UHF (CB Connectors
PL259 Plug 40p Reducer 14p
SO239 square chassis skt 38p
SO 239S round chassis socket 40p
IEC 3 pin 250V/6A
Plug chassis mounting 38p
Socket free hanging 60p
Socket with 2m lead 120p

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices.

¼W 5% Resistor kit. Contains 10 of each value from 4·7Ω to 1M (650 resistors) 480p.

Ceramic Capacitor Kit. Contains 5 of each value from 22p to 0·01μ (135 caps.) 370p.

Polyester Capacitor Kit. Contains 5 of each value from 0·01 to 1μF (65 caps.) 575p each.

Preset Kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets) 425p each.

Nut and Bolt Kit. Total 300 items 180p.

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

CAPACITORS

Polyester. Radial leads. 250V. C280 type.
0·01, 0·015, 0·022, 0·033, 6p; 0·047, 0·068, 0·1, 7p; 0·15, 0·22, 9p; 0·33, 0·47, 13p; 0·68 20p; 1μ 23p.
Electrolytic. Radial or axial leads.
0·47/63V, 1/63V, 2·2/63V, 4·7/63V, 10/25V, 7p; 22/25V, 47/25V, 8p; 100/25V 9p; 220/25V, 14p; 470/25V, 22p; 1000/25V, 30p; 2200/25V, 50p.
Tag end Power Supply Electrolytics.
2200/40V 110p; 4700/40V 160p; 2200/63V 140p; 4700/63V 230p.
Polyester. Miniature Siemens PCB.
1n 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 68n, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n 20p; 470n, 26p; 680n, 29p; 1μ, 33p; 2μ2, 50p.
Tantalum bead.
0·1, 0·22, 0·33, 0·47, 1·0 @ 35V, 12p; 2·2, 4·7, 10 @ 25V, 20p; 15/16V, 30p; 22/16V, 27p; 33/16V, 45p; 47/6V, 27p; 47/16V, 70p; 68/5V, 40p; 100/10V, 90p.
Ceramic disc. 22p-0·01μ 50V, 3p each.
Mullard miniature ceramic plate.
1·8pF to 100pF 6p each.
Polystyrene. 5% tolerance.
10p-1000p 6p. 1500-4700p 8p. 6800-0·012μ 10p.
Trimmers. Mullard 808 Series.
2-10pF 22p. 2-22pF 30p. 5.5-65pF 35p.

POTENTIOMETERS

Rotary. Carbon track Log or Lin 1K-2M2. Single 32p. Stereo 85p. Single switched 80p. Slide 60mm travel single Log or Lin 5K-500K. 63p each. Preset. Submin. hor. 100 ohms-1M. 7p each. Cermet precision multiturn, 0·75W ¾in 100 ohms to 100K. 88p each.

TRANSFORMERS

Please add carriage charges to our normal post charges.
Miniature mains.
606V, 909V, 12012V all @ 100mA 100p each.
PCB mounting. Miniature.
3VA 0-6, 0-6 @ 0·25A; 0-9, 0-9 @ 0·15A; 0-12, 0-12 @ 0·12A, 200p each.
6VA 0-6, 0-6 @ 0·5A; 0-9, 0-9 @ 0·3A; 0-12, 0-12 @ 0·25A, 270p each.
High quality. Split bobbin construction.
6VA 0-6, 0-6 @ 0·5A, 0-9, 0-9 @ 0·4A, 0-12, 0-12V @ 0·3A, 220p each.
12VA 0-6, 0-6 @ 1A, 0-9, 0-9 @ 0·8A, 0-12, 0-12 @ 0·5A, 0-15, 0-15 @ 0·4A 295p each (plus 40p carriage)
25VA 0-6, 0-6 @ 1·5A, 0-9, 0-9 @ 1·2A, 0-12, 0-12 @ 1A, 0-15, 0-15 @ 0·8A, 330p each (plus 60p carriage)
50VA 0-12, 0-12 @ 2A, 0-15, 0-15 @ 1·5A, 440p each (plus 75p carriage)

The Rapid Guarantee ★ Same day despatch ★ Competitive prices ★ Top quality components ★ In-depth stock

PE

VOLUME 18 No. 8 AUGUST 1982

ELECTRONIC HOBBIES FAIR

As promised last month some more news on our exciting new exhibition for all interested in the various forms of our hobby. This new venture will take place at the recently built Alexandra Pavilion (in the grounds of the now burnt out Alexandra Palace) from the 18th to 21st of November this year. The new pavilion has been hailed as one of the best exhibition venues in the country. It is London's third largest exhibition hall, has masses of parking space, is easily approached by road, British Rail, underground or bus and has a free shuttle bus service to ferry visitors from Alexandra Palace station. For wives/girlfriends there is the added attraction of the nearby Wood Green Shopping City, one of the largest centres in the U.K., although we are sure they will find plenty to interest them in the special exhibits at the Fair.

Although planning is still in the early stages we anticipate many special exhibits, showing all aspects of the application of electronics in hobbies, broadcasting, forces communications and weapons systems, entertainment, vehicle technology etc. etc. We also expect to attract trade stands dealing with Amateur Radio, Computing, Radio Control and CB, in addition to the "regular" electronic hobby suppliers.

Next month we will be starting a monthly Electronic Hobbies Fair information section within *News and Market Place* to lead up to the event and to keep readers up to date on every aspect of the Fair. We already have the backing of some of the biggest names in the electronic hobby retail business.

COMPUTING

Probably the fastest growing electronic hobby area at the present time is that of computing and many companies have expanded into the computer business or have been launched into it. Like any booming market it attracts all types of new venture and small supplier, as well as the large, established names. There are the usual supply problems and the inevitable failures in the business. There are also the dubious areas where companies sail close to the law.

One area where we do not entirely approve of some practices is in the "user clubs" or "groups", set up—often by hobbyists—to assist each other in their hobby. This is to be commended and is in the spirit of "amateur electronics" but when such user groups are run as businesses for the financial benefit of the founders, possibly without the members or subscribers being aware of such a situation, we wonder just how ethical it all becomes?

Comments from readers, members and proprietors of such organisations are welcome for our *Readout* section!

FRONT COVER

Just in case you are wondering about this month's front cover, which is a departure from our normal illustration of projects, it's not just a fancy design. The photograph shows the view looking into the faceted mirror used on the *Infra-Red Burglar Alarm.* One of the three projects in our *Comprehensive Home Alarm System* article. (The "T" piece holds the pyroelectric sensor).

PRICE

We must reluctantly announce an increase in cover price next month. We know only too well the effects of increasing prices, but believe PE will continue to represent good value.

Mike Kenward

Letters and Queries
We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or addressed envelope and international reply coupons, and each letter should relate to **one published project only.**

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

Back Numbers
Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at £1 each including Inland/Overseas p&p. Please state month and year of issue required.

Binders
Binders for PE are available from the same address as back numbers at £4·60 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions
Copies of PE are available by post, inland or overseas, for £13·00 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

...NEWS &

Edited by Jasper Scott

BBC introduce packaged learning for TV engineers

The BBC's Engineering Training Department have recently produced a revolutionary method of training students in the fundamentals of television engineering.

Based on the "packaged-learning" concept, the students work at their own pace using purpose-designed demonstration equipment, supported by specially written learning texts. Packaged learning has been a feature of BBC Engineering Training for some time, but because of the high cost of broadcast television equipment, it has not been possible to teach television fundamentals in this way until now.

The overall package, which consists of two main racks of equipment, plus four supporting books, and a VHS tape, covers the fundamentals of television engineering. Scanning is covered first, together with synchronisation and interlace. Picture signal processing is covered next including clamping and gamma correction. The associated equipment enables demonstration of many aspects covered in the text.

A colorimetry section deals with the principles of colour vision and the simulation of spectral colours using additive mixing techniques. The separation of a scene into its red, green and blue components is considered and the analysis required of a camera determined.

The third and final section of the package describes the coding and decoding of the colour television signal, with specific reference to PAL system 1. In addition to the text this section is supported by its own demonstration equipment.

The total package comes in three parts: i) the basic television principles equipment ii) the colour fundamentals demonstration equipment iii) the support literature and video cassette tape. Each part is easily identified, but is not necessarily self-supporting. For example, the literature requires the appropriate equipment for the student to work with.

It is possible that the package may be made available to colleges, institutions, industry and other broadcasting organisations in the near future. In comes complete except for monitors and oscilloscopes. At present there are no plans to produce SECAM or other television standard versions.

TIME TO LISTEN

It's gimmicks time again! Not content with the abundance of Walkman-size cassette players and radios, an American company JS&A has gone one step further and produced a digital watch that also incorporates an AM radio. The Advance Digital Watch Radio is sold complete with lightweight samarium cobalt headphones, and the radio is said to run for over 100 hours before a new battery is needed (don't worry, the watch department has a separate battery).

Doubtless it won't be long before a similar machine is available in this country, and if the price stays about the same ($49 in America), it could mean serious competition for the 'Walkman' market.

LOW COST LOGIC PROBE

Stotron Ltd inform us that they can now supply a new, low cost, high performance, 10MHz Logic Probe from Sabtronics—the LP-10. Operation is high speed and pulses as narrow as 50 ns are stretched to be easily detected. 'Floating' input levels, caused by open lines, bad sockets and dirty connectors, etc, are easily detected by this logic probe. There is a high impedance input of 100kΩ which avoids circuit loading.

Two l.e.d.'s indicate the presence of a logic '0' or a logic '1'. The relative brightness of these two l.e.d.'s, in a rapidly switching signal, indicates the amount of time spent at each logic state. Invalid logic outputs fail to light either of the l.e.d.'s. Logic transitions are detected and displayed on a third l.e.d.

Clip leads, supplied with the unit, allow the approximately 35 mA required to power the probe to be supplied from the circuit under test.

The LP-10 is priced at £24.95 plus VAT and p & p, and is available from Stotron Ltd, 72 Blackheath Road, London SE10 8DA (01-691 2031).

MARKET PLACE

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

Briefly...

Hobbyists in the Thornton Heath area will be pleased to hear of a new company which has recently been launched. CMC Electronics supply a range of components, hi-fi, televisions, telephone answering machines and technical books. As well as the retail side of their business, CMC also provide a repair service. Opening hours are 9 am to 6pm, Monday to Saturday.

CMC Electronics, 70 Brigstock Road, Thornton Heath, Surrey (01-684 2188).

● ● ● ●

Component suppliers Rapid Electronics have recently moved from their original premises in Eynsford to new tailored premises at Boxted, Colchester, Essex. Their new catalogue which is priced at 45p (or free with orders over £5) is now available and contains over 2,500 lines. Among new lines in stock are Denco coils, l.c.d.s, cremet presets and an extended and very comprehensive CMOS and linear range.

Personal shoppers are welcome at the premises which are open from 9am to 6pm Monday to Friday, and from 9am to 5pm on Saturdays. Rapid Electronics, Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4 5RD (0206 36412).

NEW FLUKE DMMs

Two new 4½ digit handheld DMMs are the latest models to emerge from the Fluke stable.

Fluke say that the 8060A is virtually a handheld testlab, providing direct frequency measurement, dB computation and relative/offset modes in addition to traditional multimeter functions. A simplified sister machine, the 8062A, provides the same high performance, but without the frequency and dB facilities.

The 8060A is the first general purpose handheld DMM to be able to measure modem and communications equipment performance, and as such should be of particular interest to engineers working in the field of computer communications.

Key features include a true RMS capability up to 100kHz, voltage ranges from 10mV to 1000V, autoranging frequency measurements to 200kHz, current to 2 amps, resistance to 300 Mohms, audible continuity detection, conductance and diode test facilities. Readings can be displayed in volts, relative dB or dBm referenced to 600 ohms. Using the relative function, any reading can be offset to zero and only the deviation is displayed on the l.c.d.

To achieve all this performance in a handheld DMM, Fluke have used microcomputer techniques and have even designed and manufactured their own custom CMOS LSI circuit. The built-in microcomputer not only controls all the functions and computes the readings, but also allows sophisticated self-testing to be carried out automatically every time it is used.

The 8060A is priced at £270 and the 8062A at £210. Further information from Fluke (GB) Ltd., Colonial Way, Watford, Herts. WD2 4TT (0923 40511).

Countdown...

Please check dates before setting out, as we cannot *guarantee* the accuracy of the information presented below.

BAEC Amateur Electronics Jul. 17–25. Penarth Esplanade, S. Glamorgan. **B9**
Harrogate International Festival of Sound & Video Aug. 14–17. Exhibition Cntr. and hotels. **X**
BEX Manchester Sept. **K**
Personal Computer World Show Sept. 9–12. Barbican Cntr, London. **M**
Laboratory London Sept. 14–16. Grosvenor Ho. Park Lane. **E**
ElectroWEST Sept. 14–16 Bristol Exhibition Centre **Q**
Two Counties Fair Sep. 15–18. Plymouth Ex. Centre, Millbray, Plymouth, Devon. **T**
IBC Sept. 18–21. Metropole, Brighton. **N**
Microprocessors In Audiology Sept. 24 **A7**
Holographic Techniques Sept. 30–Nov. 28. Light Fantastic Gallery, Covent Gdn. **A8**
BEX Cardiff Oct. **K**
Viewdata Oct. 12–14. Wembley Conf. Centre. **O**
Video Show Oct. 16–18. West Cnt. Hotel. **Z1**
Computer Graphics Oct. 19–21. London. **O**
Testmex Oct. 26–28. Wembley Conf. Centre, London. **T**
Compec Nov. 16–19. Olympia, London. **Z1**
Hobby Electronics Fair (taking exhibitions for the amateur a bold step forward!) Nov. 18–21 Alexandra Palace, London **Z1**
ElectroNORTH Dec. 7–9 Harrogate Supercentre **Q**
Continuous events at the National Microprocessor and Electronics Centre (Nr. Tower of London) **L1**
Christmas Holography (and sales items) Dec. 2–Mar. 83. Light Fantastic Gallery, London. **A8**

A7	Institute of Acoustics, ✆ 031-225 2143
A8	Holographic Exhibitions ✆ 01-836 6423
B9	BAEC, Penarth ✆ 0222-707813
E	Evan Steadman, Saffron Walden ✆ 0799 22612
K	Douglas Temple, Bournemouth ✆ 0202 20533
L1	World Trade Cntr. ✆ 01-488 2400
M	Montbuild ✆ 01-486 1951
N	IEEE
O	Online, Northwood, Middx. ✆ 0822 4671
Q	Exhibitions For Industry, ✆ 08833 4371
T	Trident Tavistock ✆ 0822 4671
X	Exhibition & Conference Services ✆ 0423 62677
Z1	IPC Exhibitions, Sutton ✆ 01-643 8040

Comprehensive HOME ALARM SYSTEM

G. DAVIES

The three alarms featured in this article are all based around one p.c.b. design which can accommodate any one of the systems.

The first is a Doppler shift ultrasonic alarm with 32·7kHz transducers driven from a crystal oscillator, resulting in no alignment or interaction problems with other such alarms. The alarm has a range adjustable up to 8 metres.

The second is a Doppler shift radar alarm based on the Mullard CL8960 module which operates on 10·687GHz and has a range up to 30 metres. With suitable weatherproofing it can be used outdoors—some consideration must be given to the fact that rain is a moving object in the eyes of radar. **To operate this Radar module a Home Office licence is required which lasts for 5 years and costs a few pounds.**

The third is the latest development in the alarm field—an infra-red heat sensor with a sensitivity peaking at human body heat. This device detects a change in heat and gives an electrical signal output. As the device only responds to a change in heat a multi-faceted mirror (US Patent 3703718) or a Fresnel lens is required to concentrate the detected area into zones, so that anyone entering these zones can be detected.

The above alarms all have their own merits for particular uses:—

	ULTRASONIC	RADAR	INFRA-RED
Range	8 metres	30 metres	15 metres
Field of coverage	full field	full field	zones
Indoor	yes	yes	yes
Outdoor	no	yes	yes
Detection	movement	movement	heat
Draughts	poor	good	good
Cost	low	high	med
Consumption at 12Vd.c. (typical in standby)	15mA	150mA	10mA

CIRCUIT DESCRIPTION (ULTRASONIC)

The circuit diagram for the Ultrasonic Alarm is shown in Fig. 1. The mains supply feeds T1 via R1 and its secondary feeds D1–D4, a full wave rectifier, before being smoothed by C1. This unstabilised voltage is fed to IC1 and stabilised to 12V d.c., and further decoupled by C2 and C16.

IC2 forms a crystal oscillator, R3 and R4, R5 and the crystal form the feedback components, whilst C3 terminates the crystal loading capacitance, C4 aids oscillator start up. The output of the oscillator at pin 3 is a 32·7kHz square wave which is filtered by R6 and C5 to remove harmonics before driving the Ultrasonic transducer X1.

The Ultrasonic sound is received by X2, then decoupled by C18 feeding IC3, the 32·7kHz amplifier. R7, R8, R9 and C6 form the biasing for IC3. VR1, R10 and C7 form the feedback components to determine the gain and response of the stage—VR1 being the sensitivity control.

D6, R11, R12 and C8 form a diode detector to remove the 32·7kHz and recover the Doppler frequency envelope which is fed to IC4, a high gain Doppler frequency amplifier. The gain is set by feedback components R14, R13 and C9 and selected for optimum performance for 32·7kHz ultrasound.

The output of IC4 feeds a bootstrapped diode pump detector consisting of C10, D7, TR1, C11 and R15 which converts the Doppler frequency into a d.c. level then buffered by IC5.

Ultrasonic Alarm

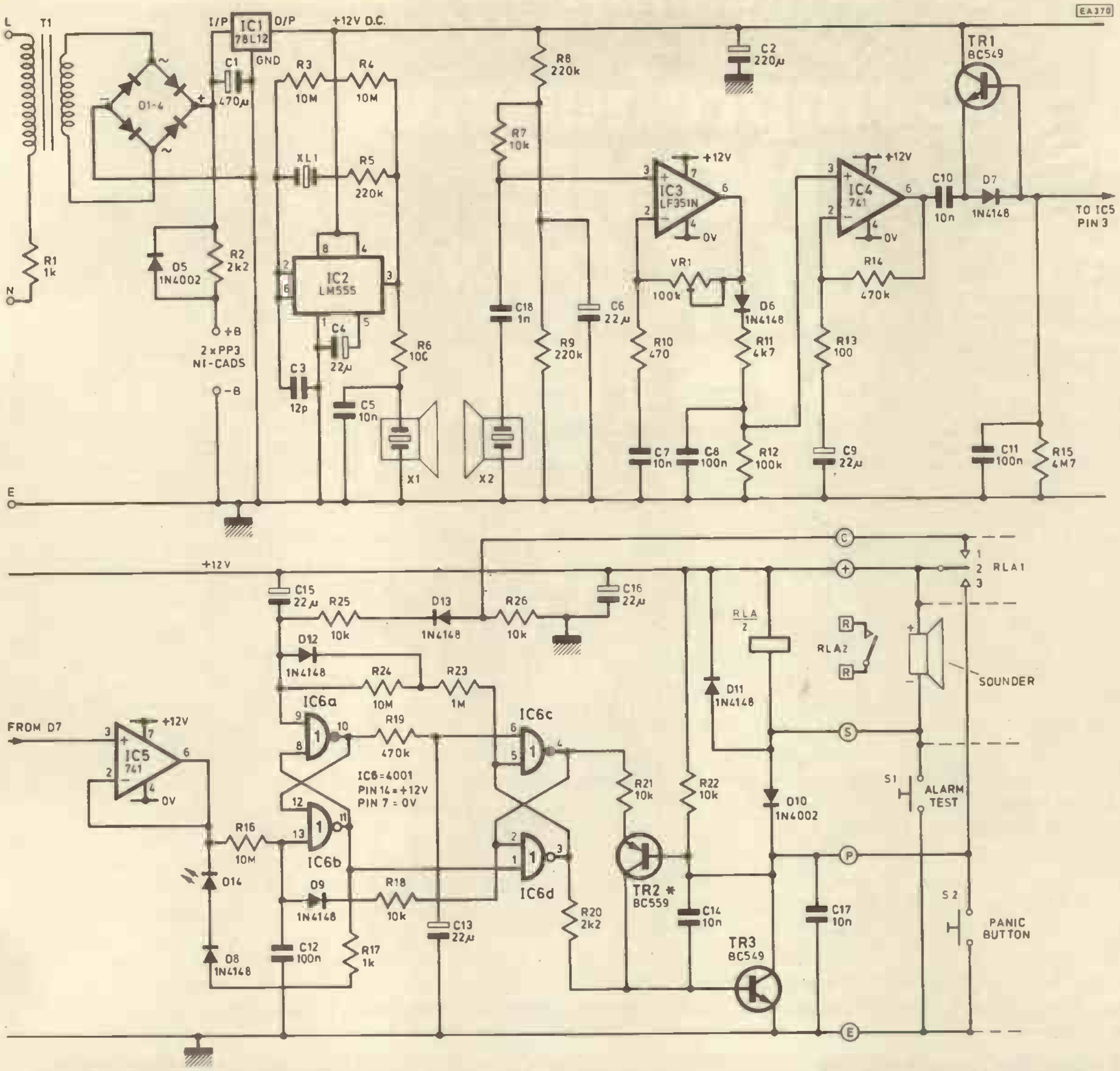


Fig. 1. Complete circuit diagram of the Ultrasonic Alarm Unit. *Not required if the panic button is not used.

SPECIFICATIONS

CONTROL SECTION

1 second invalid movement delay (IR 0·1 sec)
20 second delay on leaving (IR 1 min at power up)
10 second delay on entry
2–3 minutes alarm-on time
10 second inhibit after alarm has ended

Timing activated at power switch on/external control
Panic button facility will instantly sound the alarm and latch until reset—this can be used for other applications, i.e. pressure mats, fire detector etc. The output is designed to easily accommodate common switching and alarm switching. A s.p.c.o. centre off keyswitch provides all switching:—

Position (1) Detection 'OFF' panic active
(2) Detection 'ON' panic active
(3) Panic reset only—MUST NOT be left in this position

ALARM UNITS

ULTRASONIC:	8 metres range—full field coverage
RADAR:	30 metres range—full field coverage
INFRA-RED	15 metres range—12 zones covering 80 degrees

Both the ultrasonic and radar are most sensitive to objects moving in front of and towards the unit. The sensitivity will be reduced when the unit is approached from the side. The infra-red however is most sensitive to humans moving across the field and this must be considered when installing the alarm.

When setting up the alarm the red l.e.d. on the front of the unit should not flicker; if it does the unit is detecting a signal—either re-site the unit or reduce the sensitivity.

All units can drive a solid state sounder rated at 12V d.c. at 25mA directly which can therefore be driven from the alarm's own Ni-Cad power in the event of power failure. These high efficiency sounders can produce sound levels from 95 to 110dB at 1 metre which should be enough to deter all but the most persistent intruder.

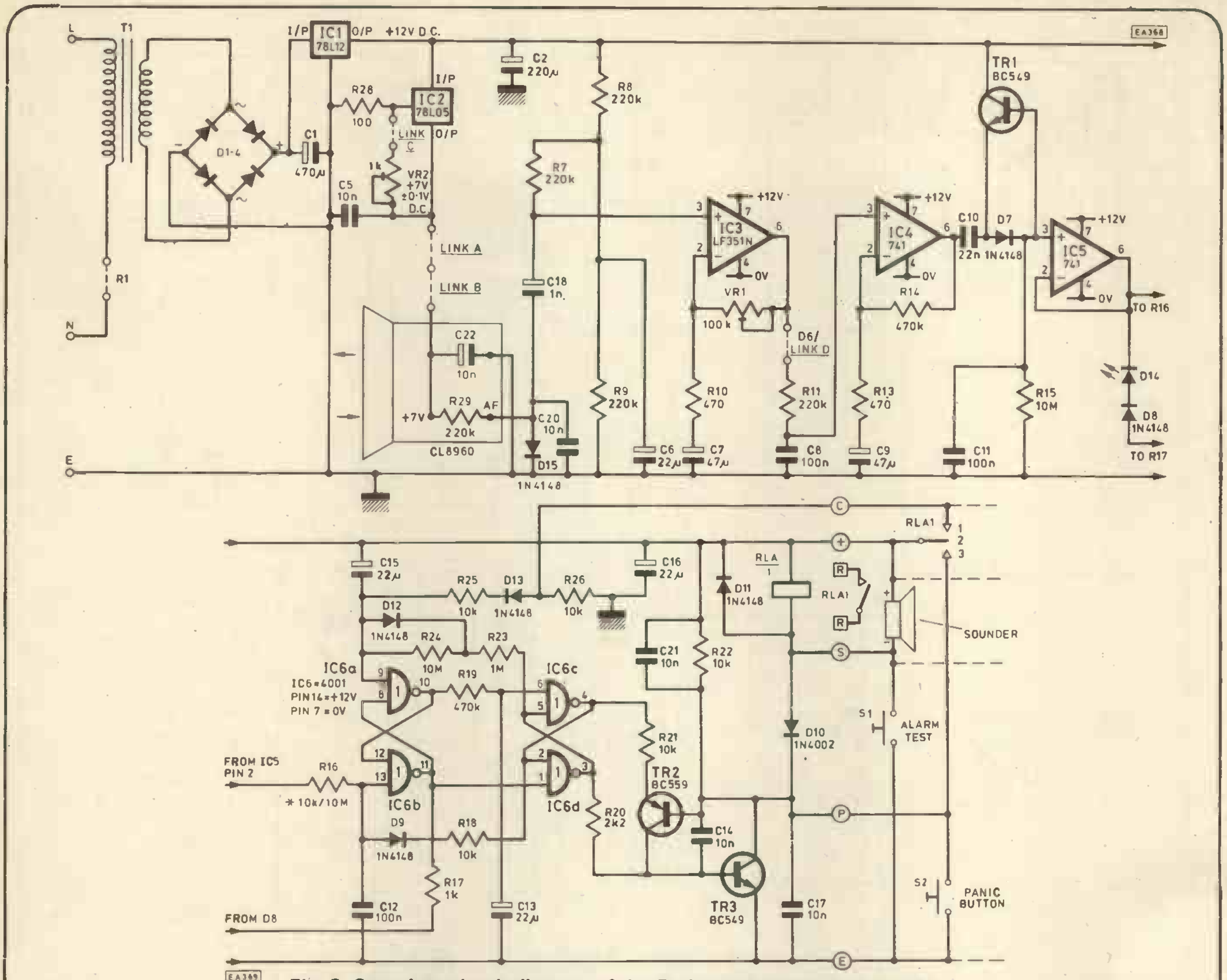


Fig. 2. Complete circuit diagram of the Radar Alarm Unit. R16 is 10M

CIRCUIT DESCRIPTION (RADAR)

The circuit diagram for the radar system is shown in Fig. 2. The mains supply feeds T1 and its secondary feeds D1–D4, a full wave rectifier, before being smoothed by C1. This unstabilised voltage is fed to IC1 and stabilised to 12V d.c., and further decoupled by C2 and C16.

As the radar module requires +7V d.c. within 0·1V d.c. at 150mA, IC2, VR2 and R28 form an adjustable voltage regulator set by VR2. This voltage is adjusted BEFORE the CL8960 is connected to prevent damage to the module and then finely adjusted when connected, measuring the voltage at the module end to compensate for any volt drop in the supply leads. C22 is connected directly onto the module using short leads and provides local rail decoupling. R29 provides correct biasing for the mixer diode, again mounted on the module.

The Doppler output 'AF' is terminated by D15 and C20 to prevent surges being induced in the mixer diode, then decoupled by C18 to IC3, the Doppler frequency pre-amp. R7, R8, R9 and C6 form the biasing for IC3. VR1, R10 and C7 form the feedback components to determine the gain of this stage and select a suitable response for the 10·687GMz radar module. VR1 is the sensitivity control. R11 and C8 form a low pass filter to remove frequencies not required

Radar Unit

before further amplification by IC4, the 2nd Doppler frequency amplifier, the gain being set by feedback components R14, R13 and C9.

The output of this stage feeds a bootstrapped diode pump detector consisting of C10, D7, TR1, C11 and R15 (the ratios of C10 to C11 and the time constant C11 and R15

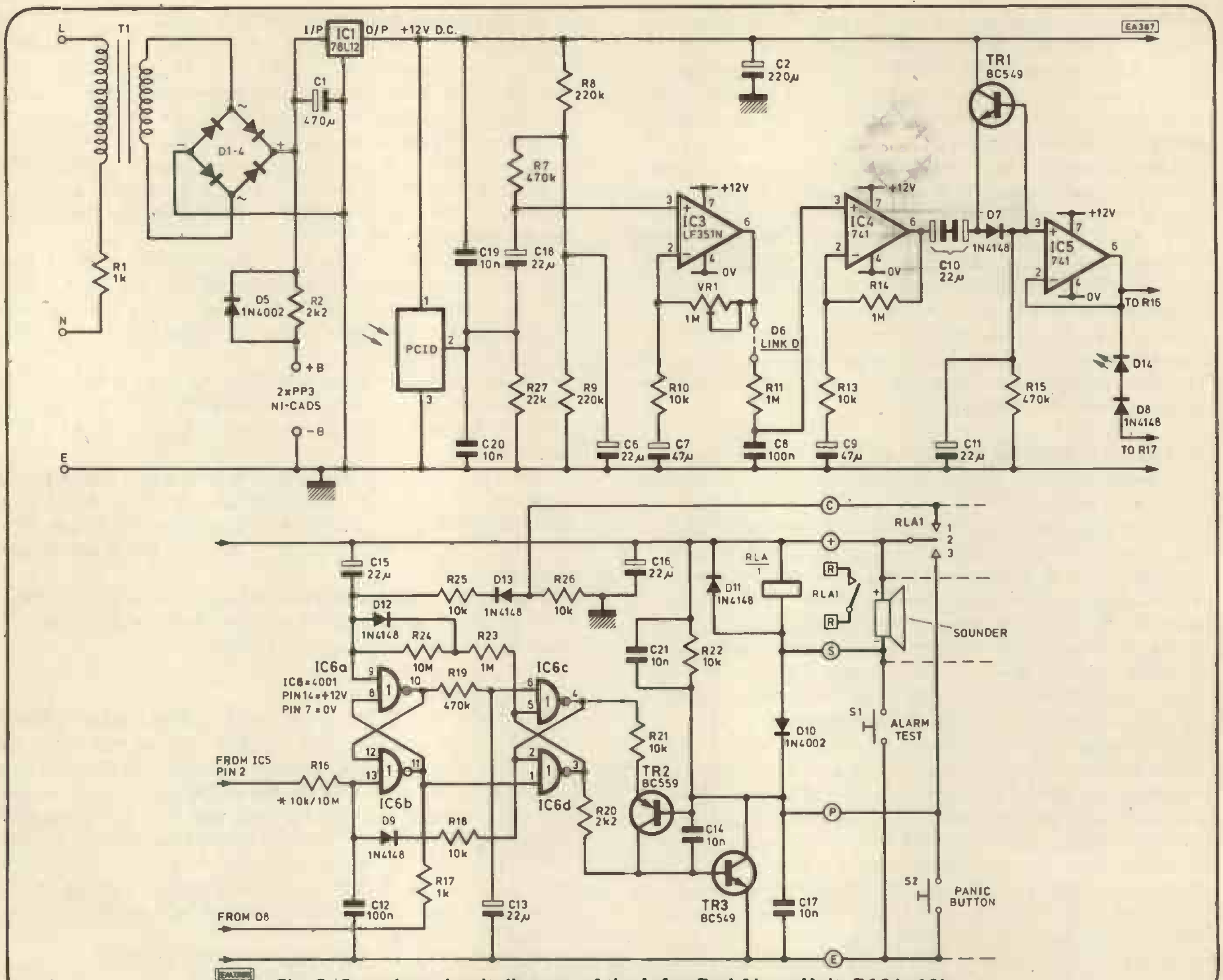


Fig. 3. Complete circuit diagram of the Infra-Red Alarm Unit. R16 is 10k

chosen for Doppler frequencies for the 10·687GHz radar) which converts the Doppler frequency into a d.c. level then buffered by IC5.

PYROELECTRIC CERAMIC INFRA-RED DETECTOR

The development of infra-red detectors that are both rugged and sensitive such as pyroelectric detectors makes them ideal for use in intruder alarms. Each detector consists of two pyroelectric ceramic elements mounted in a TO5 transistor header complete with silicon filter window coated for maximum transmission at 10µ, blocking radiation and visible light below 6·5µ.

Incorporated within the package is an impedance matching JFET preamplifier.

THE PYROELECTRIC EFFECT

The pyroelectric effect, exhibited by all ferroelectric materials, has been utilised to develop a series of infra-red detectors. Pyroelectric material exhibits a strong temperature sensitive spontaneous electric polarisation. Any infra-red energy absorbed by the material will increase its temperature and produce an associated change in electric polarisation. Before the effect can be utilised, the normally random oriented electric dipoles which exist in the bulk of the material, must be 'poled'. The effect of this operation is to line up the dipoles along one axis in the crystal.

Infra-Red Unit

In many single crystal materials, poling must occur along specific crystallographic axes. Ceramic materials can be poled along any axis, the dipoles themselves as near as possible along this axis in the randomly oriented crystallites.

Depending on the material type, poling is normally performed at an elevated temperature. The process involves applying an electric field to the material and allowing it to cool under the influence of the field. Heating the material reduces the coercive field and hence the voltage that must be applied for poling to occur. The electric field is applied by depositing electrodes on the opposite faces of the material and applying a potential across them. As a result of the poling process a permanent polarisation of the crystal exists, resulting in an excess of one particular charge at the surface of the material. This charge is captive within the structure of the material, but the equal and opposite charge on the electrodes are free to move. Thus the electrode which was positive during the poling process acquires a positive charge.

A pyroelectric element, which makes use of its self-polarisation effect, produces a change in surface charge with temperature which is detected by the integral JFET to produce a varying current output.

APPLICATIONS OF PYROELECTRIC DETECTORS

A healthy human being dissipates approx 100 watts of detectable radiation. Thus, with suitable collecting optics, it is possible to detect a man well over 100 metres distance. In this project the mirror used has 6 facets and a range of 15 metres which is more in keeping with domestic requirements. The peak emission from a human being, resulting from the natural body temperature, occurs at around 10μm in the infra-red range. Passive infra-red alarm systems respond to the combined movement and emission of the intruder which provides a varying radiation signal at the detector. Faceted mirrors or Fresnel lens are used to sub-divide the protected area into separate zones. Movement of the intruder between zones provides the required modulation of the infra-red signal. In practice, broadband thermal detectors are used in these systems and anti-reflection coated germanium windows are included to restrict the response to 8–14μm spectral region. Exclusion of radiation below 7μm avoids such potential sources of false alarms as sunlight and car headlamps, which can be transmitted through external windows. Pyroelectric detectors respond readily to varying infra-red signals but not to a steady radiation level.

Prototype Infra-Red Alarm

CIRCUIT DESCRIPTION (INFRA-RED)

The circuit diagram for the infra-red system is shown in Fig. 3. The mains supply feeds T1 via R1 and its secondary feeds D1–D4, a full wave rectifier, before being smoothed by C1. This unstabilised voltage is fed to IC1 and stabilised to 12V d.c., and further decoupled by C2 and C16.

When a variation in IR heat is sensed (9μm to 14μm) the output current of the detector varies, producing a voltage change across load resistor R27 (C19 and C20 form interference suppression).

This small voltage change is then decoupled by C18 to IC3, a very low frequency amplifier. R7, R8, R9 and C6 form the bias for IC3 whilst VR1, R10 and C7 are the feedback components to determine the gain of this stage, VR1 being the sensitivity control.

R11 and C8 form a low pass filter to remove frequencies not required before further amplification by IC4, a second very low frequency amplifier, the gain being set by R14, R13 and C9.

The output from IC4 feeds a bootstrapped diode pump detector consisting of C10 (two back to back electrolytic capacitors), D7, TR1, C11 and R15, the ratios of C10 to C11 and time constant C11 to R15 chosen for the infra-red detector.

The invalid movement delay formed by R16 and C12 has been reduced to prevent filtering of 'peak' waveforms encountered with pyroelectric detectors.

CONTROL SECTION (COMMON TO ALL ALARMS)

The output of IC5 is normally low and the output of IC6 pin 11 is normally high, driving the l.e.d. D14 via R17 and D8. As movement is detected the output of IC5 rises, reducing the resultant drive to the l.e.d., reducing the brightness indicating movement. If movement and therefore the voltage at IC5 pin 6 is sufficient to reach the threshold of IC6 pin 13, the output of the gate at pin 11 will go low, turning off the l.e.d. D8 is included so that the l.e.d. will not be reversed biased for reliability.

Therefore the l.e.d. indicates:—

(1) That power is connected.
(2) Aids correct setting of sensitivity control—important to prevent false alarms. (Decreasing brightness with movement.)
(3) Indicates the trip threshold of the alarm.
(4) Functions as a walk test—with the alarm in the 'OFF' mode.
(5) The l.e.d. is off when alarm is tripped to be inconspicuous.

Gates a and b of IC6 form a bistable which is held in the reset mode via R26, D13 and R25 when control terminal 'C' is at 12V d.c. When terminal 'C' is open circuit C15 charges via D12 and R23 (the delay on leaving) until the lower threshold of gate a pin 9 is reached, allowing the bistable to be set by pin 13 going high.

When pin 13 goes high pin 10 goes high, charging C13 via R19 (the entry delay) when the threshold voltage of gate c is reached the bistable formed by IC6 gate c and d is set, causing the output at pin 3 to go high, driving TR3 via R20. TR3 turns on and drives the relay RLA via D10. D11 suppresses the back e.m.f. of the relay coil whilst D10 forms an 'OR' function when more than one unit is used, such as in multiple alarm systems.

As the output of IC6 pin 3 is now high C15 is discharged via R23 and R24 (the alarm on time) until the threshold of

IC6 pin 9 is reached, resetting the bistable, causing its output at pin 11 to go high feeding IC6 pin 1 and resetting the output of the bistable, turning off TR3 and RLA. Pin 10 goes low, discharging C13 via R19 when the threshold of IC6 pin 6 is reached IC6 pin 4 goes high, removing the inhibit formed by R18 and D9 (alarm inhibit) at pin 13 IC6.

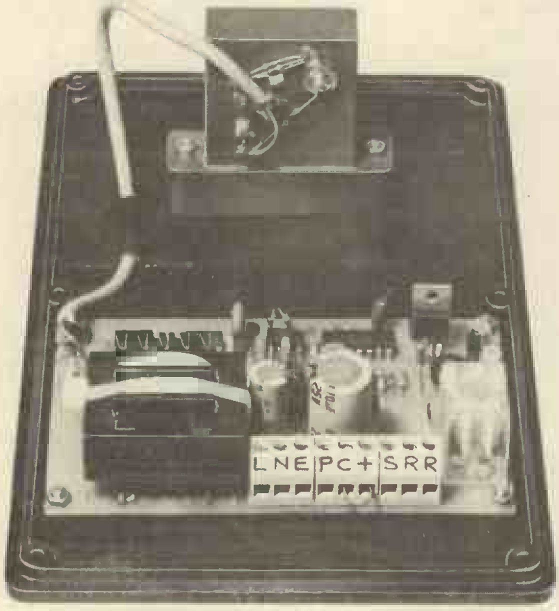
The bistable formed by IC6c and d is normally in its reset state, pin 4 high and pin 3 low. TR2 is normally turned off. If terminal 'P' is connected to terminal 'E' by an external button TR2's base goes low causing it to turn on. Its collector drives the base of TR3, limited by R21, turning it on causing the relay to be activated and instantly sounding the alarm and will latch until reset. If the external button is released TR3 now holds on TR2. By connecting 'P' to '+' TR2 loses its base drive from TR3 and in turn cancels the alarm. C14 and C17 are included to prevent spurious spikes from tripping the panic.

The panic reset switch MUST NOT be left in this position as this will cause the output transistor to overheat and die as the alarm in this position is also in the Ultrasonic active mode and could be tripped via movement. When battery back up is used R2 trickle charges the 2 x PP3 Ni-Cad cells when power is connected and in the event of power failure D5 supplies power for the battery to C1.

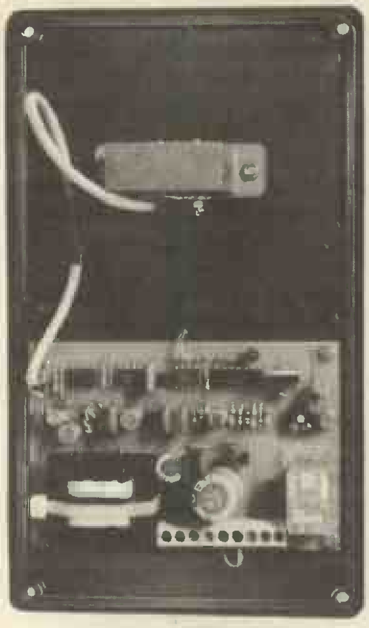
When battery back up is required with the radar system, because of the higher current requirements, the PP3's have insufficient capacity. In this case it is suggested that a more powerful external battery is connected, i.e. 12V car battery. For such a system it is worth while trickle charging a car battery and powering the alarm system from the battery feeding the alarm unit's 12V rail directly, therefore dispensing with the transformers etc.

SWITCHING

All alarm switching is done at 12V d.c., an s.p.c.o. centre off keyswitch provides the control of the alarm whilst a normally open push button operates the panic. If an alarm test is required a normally open push button will sound the alarm but will not latch and will sound the alarm as long as the button is pressed.



Prototype Radar Alarm



Prototype Radar Alarm

PRECAUTIONS WHEN HANDLING CL8960

The microwave module requires some cautionary remarks because the mixer contains a diode of extremely small proportions to enable it to respond to the 10·687GHz frequency. If the mixer or the lead between it and the amplifier is touched with a measuring lead or an object which has not been grounded to the module metalwork, the mixer may be destroyed by static discharge. The mixer is supplied with protection which should be left permanently in situ.

The following procedure should be adopted when connecting the module to the amplifier.

(1) Use screened lead to the main p.c.b. keeping the unscreened ends short (about 12mm).
(2) Connect the 0V rail (E) to the module metalwork 0V tag.
(3) Clip a lead between the module metalwork and the soldering iron bit to equalise potentials.
(4) If the soldering iron is not earthed, clip a second lead between the module and earth.
(5) Touch the live input lead from the amplifier on the module metalwork just prior to connection.
(6) Make the connection to the mixer while maintaining one finger on the module metalwork. Use an iron hot enough to solder quickly to avoid prolonged heat resulting in damage.
(7) Do not measure the voltage at the mixer diode directly—a 10k resistor must be fitted to the end of the lead and touched on the metalwork prior to the measurement.

CONSTRUCTION

Any one of the three alarm units can be constructed on the p.c.b. design shown in Fig. 4. The components layouts are shown in Figs. 5, 6 and 7. The prototype ultrasonic alarm unit was housed in a standard ABS box with the two transducers mounted inside 20mm grommets. Before inserting any components into the case the p.c.b. mounting holes should be drilled along with the adjustment hole in the bottom of the case for VR1. Five 10mm holes should be drilled in the rear of the case for the mains and output leads. These holes should be fitted with 10mm grommets. The centre of the front panel should be drilled to accommodate the indicating l.e.d.

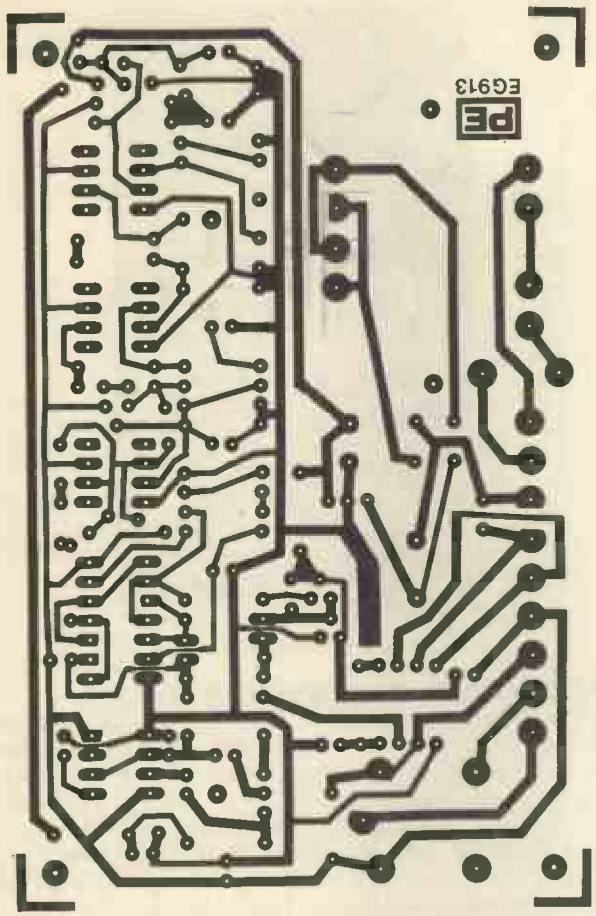


Fig. 4. P.c.b. design for all three alarm units

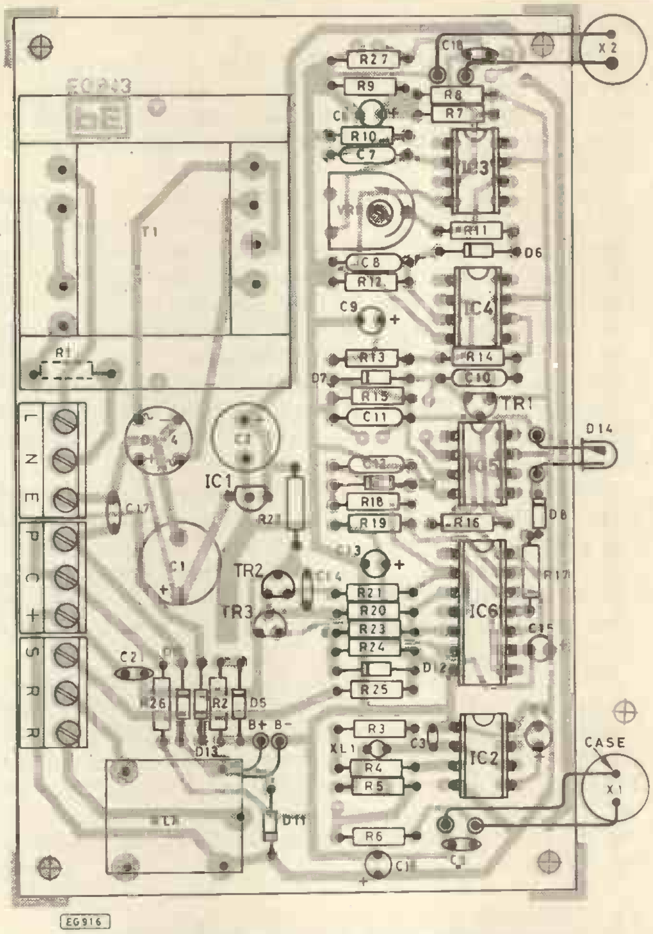


Fig. 5. Component layout for the Ultrasonic Alarm

COMPONENTS . . .

Resistors

	Ultrasonic	Radar	Infra-Red
R1	1k	Link	1k
R2	2k2	—	2k2
R3	10M	Link	—
R4	10M	—	—
R5	220k	—	—
R6	100	Link	—
R7	10k	220k	470k
R8	220k	220k	220k
R9	220k	220k	220k
R10	470	470	10k
R11	4k7	220k	1M
R12	100k	—	—
R13	100	470	10k
R14	470k	470k	1M
R15	4M7	10M	470k
R16	10M	10k	100k
R17	1k	1k	1k
R18	10k	10k	10k
R19	470k	470k	470k
R20	2k2	2k2	2k2
R21	10k	10k	10k
R22	10k	10k	10k
R23	1M	1M	1M
R24	10M	10M	10M
R25	10k	10k	10k
R26	10k	10k	10k
R27	—	22k	22k
R28	—	100k	—
R29	—	220k	—

All resistors ¼W 5% carbon

Capacitors

	Ultrasonic	Radar	Infra-Red
C1	470µ 25V elect	470µ 25V elect	470µ 25V elect
C2	220µ 16V elect	220µ 16V elect	220µ 25V elect
C3	12p ceramic	—	—
C4	22µ 16V elect	—	—
C5	10n ceramic	10n ceramic	—
C6	22µ 16V elect	22µ 16V elect	22µ 16V elect
C7	10n polyester	47µ 16V elect	47µ 16V elect
C8	100n polyester	100n polyester	100n polyester
C9	22µ 16V elect	47µ 16V elect	47µ 16V elect
C10	10n polyester	22n polyester	2 × 22µ 16V elect
C11	100n polyester	100n polyester	22µ 16V elect
C12	100n polyester	100n polyester	100n polyester
C13	22µ 16V elect	22µ 16V elect	22µ 16V elect
C14	10n ceramic	10n ceramic	10n ceramic
C15	22µ 16V tant	22µ 16V tant	22µ 16V tant
C16	22µ 16V elect	22µ 16V elect	22µ 16V elect
C17	10n ceramic	10n ceramic	10n ceramic
C18	1n ceramic	1n ceramic	22µ 16V elect
C19	—	—	10n ceramic
C20	—	10n ceramic	10n ceramic
C21	10n ceramic	10n ceramic	10n ceramic
C22	—	10n ceramic	—

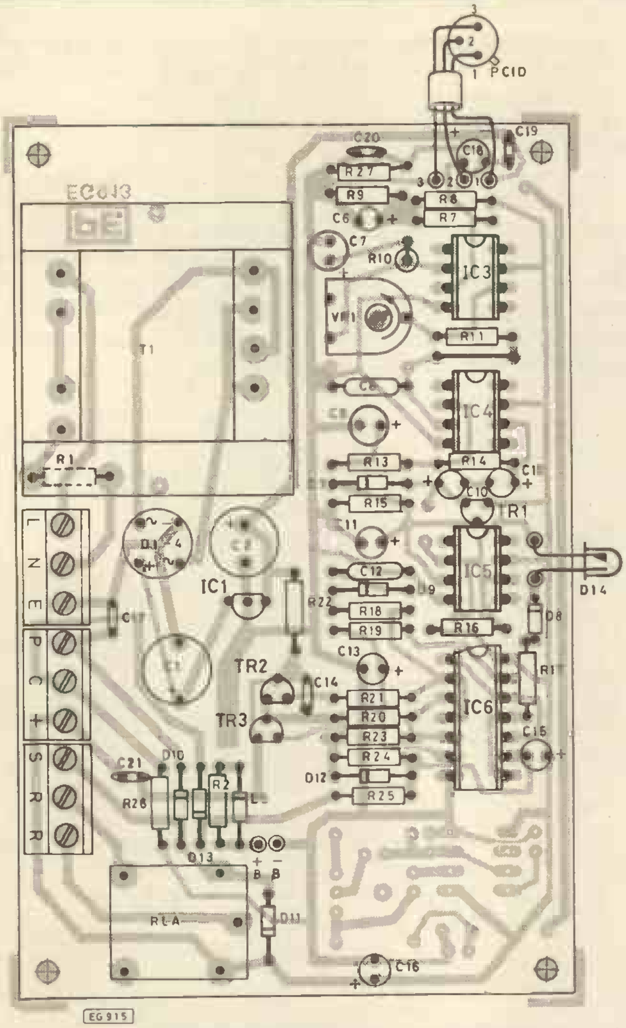


Fig. 6. Component layout for the Infra-Red Alarm

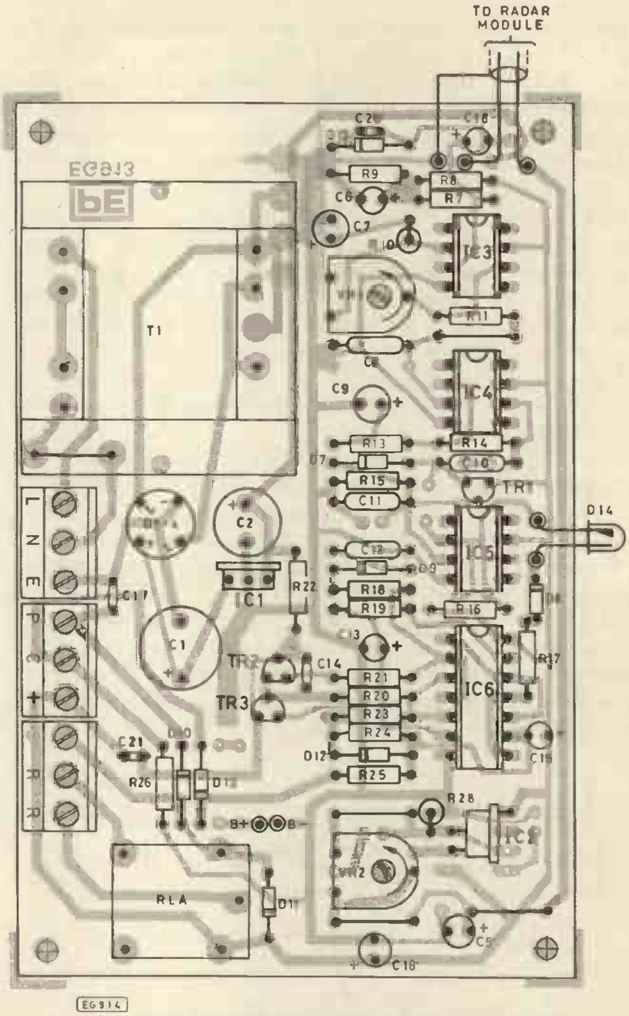


Fig. 7. Component layout for the Radar Alarm

Semiconductors

	Ultrasonic	Radar	Infra-Red
D1-D4	1A bridge rect.	1A bridge rect.	1A bridge rect.
D5	1N4002	—	1N4002
D6	1N4148	Link	Link
D7	1N4148	1N4148	1N4148
D8	1N4148	1N4148	1N4148
D9	1N4148	1N4148	1N4148
D10	1N4002	1N4002	1N4002
D11	1N4148	1N4148	1N4148
D12	1N4148	1N4148	1N4148
D13	1N4148	1N4148	1N4148
D14	3mm l.e.d.	3mm l.e.d.	3mm l.e.d.
TR1	BC549	BC549	BC549
TR2	BC559	BC559	BC559
TR3	BC549	BC549	BC549
IC1	78L12	78L12	78L12
IC2	LM555	78L05	—
IC3	LF351N	LF351N	LF351N
IC4	741	741	741
IC5	741	741	741
IC6	4001	4001	4001

Potentiometers

	Ultrasonic	Radar	Infra-Red
VR1	100k	100k	1M
VR2	—	1k	—

Miscellaneous

T1	15V at 200mA	15V at 200mA	15V at 200mA
RLA	LCNIN-E	LCNIN-E	LCNIN-E

case, grommets, M3 hardware, p.c.b., mounting box, PP3 battery clips, p.c.b. mounting terminals. s.p.c.o. keyswitch.

Special components

Ultrasonic system

XL1	32·7kHz sub-min
X1	T32-18
X2	R32-18

Radar system

CL8960 radar module

Infra-Red system

Pyroelectric dual element detector (PCID)
Faceted mirror
Fresnel lens

Constructor's Note

Complete sets of kits are available from **GJD Electronics, 105 Harper Fold Road, Radcliffe Road, Manchester.**

After the components have been assembled onto the p.c.b. carefully check the tracks for any solder splashes and then check the orientation of the semiconductors and the electrolytic capacitors. The leads to the transducers should be kept as short as possible if unscreened cable is used. If screened cable is used then ensure the braid is connected to the 0V terminal on both transducers.

The prototype radar alarm unit was mounted in a larger ABS box with both the p.c.b. and radar module mounted onto the case lid. The components and leads should be mounted onto the radar module as shown in Fig. 8. A thin layer of polythene should be placed between the module and base to prevent the ingress of dirt and moisture.

Mounting holes for the p.c.b., the two presets and the l.e.d. should be drilled before the components are mounted on the board.

The infra-red alarm was also fitted into a large ABS box with both the board and the faceted mirror mounted on the lid. After the lid has been drilled for the p.c.b. mounting holes, l.e.d. and mirror the p.c.b. can be assembled.

The mirror should be placed in position using double sided adhesive tape. The pyroelectric detector is fitted into a plastic spider to position it correctly at the focal point of the mirror. With the mirror used an 80 degree horizontal angle is obtained over six zones. The dual element pyro doubles this coverage to twelve zones. The mirror can be protected using black polythene although some types may reduce the sensitivity of the unit. Because the infra-red band used is relatively new to this application commercially made filters are not readily available.

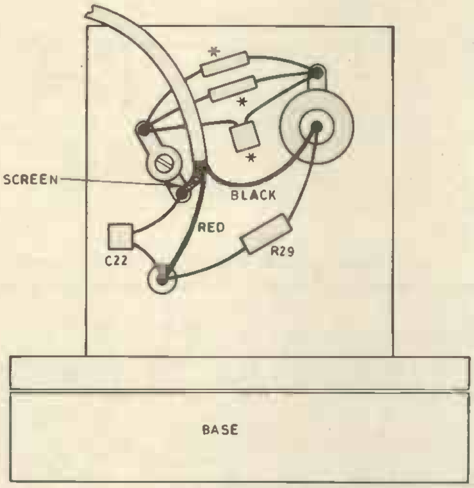


Fig. 8. Wiring diagram of the Radar Module. *These components are supplied ready fitted.

INSTALLATION-ULTRASONIC

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

DO NOT place the alarm on a vibrating surface.
CLOSE all doors and windows.
DO NOT point the alarm at a radiator or convector heater.
Try to install the unit away from direct sunlight because of its heating effects.
Try to install the unit away from telephone bells as they can produce high frequency sound which could trigger the alarm.

Dogs, cats, insects and automatic washing machines should be taken into consideration along with warm air central heating.

In practice best results have been obtained with the unit at floor level as air currents are minimal and foot movement is detected. Objects in front of the unit will limit its range.

When setting up the unit with no movement the red l.e.d. should not flicker; if it does the sensitivity is set too high or air currents are being detected—always use the minimum sensitivity required as over sensitivity could give rise to a false alarm. When adjusting the sensitivity externally a clockwise rotation will increase the sensitivity—a very small screwdriver is required for this adjustment.

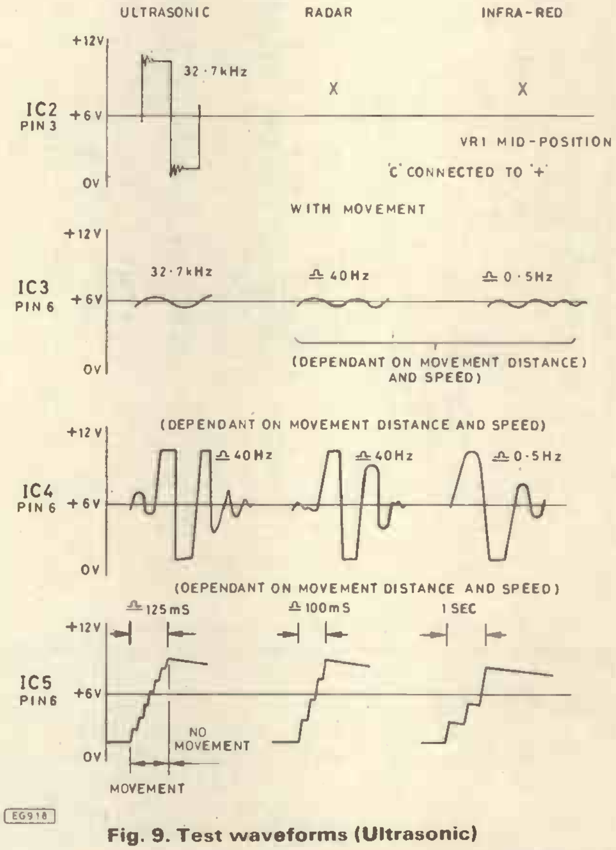
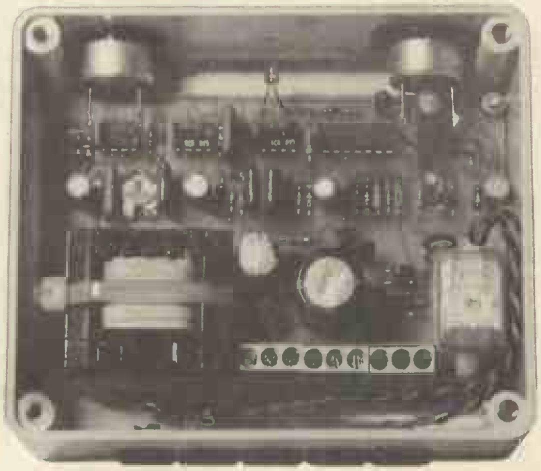


Fig. 9. Test waveforms (Ultrasonic)



Internal view of the Ultrasonic Alarm

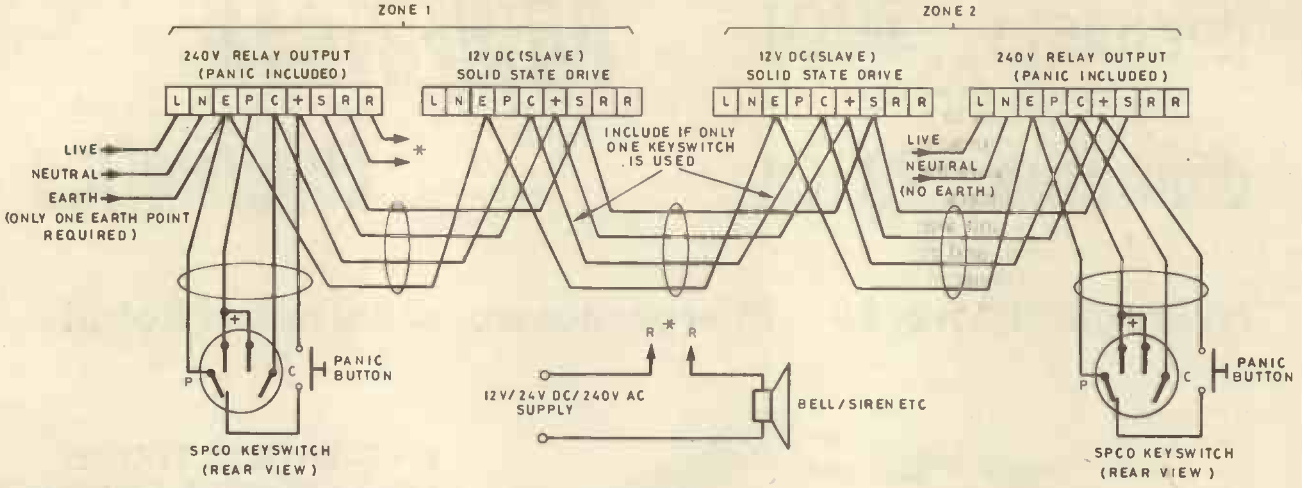


Fig. 10. Wiring diagram for multi-zone protection. A slave unit is powered from a master and does not require its own p.s.u.

TEST VOLTAGES (NOMINAL)

	ULTRASONIC	RADAR	INFRA-RED
Supply	15V d.c.	15V d.c.	15V d.c.
IC2 pin 3	5V	—	—
IC3 pin 7	12V	12V	12V
IC3 pin 6	6V	6V	6V
IC4 pin 6	5·5V	6V	5V
IC5 pin 6	3V	3V	3V
IC6 pin 11	12V	12V	12V
IC6 pin 10	0V	0V	0V
IC6 pin 3	0V	0V	0V
IC6 pin 4	12V	12V	12V

VR1 fully anticlockwise
'C' connected to the supply (no movement)

TERMINAL CONNECTIONS

'L' Mains live feed
'N' Mains neutral
'E' Earth—also the 0V rail of the alarm
'P' When connected to 'E' instantly trips the alarm and latches until reset
'P' When connected to '+' instantly cancels the alarm
'C' When connected to '+' the Ultrasonic is inactive, but in the walk test mode—panic active
'C' When left open circuit activates the Ultrasonic after the 20sec leaving delay
'+' Provides external power up to 12V d.c. at 50mA for solid state sounders
'S' When connected to 'E' activates the alarm sounder for as long as the connection is made—also provides expansion facility.
'R' Normally open relay contacts for switching loads up to 3A at 240V a.c. resistive

The above switching is all done by a s.p.c.o. centre off keyswitch with separate panic and alarm test buttons.

INSTALLATION—RADAR

The sighting of the radar alarm must be done with care as walls and windows can be partially transparent to radar, therefore the following points should be observed:

Consider rain, snow, birds if the alarm is to be used outside with suitable weatherproofing.

Water in plastic drain pipes.

Effects of wind on objects.

Fluorescent lights produce ionised gas which radar reflects.

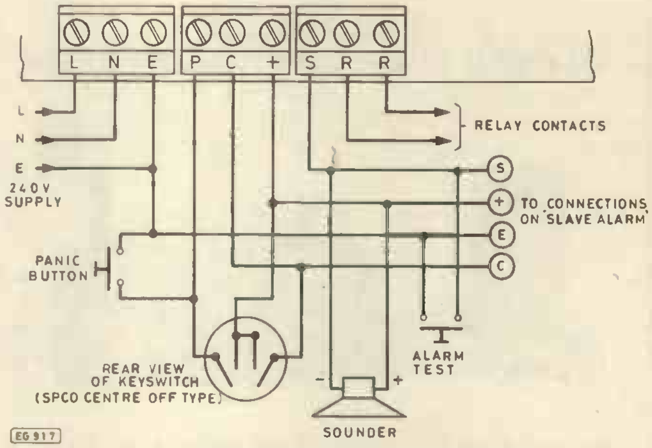


Fig. 11. Connections to a slave unit

Radar reflects off metal objects such as radiators, garage doors, etc. and this effect can be used to increase the area covered by the alarm and also for 'seeing' around corners.

INSTALLATION—INFRA-RED

As most of the heat from a human body comes from the head (when it is clothed) the best position for the unit is around eye level; individual tests will soon reveal the correct height. This still enables pet lovers to protect their home even with the family pet roaming around the house. Because draughts and open windows do not readily cause false triggering open fronted premises and warehouses can also be protected.

If an electronic fence is required a narrow twin beam using a Fresnel lens (suitable for transmission of 10μm) can be used to focus the heat onto the pyro. This lens eases weatherproofing problems as the enclosure can now accommodate the lens as a weatherproof window.

Although the pyro itself does not detect draughts it should be protected from direct draughts to reduce any imbalance between the two pyro elements contained within the TO5 style can. The pyro is also microphonic and should not receive any mechanical shocks which could give rise to false triggering.

To prevent excessive heat, do not allow direct sunlight to fall onto the pyro or mirror. ★

Genesis S101

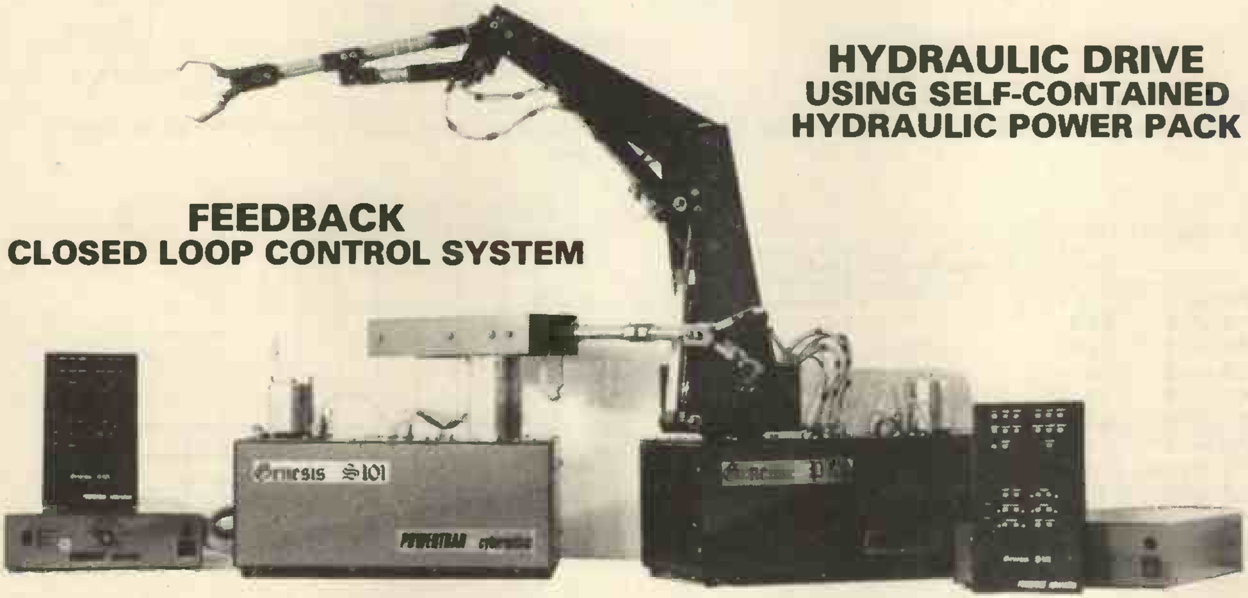
Genesis P101

POWERTRAN cybernetics

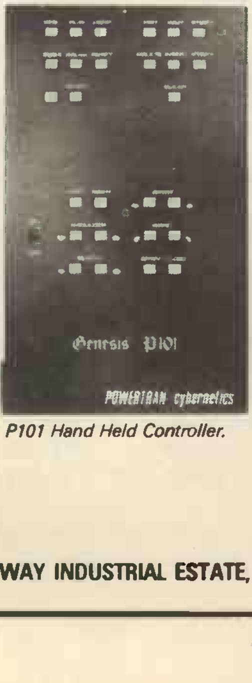
Hydraulic Powered Microprocessor Controlled Robots

HYDRAULIC DRIVE
USING SELF-CONTAINED HYDRAULIC POWER PACK

FEEDBACK
CLOSED LOOP CONTROL SYSTEM



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



P101 Hand Held Controller.

Example prices and specifications

Genesis S101

Base: 19.5″ × 11″ ×7.5″
Lifting capacity: 1500gm
Arm lift: 6.6″
Weight: 29Kg

4 axis model in kit form **£390**
5 axis model in kit form **£445**
5 axis model READY BUILT **£790**

Genesis P101

Base: 19.5″ × 11″ × 7.5″
Lifting capacity: 2000gm
Arm lengths between axles: 14.0″
Weight 34Kg

4 axis model in kit form **£495**
6 axis model in kit form **£595**
6 axis model READY BUILT **£950**

COMPLETE SYSTEMS AS SHOWN IN PHOTOGRAPH ABOVE

Genesis S101

4 axis system in kit form **£635.50**
5 axis system in kit form **£695.00**
5 axis system READY BUILT **£1355.00**

Genesis P101

4 axis system in kit form **£742.00**
6 axis system in kit form **£852.00**
6 axis system READY BUILT **£1525.00**

As featured in this journal November '81–April'82 issues.

For further details please contact:

POWERTRAN CYBERNETICS

PORTWAY INDUSTRIAL ESTATE, ANDOVER, HANTS SP10 3WN

Telephone: ANDOVER (0264) 64455

INDUSTRY NOTEBOOK

By Nexus

£12k Off!

We are all suckers for the supposed 3p or 5p off a bar of soap or a packet of cornflakes in the local supermarket but when exhorted to save £12,000 even the most cynical shopper feels compelled to investigate.

This is the enticing offer made by Piher, the big name in small resistors. Certainly an eye-catching ploy but reading the smaller print we discover that the saving is per million resistors on assembled cost.

Productivity and cost-cutting is the name of the game on production lines so production managers are keenly examining Piher's offer and analysing the argument advanced for using resistor modules.

The modules consist of factory-assembled (by Piher) resistor arrays in 14 or 16-pin dual-in-line packages containing, respectively, 7 or 8 carbon-film resistors to the customer's specified values. Piher's £12,000 is the saving obtained through inserting 125,000 8-resistor modules into PCBs compared with inserting a million individual resistors one at a time.

Certain assumptions are made in Piher's calculations which will probably surprise the electronic hobbyist unfamiliar with large-scale electronics assembly or production costings. First is the assumption that the assembly worker is paid £2·25 per hour wage but with factory overheads added the true cost to the company is £9 per hour. Second is that resistors cost £4 per thousand. Third is that on average throughout the day 360 resistors are manually inserted per hour. On these assumptions the total cost of buying a million resistors and manually inserting them in PCBs is £29,000 of which £25,000 is labour cost.

With the same resistors pre-assembled into 16-pin packages the line assembler inserts only 140 units per hour but as each module contains eight resistors the insertion rate is much faster per resistor and labour cost per million resistors falls to £8,000, a saving of £17,000. But whereas the discrete million resistors cost £4,000 the cost of the same million pre-assembled into modules is more than double at £8,750. This, however, still represents a net gain of £12,250, handsomely meeting Piher's claim of £12,000 'off'.

Of course there are a lot of variables in individual cases and Piher thoughtfully provide a set of graphs on which production managers can plot their own labour, overhead and other costs to determine the benefit, if any, he may expect to obtain.

I have described the philosophy of resistor modules in some detail because it so ably illustrates the facts of life in competitive industry. Clearly the equipment manufacturer stands to gain. Equally clearly the resistor manufacturer gains because he has doubled the cost of his product and so increased his turnover and profit. The end customer stands to gain if the equipment manufacturer passes some part of his saving on to the purchaser.

It looks as if everybody wins. But not quite. As labour costs have tumbled by two-thirds it suggests that only one assembler is now required rather than three. The resistor manufacturer has increased his workload, of course, but as the modules will be machine-assembled he needs only a marginally increased workforce, a tiny fraction of one of the two workers made redundant. The transfer of work between the two companies does not result in an equal transfer of employment.

Look-Alikes

Piher's low-cost resistor modules are available to anybody, the more the merrier as far as Piher is concerned. The cost benefits, whether more or less, depending on individual circumstances, are universal.

When it comes to an end-product a typical aim is exclusivity. The commonly used protection is to take out a patent but this is not always fully effective. There are many direct infringements bringing good business to lawyers and much ingenuity is often applied to getting round existing patents by would-be copiers.

Thus, Fluke's novel 8020 Series of hand-held digital multimeters which appeared in 1978 were unique. Their 'brain', was a custom-built IC chip which gave them exclusivity. Or so Fluke thought at the time. But similar instruments soon appeared on the market and today some 25 manufacturers are making look-alikes using what is said to be an almost identical but commercially available chip.

Fluke's response has been to set up their own chip-making plant in the USA in the hope that a new digital multimeter due for launch about now will retain the marketing edge conferred by a Fluke-designed, Fluke-manufactured IC. By bringing the whole operation in-house the possibility of leak of chip design to outsiders is minimised. No doubt the new design will attract copiers but this time a look-alike competitor model could take longer to achieve and probably not worth while in time or money.

Despite the rash of imitations a Fluke spokesman claims that the company holds over 30 percent of the market in hand-held digital multimeters and expects to win a much larger slice with the new model.

On the Beam

The laser, in its early days very much an invention in search of an application, has turned out to be more versatile than any of us ever imagined and has generated plenty of new business.

Who would have thought that the ladies, God bless 'em, would be queueing up for laser rejuvenation courses at beauty salons? Both pulsed and CW lasers are in use with rival claims for success in revitalising skin tissue. One treatment depends on the laser beam being directed at acupuncture points, so bringing space-age technology and an ancient Chinese therapy into newly fashionable conjunction.

Those most ardent perfectionists, banknote forgers, have latched on to the merits of the laser beam colour scanner in the printing industry. Highest quality counterfeit notes produced by this technique are appearing in several countries and, according to Interpol, are difficult to detect. In the UK the £10 and £20 denominations are most commonly forged. You have been warned!

Defence

The political and military confrontation over the Falkland Islands is bound to have a long term effect on the defence electronics industry. This was the first ever major naval engagement in which the whole range of modern defence electronics has been fully deployed in real, rather than simulated, battle. Moreover, deployment was in the most testing physical environment. What equipment worked well, badly or not at all will be the subject of months of study. How efficient was the man-machine interface when the man himself was weary after weeks at action stations and constant alarms? How reliable the communications and command network? How effective the electronic countermeasures?

The analysis will be rigorous, the lessons one hopes honestly faced and acted upon. But as well as performance analysis of the equipment in the South Atlantic environment there is certain to be a reappraisal of overall defence strategy which will probably result in greater emphasis on the conventional surface fleet and less on the sub-surface nuclear deterrent.

Defence electronics is a key element in the industry as a whole and is likely to be stimulated rather than retarded by the Falklands experience.

Indicators

Meanwhile, despite the crisis, all the economic indicators showed continued improvement. Shares, balance of payments, strength of sterling remained on an upward trend. Investment continued with Honeywell putting up £1·3 million for a new keyboard plant in Scotland as just one example. Employment remains the domestic trouble spot. That £1·3 million, for instance, creates only 40 new jobs initially, with a potential of 100 jobs, but the probability is that they will be filled by internal transfers as productivity increases elsewhere in Honeywell.

COMBO AMPLIFIER

PART ONE

Fred Judd
E.A. Rule

A TOP performance "combo amplifier" costs a good deal of money these days. The design offered here can be constructed for about half the price of an amplifier with similar facilities and comparable performance, in fact the performance is *better* than comparable with others at present available since it is based on the *Practical Wireless* "Winton" high fidelity amplifier design by E. A. Rule.

The facilities available with the *PE* combo amplifier are as follows:

1) Completely self-contained.
2) Maximum power output: 50 watts—single 8 Ohm speaker/100 watts—two 8 Ohm speakers in parallel.
3) Twin preamplifier channels with mixing facilities.
4) Bass and treble controls both channels.
5) Auxiliary preamplifier for high level signals.
6) 6dB bass lift (20Hz) for full frequency range—hi-fi range.
7) Inputs for microphone or guitar on each channel.
8) Output/input sockets for external accessories such as Wah and Fuzz units etc.
9) Speaker system tested and proved in an Anechoic chamber to hi-fi standards.
10) Output stages use latest and virtually indestructible power MOS-FET's.

PRE-AMP SPECIFICATION

Mic. inputs	Suitable 200 ohm or higher 2mV for max output
Guitar input	Impedance approx 100Kohms 30mV for max output
Aux. input	Impedance approx 100Kohms 30mV for max output
Accessories socket OUT	J5 or J7 low Z 200mV
Accessories socket IN	J6 or J8 low Z 150mV
Signal to Noise	Guitar and mic inputs–60dB relative to maximum output
Signal to Noise	Auxiliary input –75dB relative to maximum output
Distortion factor	Comparable with that of power amplifier
Tone controls	±10dB 50Hz–10,000Hz.
Frequency response	Flat 20—20,000Hz (with S1 at +dB bass recovery). See responses in Fig. 2.

THE CIRCUITRY

A block diagram of the system is shown in Fig. 1. The primary inputs on each of two channels are for microphone (200 Ohms or higher) and/or guitar. The arrangement therefore allows one microphone and one guitar to be used simultaneously at any set level, or, of course, two microphones or two guitars.

The Accessories Links (one for each channel) allow for the insertion of wah-wah, fuzz unit or reverb units etc. on either channel. The following stage (IC2) provides full bass and treble lift or cut (approx ±10dB) after which the channel outputs are mixed into IC3 (one half). This stage, and the auxiliary amplifier (half of IC3) each have a facility for a +6dB bass lift at 20Hz to compensate for speaker roll-off. The combined outputs from IC3 then go to the main amplifier which is capable of driving one 8 Ohm bass mid/range speaker system at 50 watts or two similar speaker systems in parallel at 100 Watts.

PREAMPLIFIER PERFORMANCE SPECIFICATION

The full circuit for the preamplifier stages is given in Fig. 3 in which IC1 is the initial stage for the microphone and guitar inputs on each channel. The output (each channel) is taken to an accessory output socket (JK5 and JK7) for feeding wah, fuzz, phasing or reverb units etc. with outputs being returned to the input(s) of IC2, and which also has the tone control networks in feedback between output and input. The outputs from IC2 are taken via a mixing network VR3-VR4 and R15-R16 to the final stage (IC3B) which has provision

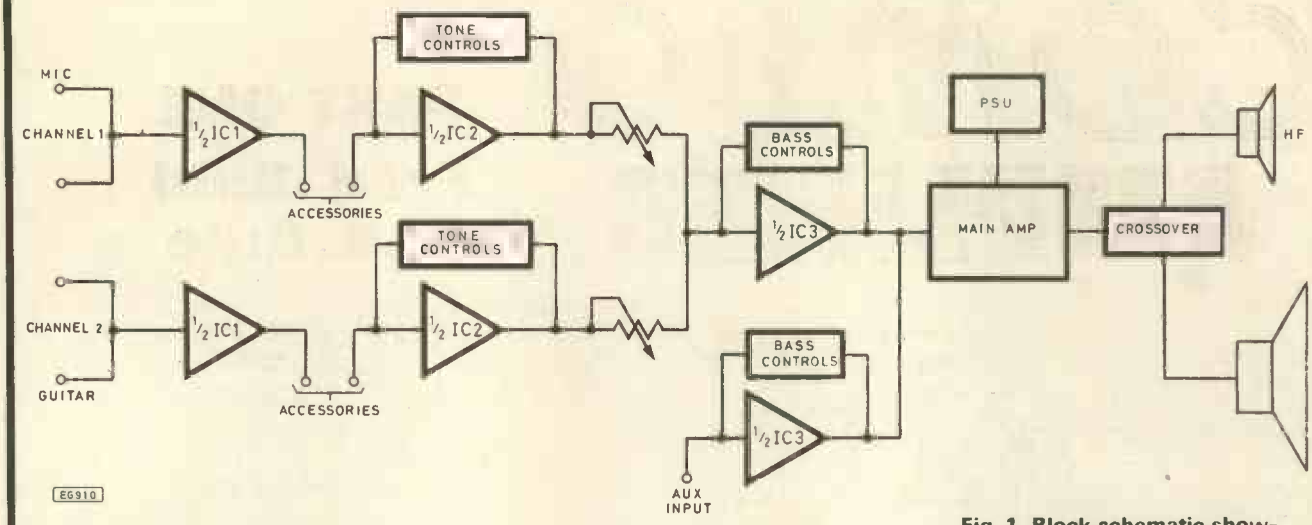


Fig. 1. Block schematic showing details of the combo-amplifier system

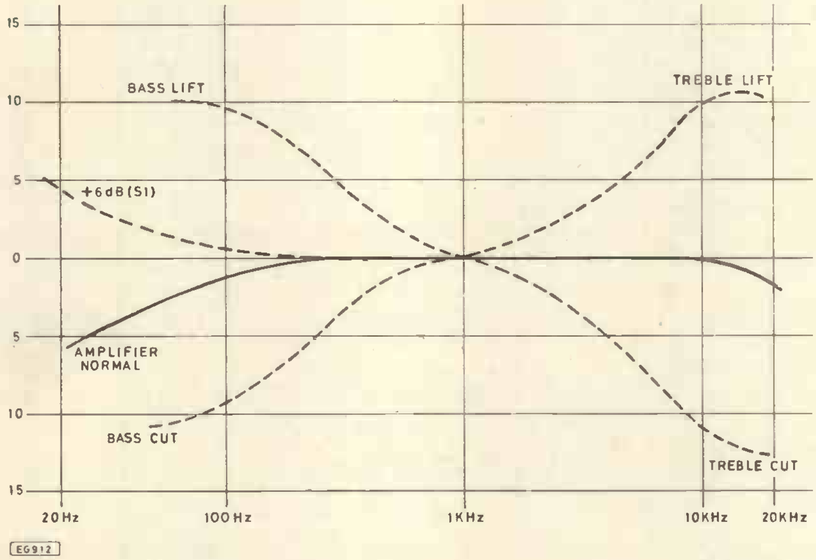


Fig. 2. Frequency responses including those of the tone controls

for a bass lift (S1) of 6dB at 20Hz to make the overall frequency response including speaker system virtually flat between 20 and 20,000Hz. The remaining half of IC3 is the auxiliary input amplifier with feedback adjusted gain to provide an input sensitivity of 300mV suitable for line output from a tape recorder or similar source. This also has provision for the 6dB bass lift at 20Hz. The combined outputs of channel 1 and 2 (via IC3b) and the auxiliary amplifier (IC3a) are taken directly to the power amplifier unit which will be fully dealt with in Part 2.

NOTE: R21 and R41 in the preamplifier circuit have been deleted and the capacitors (68p) marked CX1, 2 and 3 have been added.

THE CIRCUIT BOARD

Layout and component positions for the preamplifier printed circuit board are given in Fig. 4. Note that R21 and R41 as in the circuit diagram Fig. 3 have been replaced by wire

A three part project describing the following:

1) Pre-amplifiers performance and construction

2) Power amplifier and PSU construction

3) Cabinet construction

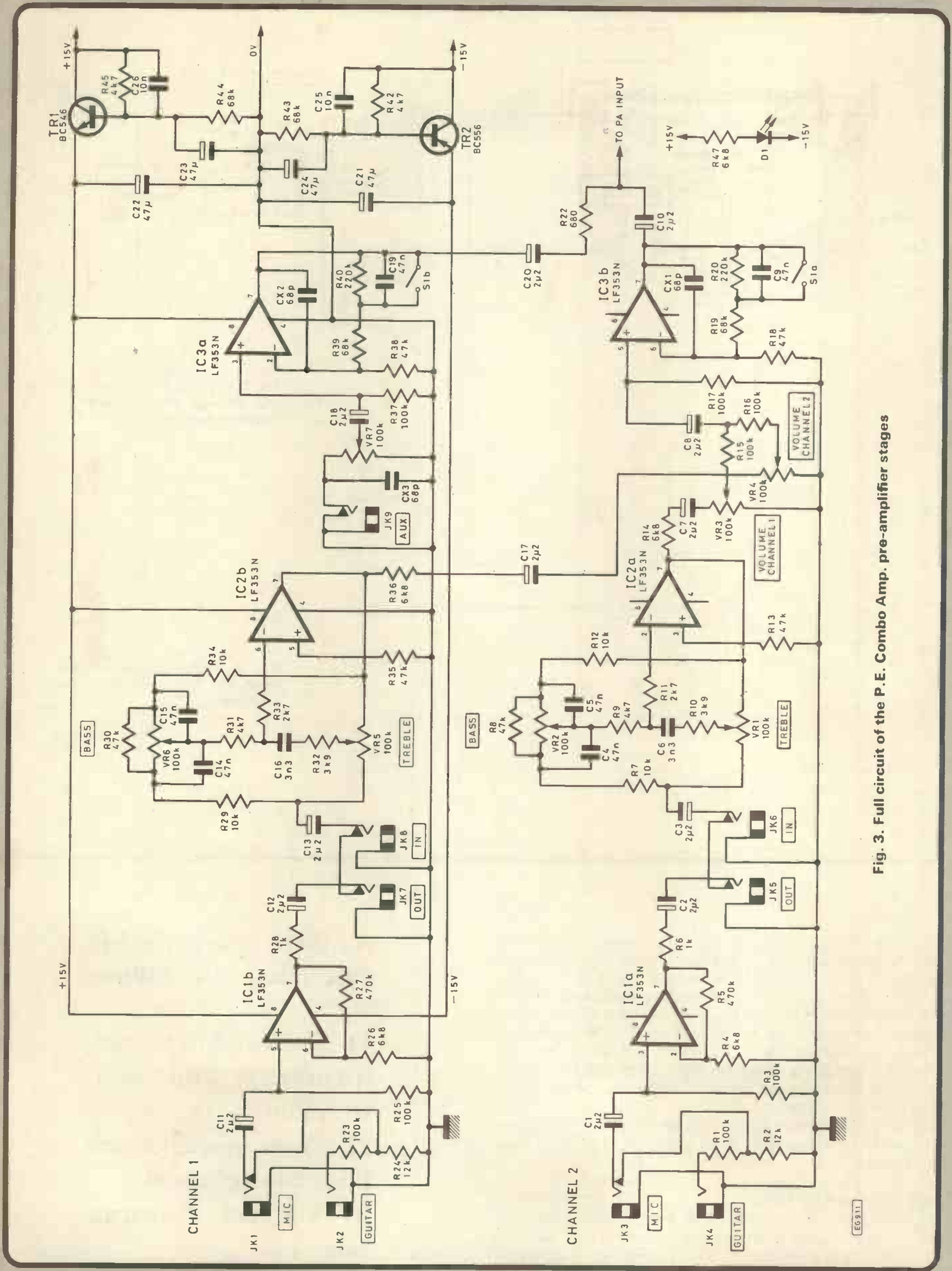


Fig. 3. Full circuit of the P.E. Combo Amp. pre-amplifier stages

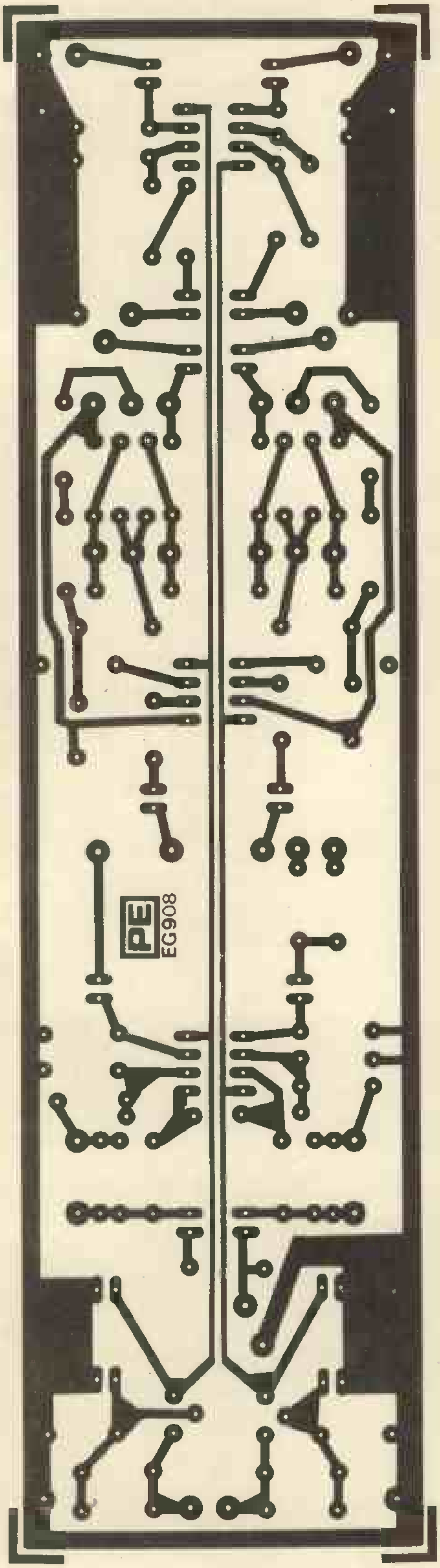


Fig. 4. Printed circuit layout of preamp

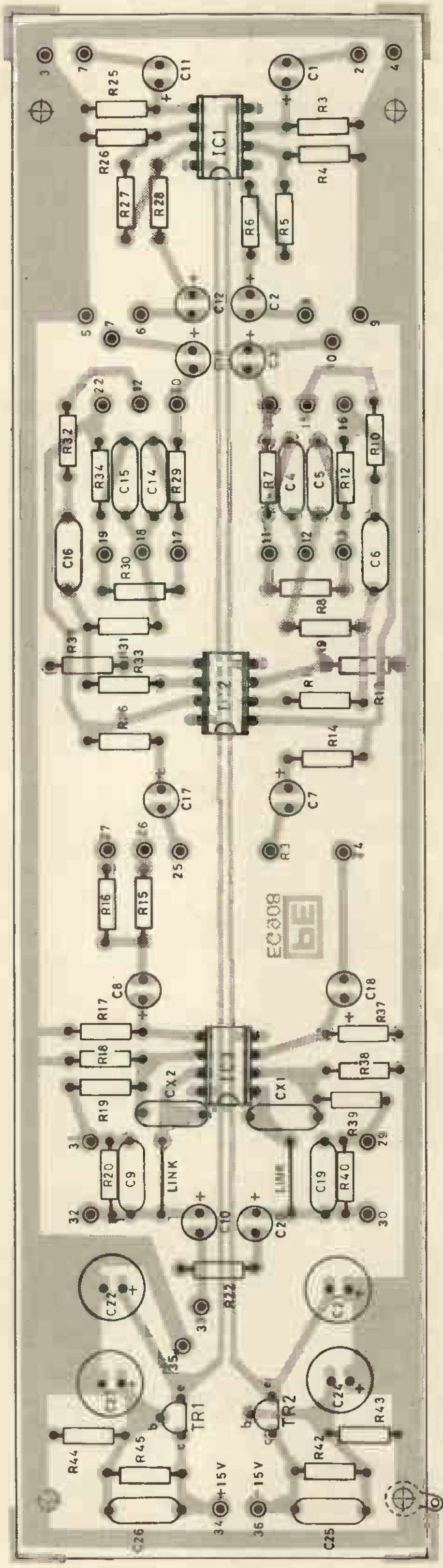


Fig. 5. Component overlay of preamp

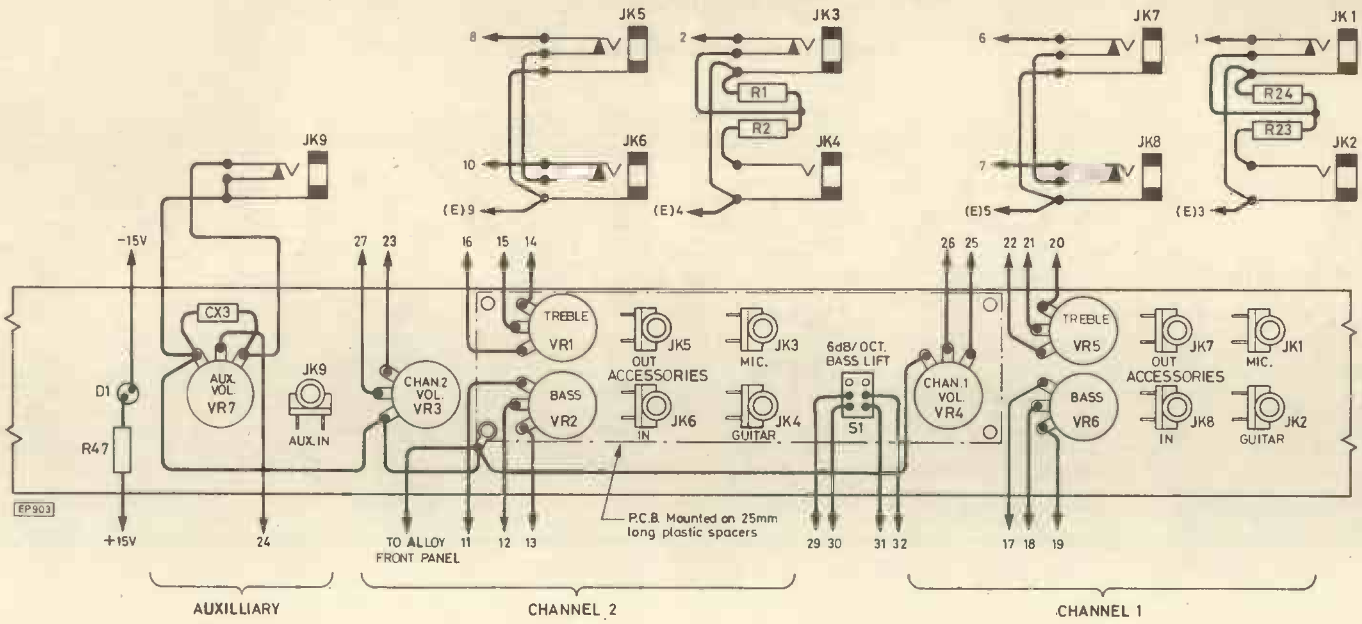


Fig. 6. Location of input/output sockets, panel controls and wiring. (Circuit board is mounted on pillars)

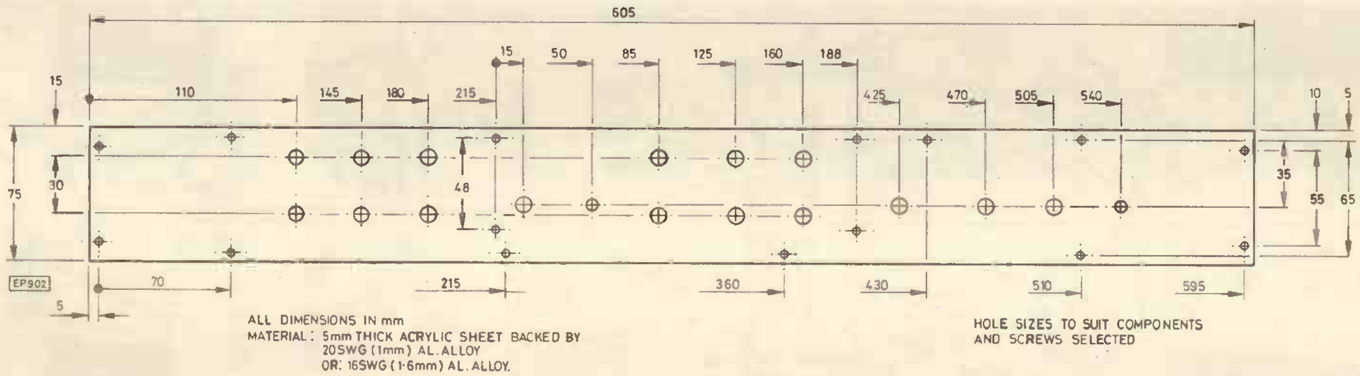


Fig. 7. Details for drilling of front panel

COMPONENTS . . .

PREAMPLIFIERS

Resistors

R1, R3, R15, R16, R23, R25, R37	100k (7 off)
R2, R24	12k (2 off)
R4, R14, R26, R36, R47	6k8 (5 off)
R5, R27	470k (2 off)
R6, R8	1k (2 off)
R7, R12, R29, R34	10k (4 off)
R8, R13, R18, R30, R35, R38	47k (6 off)
R9, R31, R42, R45	4k7 (4 off)
R10, R32	3k9 (2 off)
R11, R33	2k7 (2 off)
R19, R39	68k (2 off)
R20, R40	220k (2 off)
R21 and R41 (deleted—see text)	
R22	680 ohms

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

Potentiometers

VR1, VR2, VR5, VR6	100k midget linear (RS161-818) (4 off)
VR3, VR4, VR7	100k midget log (RS161-723) (3 off)

Capacitors

C1, C2, C3, C7, C8, C10, C11, C12, C13, C17, C18, C20	2µ2 50V elect. (12 off)
C21, C22, C23, C24	47µ 50V elect. (4 off)
C4, C5, C9, C14, C15, C19	47n (6 off)
C16, C17	3n3 (2 off)
C25, C26	10n (2 off)
CX1, 2, 3	68p (silver mica)

Type immaterial unless stated

Semiconductors

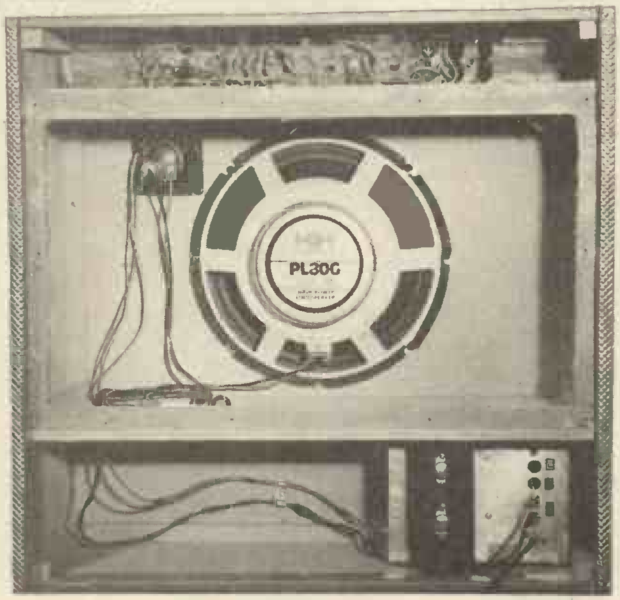
D1	Red l.e.d.
TR1	BC546
TR2	BC556
IC1, 2, 3	National LF353N or Texas TL072CP (3 off)

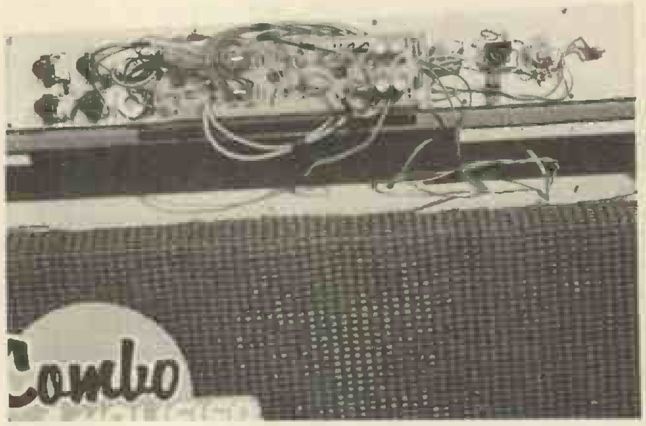
Miscellaneous

Printed circuit board
Front panel

JK1–JK9	Standard $\frac{1}{4}$in. jack sockets with closed contacts (RS477-573) (9 off)
S1	DPDT miniature toggle (RS316-989)

P.c.b. pillars





straps and CX1 and CX2 (68p) have been connected between pins 1 and 2 and 6 and 7 respectively on IC3. *Note also that screened leads must be used for connections to the jack sockets JK1/2, JK3/4, JK5/6, JK7/8.* The finished board is mounted on stand-off pillars on the front panel and details of this will be found in Fig. 6.

The front panel may be made from black or coloured perspex backed with a thin aluminium panel (20 or 22SWG) as in the prototype or the panel may be all aluminium of 16SWG thickness. If perspex, or other non-conducting material, is used, the thin aluminium backing panel must be included. Details for drilling are given in Fig. 7. Distribution of the panel components is shown in Fig. 6.

The preamplifier could, of course, be completed before the main amplifier (details in part 2) and this could be checked out with a suitable voltage supply. Input signal levels and frequency responses etc., as quoted, can be related to approximately 150mV output from the preamplifier with volume controls at maximum.

NEXT MONTH:
the power amplifier and PSU module

MICRO-PROFESSOR REVIEW

MICHAEL TOOLEY B.A.

Michael Tooley is Principal Lecturer in Electronics at Brooklands Technical College, Weybridge.

THE Micro-Professor is a low-cost Z80 based microcomputer system intended for the hobbyist and enthusiast as well as the student and technician. The Micro-Professor aims to provide the user with an interesting and inexpensive introduction to the microprocessor world and, since it is primarily intended as a learning aid, the accompanying "User's and Experiment Manual" forms a significant part of the package. Other applications include process control, timing, sequential tone generation ("music") and as a low-cost microprocessor development aid.

The basic system incorporates an Z80 central processor unit (CPU), 2K read-only memory (ROM) and 2K random access memory (RAM) together with a keyboard and hexadecimal display consisting of six seven-segment l.e.d. indicators. A cassette tape interface is included; also a small loudspeaker. An on-board regulator provides power for the system in conjunction with an external a.c. mains adaptor. The system is fully expandable and a range of additional modules is available which includes additional RAM and ROM, programmable input/output (PIO) and counter/timer circuits (CTC). For those wishing to develop the system even further, speech synthesis and EPROM progammer boards may also be added.

FIRST IMPRESSIONS

The Micro-Professor comes securely packed in a corrugated cardboard box measuring 350 × 210 × 70mm (approx.). Inside, the Micro-Professor itself is contained within a neat, but rather "plastic", book-style case measuring 255 × 200 × 48mm (approx.). The case is secured by means of a press-stud fastener and opens out to reveal the microprocessor board in the right hand leaf and a deep recess in the left hand leaf. Just what this, apparently unused, space is intended for is not immediately obvious since neither the "User's Manual" nor the a.c. power unit will fit into the space! However, it appears that an earlier (and smaller) edition of the manual was intended to occupy this position and it can also be used to accommodate such items as the optional speech synthesiser or EPROM programmer boards.

The a.c. mains adaptor operates from a nominal 240V 50Hz supply and provides a nominal 9V output at 600mA. Early Micro-Professor power units were enclosed in a moulded case fitted with an integral 2-pin round mains plug. This type of plug is very inappropriate for use in the U.K. unless, of course, you happen to have an abundance of shaver sockets in your home! Happily, the unit is now supplied with a conventional 13A mains plug.

The sizeable manual has a format just slightly smaller than standard A4 size and contains well over 300 pages. The manual is divided into three parts; a "User's Manual", monitor listing, and a section entitled "Microcomputer Experiments (Software/Hardware)". The first section (111 pages) is extremely comprehensive and includes basic operations, program de-bugging and monitor sub-routines as well as a description of the software and hardware (including full circuit diagrams and i.c. pin-outs). The second section (51 pages) contains a full monitor listing (Copyright Multitech Industrial Corporation) which has 2659 statements. The final section (144 pages) provides an introduction to the design of microcomputer programs and gives details of 18 varied experiments based on the Micro-Professor system.

The system hardware is mounted on a neat and tidy p.c.b. measuring 220 × 155mm (approx.). This screen printed, double sided p.c.b. is a push-fit into the book-style case and includes a user breadboard area. The display and keyboard are both eminently visible and easy to use. These items alone render the Micro-Professor superior to many of its rivals.

HARDWARE

The hardware specification of the Micro-Professor is shown in Table 1. The system clock at 1·79MHz is derived from a TTL oscillator and 3·58MHz crystal. The fundamental frequency is divided by a 74LS74 bistable and then applied to the Z8—CPU. A second 74LS74 bistable provides system reset from the keyboard 'RS' button. A 2516 EPROM contains the monitor (address 0000–07FF) whilst a 6116 static RAM provides 2K bytes of user memory (address 1800–1FFF). To provide a further 2K bytes of memory a second 6116 RAM may be fitted in a "memory expansion area". Alternatively a 2516 (or similar) EPROM may be fitted in order to facilitate demonstration or

The Micro-Professor in its case together with the EPROM and Speech Synthesis boards and respective manuals.

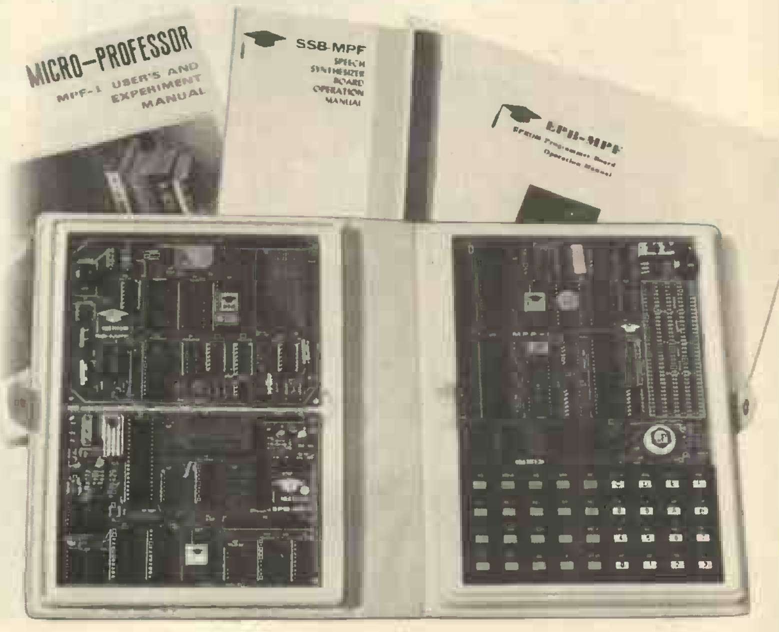


Table 1 HARDWARE SPECIFICATION OF THE MICRO-PROFESSOR

CPU: Zilog Z-80 CPU with 158 instructions and 2·5MHz maximum clock rate. For MPF-I, system clock is 1·79MHz.
ROM: Single +5V EPROM 2516(2532)x1, total 2K(4K) bytes. Monitor EPROM Address: 0000-07FF(0FFF).
RAM: Static RAM: 6116, total 2K bytes. Basic RAM Address: 1800-1FFF.
Memory Expansion Area: Single +5V EPROM 2516/2716/2532/2732 EPROM or 6116 static RAM on-Board Expansion Address: 2000-2FFF.
I/O Port: Programmable I/O Port 8255x1, total 24 parallel I/O lines. I/O Address: 00-03.
Programmable PIO, a total of 16 parallel I/O lines. I/O Address: 80-83H.
Programmable CTC, a total of 4 independent counter timers. I/O Address: 40-43H.
Display: 6 digit 0·5 inch 7-Segment red l.e.d. display.
Keyboard: 36 keys including 19 function keys, 16 hexadecimal keys and 1 user defined key.
Speaker and Speaker Driver Circuits: A 2·25 inch diameter speaker is provided for user's expansion.
User Area: Provides a 3·5 inch x 1·36 inch wire wrapping area for user's expansion.
Audio Tape Interface: Can be connected to any cassette. Data rate is 165 bps.
System Clock Rate: 3·58MHz crystal divided by 2, cycle time is 0·56 micro-sec.
System Power Consumption: Single 5V power supply, current consumption 500mA.
Mains Power Input: Power adapter Input 240V 9V/600mA.

Physical Characteristics:	Height:	1·60mm (W/O case)
	Width:	15·75cm (W/O case)
	Depth:	22·30cm (W/O case)
	Weight:	1·41lb (with case)

user-defined programs in ROM. A somewhat primitive, but none the less effective, 2K BASIC ROM is also available for those wishing to extend the system for programming in this ever-popular high level language.

An 8255 programmable input/output port interfaces the keyboard and display with the rest of the system. In addition sockets are fitted for Z80—PIO (programmable input/output) and Z80—CTC (counter/timer) integrated circuits. The PIO/CTC bus is available on a 40-way connector as is the Z80—CPU bus. The left-hand four digit of the seven segment display indicate the address while the two remaining digits indicate the data. The segments (anodes) are fed from the 8255 via two 75491 drivers whereas the cathodes are multiplexed from the 8255 and driven by a single 75492.

The keyboard has 36 keys; 19 are function keys, 16 are hexadecimal keys and there is 1 user-defined key. The function keys occupy the left-hand side of the keyboard whilst the hex. keys are grouped together at the right-hand side. Despite the relatively small size of the individual keys, there is plenty of clearance around them and, furthermore, the action is quite "positive"; requiring a depression of approximately 2mm before the contacts make. Altogether the keyboard is very satisfactory from the ergonomic as well as mechanical and electrical standpoints.

The user breadboard area measures 90 x 35mm (approx.) and has 175 separate pads on a 0·1 inch matrix for mounting dual-in-line integrated circuits at either 0·3 inch or 0·6 inch spacing. Supply rails are also provided and there is ample space for mounting either 1 x 40-pin, or 2 x 28-pin, or 8 x 14-pin DIL devices together with associated components.

The on-board 7805 regulator has barely adequate heatsinking which is provided by a small area of copper foil on the component side of the p.c.b. At 500mA load current the regulator is dissipating 2·5W and runs at an alarmingly high temperature. The tape recorder sockets (3·5mm printed circuit mounting jacks) are adjacent to the regulator and consequently they also run warm. One wonders whether this was intentional or just a fortunate coincidence? Despite the very high temperature of the regulator, no adverse effects were noticed after soak testing the unit for several hours at an ambient temperature of 30 degrees C and with the display reading "8888–FF". *(We understand that all units are now being supplied with a heat sink fitted to the regulator—Ed.)*

SOFTWARE

The software specification of the Micro-Professor is shown in Table 2. The 2K byte monitor program contained in a 2516 EPROM provides the necessary facilities to enable the user to develop and run his own programs. The most elementary function of the monitor is that of allowing the user to inspect and alter the data at each address in the user RAM. Various other functions, such as single-step, set break point etc, are available together with routines which allow reading and writing of data from an external cassette recorder. A full listing of the monitor program is included in the "User's Manual" and, although this may be of little use to the beginner, it will undoubtedly prove to be of considerable value to the more advanced student.

A few simple safeguards are provided in order to warn the user of error conditions. One of these alerts the user to "illegal" key entry by blanking out the display. The display returns when the "illegal" key is released. The monitor functions are, on the whole, straightforward and easy to use however, the "User's Manual" has some serious shortcomings, particularly when the user is unfamiliar with the terminology and may have no previous experience of programming in machine-code. Furthermore, the relatively complex Z80 is a rather inappropriate choice of microprocessor for use in an elementary training aid which concentrates on machine level programming. Many other 8-bit microprocessors would have been better suited to this application and one can only speculate as to why the Z80 was chosen.

THE USER'S MANUAL

The "User's Manual" is extremely comprehensive but does not, unfortunately, adequately cater for the absolute beginner. This may be of little consequence when the user is following an established course of study but could present very severe problems for the individual starting from scratch. An early introduction to the general concepts and terminology of microprocessor systems would be highly desirable. The manual is also a little illogical in its structure. Early "examples" of the use of the keyboard are more readily understood if the "description" (which follows each section) is studied *before* attempting to key the examples into the microcomputer. Furthermore, some of the examples are explained in bewildering terms and there are numerous (and sometimes inexcusable) typographical errors. It

Table 2

SOFTWARE SPECIFICATION OF THE MICRO-PROFESSOR

2K-byte monitor provides key functions and incorporates a memory checking routine. The key functions are as follows:—

RS	: system reset.
ADDR	: set memory address.
REG	: set register name.
DATA	: input data to memory or register.
PC	: recall program counter.
+	: check the next memory address or register.
−	: check the last memory address or register.
STEP	: execute user's program, a single step.
SBR	: set break point of user's program.
CBR	: clear break point of user's program.
MONI	: immediately break user's program.
GO	: go to user's program or execute some monitor function.
INS	: insert 1 byte into memory.
DEL	: delete 1 byte from memory.
MOVE	: move data block from one area to another.
RELA	: relative address calculation.
TAPE WR	: store memory data onto audio tape.
TAPE RD	: retrieve data from audio tape.
INTR	: maskable interrupt, connected to CPU's INT pin.
USER KEY	: user defined key, connected to input port 00, bit 6.

*

AF	BC	DE	HL	AF	BC	DE	HL	IX	IY	SP	I·IF	SZ·H	·PNC	SZ·H	·PNC
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

: hexa-digit or register name.

EA371

really is a great shame that, with so much useful information presented, it has not been offered in a form that can be readily assimilated.

The experiments themselves occupy the last part of the manual. They are adequately structured; each has a declared "purpose", the "time required" is stated (often this is 4-8 hours), and some "theoretical background" is given for each. The experiments have been chosen so as to familiarise the student with various facets of microcomputers. The topics are varied and well chosen and include such items as branch instructions, program loops, sub-routines, binary-to-BCD, and BCD-binary conversion, and keyboard and display multiplexing. Altogether this is a program which will be welcomed by both teachers and students of microprocessors.

EXPANSION

One of the most crucial aspects of any microcomputer system is the degree of expansion that is possible. Where a microcomputer is purchased primarily as a learning aid it is, of course, quite likely that the owner will wish to progress to a more powerful system when the time comes. For many, however, the cost of such an upgrade can be prohibitive and, whilst there seems to be an active second hand market for microcomputers, it would be nice to think that a "first" system would be sufficiently flexible to adapt and grow to meet its user's future needs. What, then, has the Micro-Professor to offer?

Firstly there are three vacant sockets on the Micro-Professor's p.c.b. One of these constitutes the "memory expansion area" to use its rather grandiose title! This 24-pin i.c. socket can accept either RAM or ROM devices and thus the user-memory may be extended to 4K or, alternatively, a 2K tiny-BASIC ROM may be fitted. The remaining two unoccupied i.c. sockets accept the Z80-CTC and Z80-PIO devices. These i.c.'s may, of course, be obtained from a large number of U.K. suppliers. They are, however, very competitively priced when purchased as part of the Micro-Professor system.

Secondly two expansion boards are available. One of these is a complete speech synthesis unit whilst the other provides EPROM programming facilities. Both boards are built to the same high standard of construction as that of the Micro-Professor and occupy exactly half the area of the host-controller p.c.b. They thus fit together neatly in the left hand leaf of the Micro-Professor book-style case. Connection to the Z80-CPU bus is by means of 40-way ribbon connectors — the only slight criticism being that the case will not close when the ribbon connectors are in place. All this makes for a very neat, tidy, and compact system.

BASIC

The 2K tiny-BASIC ROM plugs into the "memory expansion area" and allows the user to program in BASIC. The available commands and statements include CALL, CONTINUE, FOR . . . NEXT, GOTO, GOSUB, IF . . . THEN, LET, LIST, LOAD, NEW, PRINT, RETURN, RUN, SAVE and STOP. Users may also call machine-code sub-routines resident in the Micro-Professor memory. A keyboard overlay is provided and the display is used to examine the program on a line-by-line basis. This, unfortunately, takes some getting used to—particularly when the display moves! Tiny-BASIC is, of course, very limited by comparison with its more powerful counterparts. It does, however, help to bridge the gap between machine-code and high level language and may be a worthwhile addition for those wishing to progress beyond Hex.

SPEECH SYNTHESIS

The speech synthesis board is designed around the TMS5200/5220 voice synthesis processor. This device employs linear predictive coding and data held in ROM determines the instantaneous signal frequency and amplitude. The ROM fitted is a 4K TMS2532 which contains 32 words; sufficient for a simple time-clock program. Sockets are fitted which can accept two further ROMs in order that the vocabulary to over 150 words and there is a choice of eight ROMs, each containing approximately 30 words. The ROM supplied provides two speech programs a test/demonstration vocabulary and a small user storage area. The speech synthesiser uses the Micro-Professor as host controller and the keyboard, display and loudspeaker of the Micro-Professor act as input and output devices.

Voice pitch and volume are adjustable by means of multi-turn pre-set potentiometers. The manual contains operating instructions (which are somewhat brief by comparison with those supplied with the Micro-Professor), hardware details, and a program listing. There are no "experiments" as such, however, the system can be regarded as more a demonstration than an experiment package. There is, of course, considerable scope for the more intrepid programmer wishing to include speech output with programs devised for the Micro-Professor. For him, the speech synthesis board can be considered an exciting and challenging extension to the basic unit.

EPROM PROGRAMMER

Like the speech synthesis board, the EPROM programmer connects to the Z80-CPU bus via a 40-way ribbon cable. It is, in fact, possible to have both the speech synthesis board and the EPROM programmer board linked to the Micro-Professor simultaneously by virtue of duplicate 40-way male connectors fitted to each p.c.b. The EPROM programmer caters for TMS2508, 2516, 2532 and 12758, 2716, and 2732 devices. It incorporates an 8255 PIO together with 4K of static RAM in the form of two 6116 integrated circuits. The monitor is a 2516 and the 5V and 25V rails are regulated by 7805 and 723 devices respectively. A zero insertion force socket is fitted to accept the EPROMs for programming.

The manual explains the function of the monitor program and contains instructions in much the same form as that used in the Micro-Professor "User's Manual". The EPROM programmer has its own mains adaptor (as is the case with the speech synthesis board) and the system becomes a little cumbersome when all three a.c. adaptors are connected to it. The alternative would be to have one power supply for the whole system. This, of course, would have to be substantially up-rated by comparison with any one of the existing power units. If the whole system were to be powered from a single +5V rail (from, say, an external 317 bolted to an adequate heatsink) the +25V rail for the EPROM programmer could be derived from a simple on-board d.c.-d.c. converter. In the first instance this would, of course, make the system a little more expensive but it would effect a considerable saving later on and would make the fully expanded system a good deal tidier.

SUMMARY

In any equipment review, the question "Is it good value for money?" inevitably arises sooner or later. In the case of the Micro-Professor, it really depends upon what you want from the package. In terms of the hardware offered the Micro-Professor certainly does represent good value. The keyboard and display are of a particularly high standard and the quality of construction is excellent. In terms of software, and the "User's Manual" in particular, it is important to be aware of the shortcomings of the system. Prospective purchasers should be warned that the system (in its most basic form) is really only suitable for those requiring a rigorous, if a little tedious at times, introduction to machine-code programming. For those having aspirations to proceed to a higher level language the Micro-Professor, with its tiny-BASIC, is not particularly to be recommended.

As a thorough introduction to machine level programming it succeeds admirably and, as a teaching aid, it could prove invaluable. Users with no previous experience of microprocessors will, however, have to do a considerable amount of background reading in order to derive full benefit from the Micro-Professor.

The Micro-Professor is available from the U.K. distributors; Flight Electronics Ltd, at Flight House, Quayside Road, Bitterne Manor, Southampton, Hampshire SO2 4AD.

The price of the basic Micro-Professor (including mains adaptor and manual) is £69.95. The Z80 PIO and CTC devices each cost £4.02, the Speech Synthesiser Board £64.95 and the EPROM Programmer Board costs £74.95. The latter items both include power supplies, manuals, and interconnecting ribbon cables. The tiny-BASIC ROM costs £15 and is supplied with a manual and keyboard overlay. Note that prices do not include VAT. Postage and packing is £2.95 per system and 50p for individual ROM's and i.c.'s.

NOTE: The following information has been received from Flight Electronics since this review was written:

From the middle of June all Micro-Professor 1 systems will have the 2716 Monitor EPROM replaced with a 2532 EPROM that will contain both the monitor source program list and the BASIC Interpreter. Also included will be a BASIC Manual, Keyboard Overlay and a seven segment l.e.d. Interpreter Card. In addition, the User's Manual will be supplied as three separate parts to aid the user. However, the price of the system will remain the same.

Microsynth...

Part Three A.R. Bradford M.Sc.

IN this final part setting up of the synthesiser will be covered together with a series of test programs. Case construction is also covered.

VCOs

Selecting the square wave output from VCO1, take VCO1 down to its lowest frequency by pressing the lowest key, setting the Range switch to 16′, and then using the Sweep pot routed via the thumbwheel into the Keyboard, so that VCO1 is just oscillating. Adjust VR13 for the fastest buzz. Reduce frequency again using the thumbwheel and readjust VR13 for the fastest ticking. This process has nulled the offset on VCO1 integrator IC11, enabling the oscillator to stay in tune for very low input currents. Switch off VCO1 using the switch on the "Shape" pot and turn the thumbwheel to zero (towards the front). Repeat the above process for VCO2, selecting the square wave output and using the VCO2 frequency control and adjusting VR17. Remember to turn VCO2 Level up.

The ramp waveforms from each VCO are now adjusted in turn. Turn VCO2 Level down and switch VCO1 on. Selecting the ramp waveform from VCO1 sweep the oscillator over its entire range using the Range switch and the Sweep/Thumbwheel combination, and adjust VR15 to ensure that the output does not disappear or become distorted at either end of the range. An oscilloscope is useful here but by no means essential. Repeat the process for VCO2 adjusting VR19.

Next, using VCO1 at the low end of its range (16′), play a scale; this should be in tune, so bend the frequency down very low using the thumbwheel and adjust VR8 for an accurate scale. This process nulls out the offset on the keyboard range amplifier, IC7.

OCTAVES

Now the octaves may be set up using the keyboard and the Range switch. Working either side of the 4′ range, which requires no adjustment, set the ranges an octave apart by adjusting VR5 and VR6 (8′ and 2′ respectively), followed by VR4 and VR7 (16′ and 1′ respectively).

Tuning of the whole instrument relative to another instrument is achieved by turning VR1.

VCF

Select a ramp waveform from VCO1 and switch the VCF "Kbd Mod" on. Set the VCF frequency control half way thus filtering the ramp waveform down to a smooth tone and sweep the keyboard using the range switch. VR22 should be adjusted so that there is no obvious change in harmonic content as the keyboard is swept. Switch both VCOs off and turn up the Noise Level control. With the Q control at maximum it should now be possible to play a crude scale of whistles from the filtered white noise.

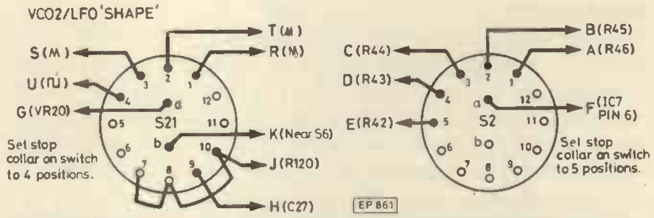


Fig. 10. Wiring of rotary switches viewed from underside of main p.c.b.

ENVELOPE

Set the Attack and Release controls about one quarter turn, and switch the Envelope Shaper to "Auto" using S8. Upon pressing a key the output may latch up (not decay away once the Attack cycle has been completed). If this is the case turn VR11 anti-clockwise until the sound dies away again. If VR11 is too far anti-clockwise, the output volume in "Auto" mode may be appreciably quieter than in "Manual" mode. Therefore turn VR11 clockwise to equalise the output volume in the two modes of operation, but making sure that the envelope resets correctly without latching up. Check also that the 'Repeat' functions. If not turn VR11 clockwise.
Finally, each time a key is pressed there will probably be a thump at the output; this should be nulled out using VR25.

FAULT FINDING

Assuming there are no faults up to now the Microsynth should be set up and ready for use. If the VCOs malfunction for no apparent reason, it may be that CMOS chip IC14 has been damaged by static during insertion. Replacing this chip usually cures such inexplicable faults. It now remains to test out all the various functions of the Microsynth. It is

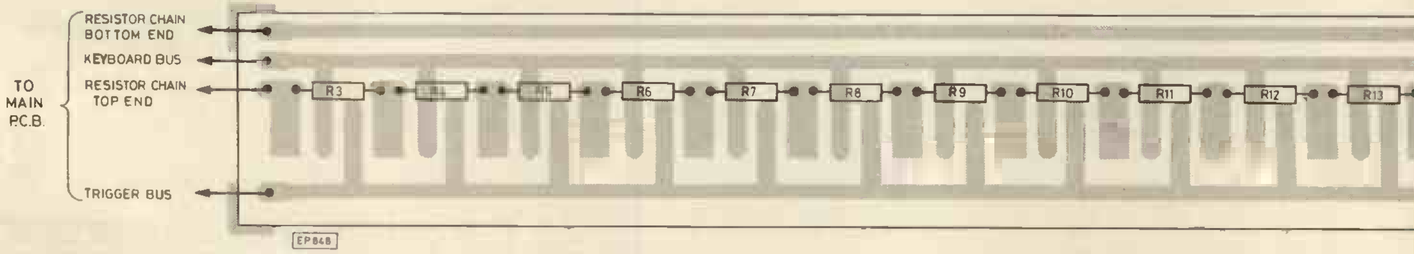


Fig. 11. Showing copper side of keyboard p.c.b.

suggested that the test programs listed below are run through—if these all work it is unlikely that there is anything wrong with the circuitry.

Should any function fail to work, check the p.c.b. against the component schedule and circuit diagrams, inspecting the relevant area of the p.c.b. for incorrect components, dry joints, solder bridges, diodes or transistors in the wrong way round, etc. Where one part of the synthesiser is connected to another some distance away, follow the relevant tracks making sure that there are no breaks, shorts, pins missing, etc, in these links. 99 per cent of all faults can be isolated in this way and will generally be found to be due to some trivial mistake in construction.

TEST PROGRAMS

Set all function switches (except "Drift") to the left between programs.

Star Wars

Switching VCO2 to LFO mode disables the audio output and sets the operating range from about 0·1Hz to 30Hz. The LFO may be used to sweep the keyboard automatically; use the ramp waveform from VCO1 and try the effect of the various waveforms available from VCO2/LFO. Route the LFO output either directly into the Keyboard using S14, or via the thumbwheel, setting "Source" to "LFO" and "Destination" to "KBD". Use the square wave from the LFO in conjunction with the "Shape" control to vary the duty cycle.

Waa-waa

Switch the Envelope output into the VCF. Set the Q control about two thirds up and VCF Frequency fairly low; set Envelope Level about half way positive. Keep Attack and Release times fairly short and remember to only use VCO waveforms with a high harmonic content, that is, ramp or square waves. You should now have the typical Moog sound. A slightly longer Attack and shorter Release and you will start to get a trumpet-like voice. Try switching in some Sub Octaves at this point!

Wind

Disable both VCOs and turn up the Noise Level control. With the VCF Q knob set fairly high and the low pass output selected, varying the VCF Frequency control will generate wind effects. Switch the VCF output to band pass and get rain too! Try the envelope on "Auto" and "Repeat" (or alternatively triggered from a slow-running LFO) for generating percussive, rhythmic effects—steam trains are quite easy using a repeat time of about 0·3 seconds and suitably short Attack and Release times. Don't have the Q control too high though. Alternatively, turn the Attack and Release times right round to maximum and switch the Sustain to "Hold". Use the "Repeat" facility rather than LFO triggering. Q low, VCF frequency mid-way, and a small positive Envelope Modulation in to the VCF and you will start to get a seascape. When you are happy with this, turn VCO1 on with

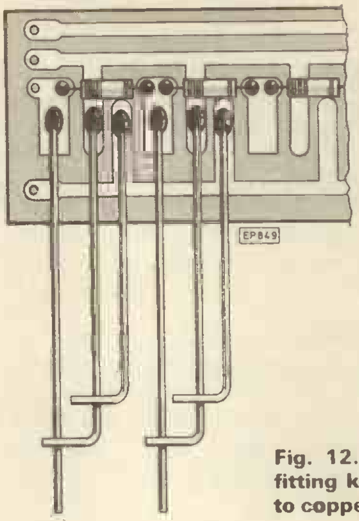


Fig. 12. Showing method of fitting key contacts (soldered to copper side)

a triangle output, switch the Range to 2′ and the "Drift" switch to "Down". The repeatedly hit keys at random for the complete treatment.

Bells

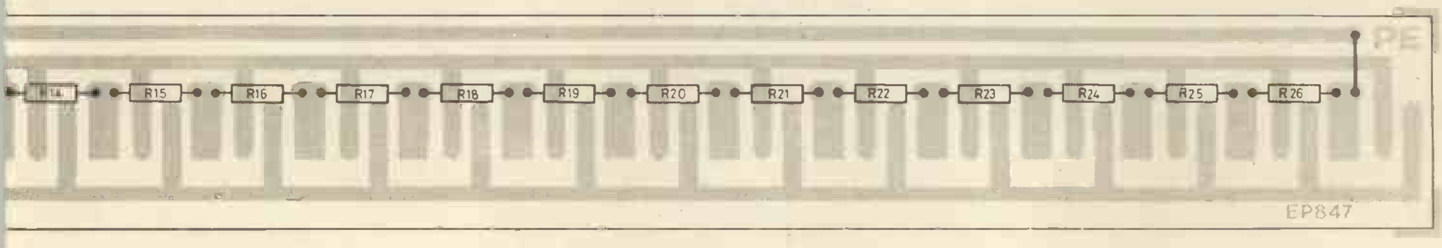
Using the triangle outputs from both VCOs, switch VCO2 to "Ring Mod" and switch VCO2/LFO modulation into the VCA. Pressing a key and bringing up the volume of VCO2 will gradually introduce sum and difference tones. Set VCO2 at some anharmonic ratio of VCO1's frequency. Switch the Envelope to "ADSR" and sustain to "Auto" with short Attack and fairly long Release times. Alternatively use VCO2 in LFO mode to modulate the keyboard with a slow, low amplitude triangle (vibrato!). Note that the LFO speed can be changed by the Envelope as it rises and falls (switch Envelope Modulation into VCO2) so that the speed of the vibrato is fast to start with and slows as the envelope dies away, or vice versa. Try the effect of the sub octaves with VCO1

Organ

The use of triangle oscillators to provide relatively pure tones, while the VCF filters other waveforms (in this case the Sub Octaves, one each under VCO1 and VCO2), really comes into its own with this program. Switch the "ADSR" off, Sustain to "Manual", with Attack and Release times short. Tune VCO2 to, say, an octave and a third below the pitch of VCO1, and there you have it!

Random/Staircase

Have the envelope repeating at a fairly brisk rate (remember to have the Sustain on "Auto" for this effect to work; with Sustain on "Manual" and the "Repeat" on you will get a sort of echo every time you release a key!) and switch the thumbwheel Source to "S & H" (Sample and Hold). Push the thumbwheel fully up. Route the thumbwheel output into the keyboard. With VCO1 and VCO2 tuned to some interval



or other, the Sample and Hold will sample VCO2 waveform and the pitch of both VCOs will be modulated apparently at random. Alternatively switch VCO2 to LFO mode, running slowly with a ramp or triangle output. VCO1 will now be modulated by the staircase waveform coming from the Sample and Hold. Next set up the wind effect again and switch the thumbwheel output into the VCF to achieve trendy random or staircase filtering effects (the LFO must be running, with the level control fully up). This also works well with a ramp output from one or both VCOs—listen to a Jean Michel Jarre album sometime!

VCO1 mark/space modulation

Use the triangle output from the LFO to modulate the VCO1 squarewave (remembering to select the square wave output from VCO1). Slow, large amplitude modulation will give a phasing effect while somewhat faster, small amplitude modulation will give a chorus or string ensemble effect. Try switching in the Sub Octaves.

Harpsichord

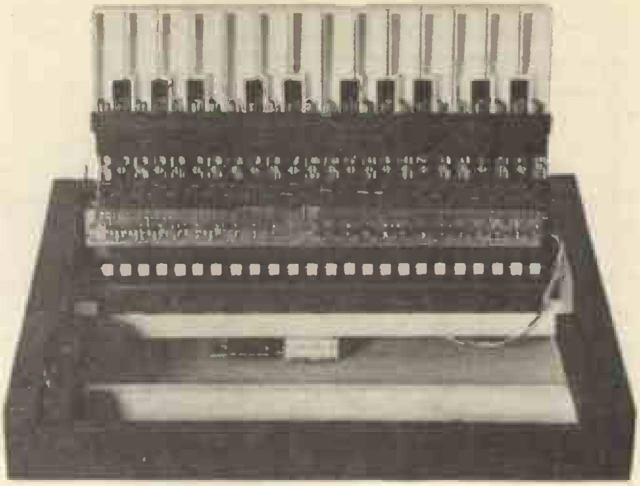
Try the chorus effect with a sharp Attack and longish Release, the "ADSR" switch on, and the VCF switched to band pass. Vary VCF Frequency control for the best result. Try the sub octaves. See what effect the VCF "Keyboard Mod" switch has.

Once the whole instrument has been tested you can really start experimenting! Try anything and everything—the most interesting effects tend to be discovered by accident. Keep a stock of program sheets and record the settings for any effect you wish to keep—there are so many possibilities it is pointless relying on memory.

CASE CONSTRUCTION

Ready built cases and panels will be available from *Clef*, but for those constructors wishing to make their own the dimensions are shown here. It is possible to use a longer keyboard if desired simply by extending the length of the case and the front panel. The end cheek shown in Fig. 14 is the same regardless of the length of keyboard used, while the front, back and keyboard support bars (all of equal length) should be 15½in for the 25 note keyboard.

The case was assembled by drilling ¼in holes in the end cheeks in the positions shown and screwing 2in wood screws through these directly into the front and back pieces, but if preferred there is ample room for gluing batons into the corners and screwing into these. Either way the screw heads should be countersunk into the wood of the end cheeks. Having built the basic frame, the bottom panel is cut from ¼in plywood or hardboard and glued and screwed in place, again countersinking. This bottom panel should be cut slightly larger than the framework and then planed off flush with the walls once in place.



Showing hinged keyboard assembly

Dummy keys are cut from ¼in wood as shown in Fig. 13 and glued inside each end cheek, having first securely araldited the thumbwheel to the left hand end cheek. Remember to solder the wires to the edge pot first, as you won't be able to get at it afterwards. ⅜in square x 6in strips of wood are glued along inside the top edges of the end cheeks to form panel supports, being placed slightly below the tops of the end cheeks to allow for the thickness of the panel. Plane off also the top edge of the back wall at a slight angle to allow for panel thickness, so that when in place the panel will fit flush with the tops of the end cheeks.

A cut out should be made in the back wall of the cabinet and a small piece of 16 s.w.g. aluminium drilled to take the sockets and the mains cable. This should then be sprayed black and labelled and screwed in place behind the cut out, see Fig. 15. The dimensions will depend on the type and number of sockets used: the sequencer terminal should be a 5 pin 180° latching DIN socket; the outputs will normally be ¼in jack sockets, although professional users may prefer cannons, while for purely domestic use through a hi-fi, phono sockets may be best.

Fill the screw holes with wood filler and sand down; the

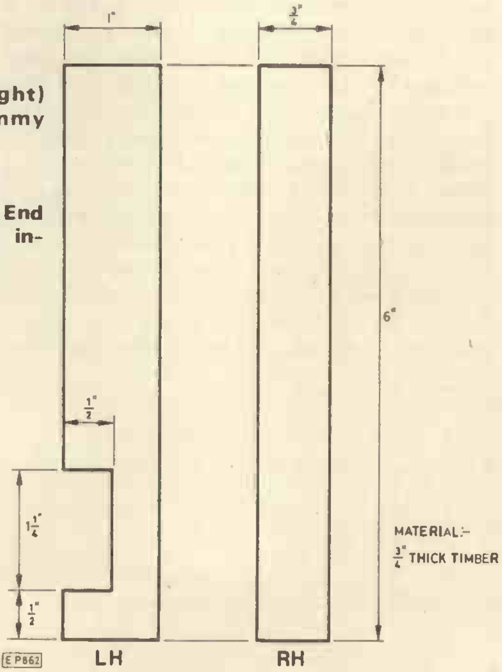
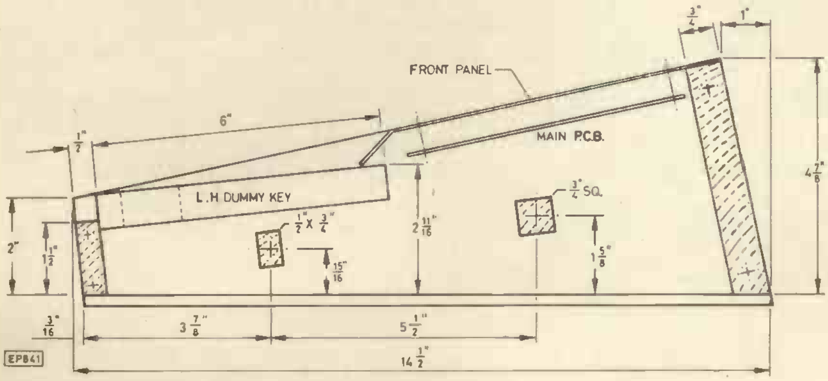


Fig. 13. (Right) Showing dummy keys

Fig. 14. (Below) End cheek detail of instrument



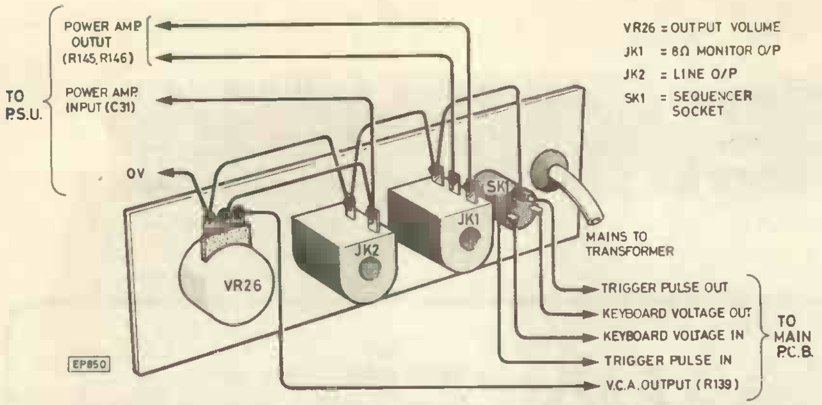


Fig. 15. Rear panel connections

entire case is now covered with black plasticised cabinet cloth (obtainable from Maplin or most electronic/disco shops), using a "Thixofix" type adhesive. Both surfaces must be completely covered with a thin layer of adhesive and allowed to dry, in order to obtain the best finish and avoid peeling.

Screw some rubber feet to the corners and bolt a strap handle through the left hand end cheek if required.

PANEL

The panel is constructed from 16 s.w.g. aluminium as shown in Fig. 16. Having cut all the holes, thoroughly clean the drilled and filed aluminium with "Brillo", then thoroughly dry with tissues taking care not to get any grease back onto the metal, and spray with several thin coats of matt black car paint, allowing a few minutes to dry between each coat. The white lines are put on with $\frac{1}{8}$in white car stripe (from most car spare shops and garages). The panel is labelled with white "Letraset" or similar, and the labelled panel is finished by spraying with a thin coat of clear matt fixative (from stationers).

FITTING THE KEYBOARD

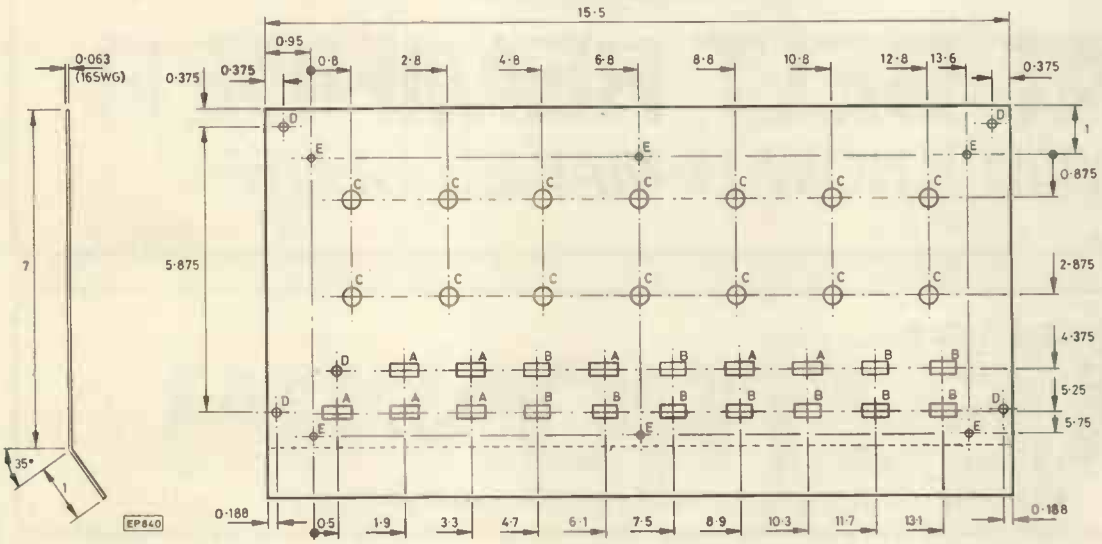
If the keyboard chassis protrudes beyond the ends of the keys, the excess must be cut off with a hacksaw; then fix the hinge at the back of the keyboard to the rear support in the cabinet using self tapping screws. If the keyboard used does not have a hinge at the back, it is recommended that the rear support be made to pivot in the cabinet by drilling $\frac{1}{2}$in deep holes in the end cheeks and in the ends of the support bar and inserting 1in metal rods (such as 1in 4BA bolts with the heads sawn off) into the holes. In any case, position the keyboard carefully so that it will pivot freely between the dummy keys at either side, and so that the keys do not foul the front of the cabinet. Check that the panel fits correctly with a slight gap between the sloping front and the tops of the keys.

The keyboard p.c.b. of Fig. 11 is glued underneath the keyboard chassis, having first mounted the resistors. The gold wire contacts should then be soldered in place so that the longest wire presses against the bottom of the key plungers. The other contacts are then added, and bent so that there is a small gap between each of the wires when the keys are not pressed. Ensure that all three wires under each key meet when that key is depressed, but avoid having too small gaps between them when the keys are not depressed, or else mechanical vibration may cause spurious triggering.

FINAL ASSEMBLY

Having made all the various connections between the three p.c.b.s, the thumbwheel edge pot and the back panel, and after setting up the circuitry, the main p.c.b. bolts beneath the front panel using 2in threaded spacers. The power supply p.c.b. should be bolted to the floor of the cabinet behind the keyboard using $\frac{1}{4}$in threaded spacers. Assembly is completed by fixing the front panel in place with four self tapping screws and then pushing the knobs over the pot spindles protruding through the panel. ★

Fig. 16. Front panel drilling detail



Hole	Dimension	No
A	15mm X 7mm	8
B	12mm X 7mm	11
C	0·375 DIA	14
D	0·188 DIA	5
E	0·125 DIA	6

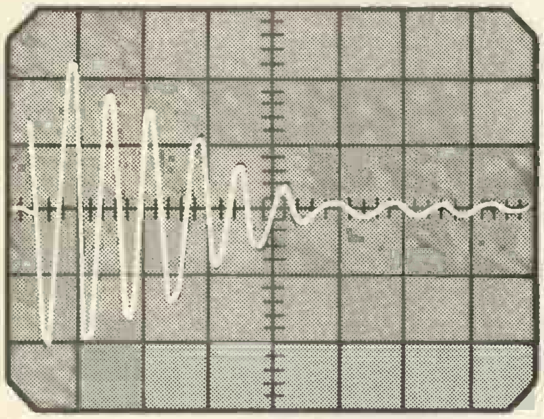
DIMENSIONS IN INCHES UNLESS STATED OTHERWISE
MTL: ALUMINIUM ALLOY

Note:-
Large dots on dimension lines indicate datums for relevant strings of dimensions.

all in your

SEPTEMBER

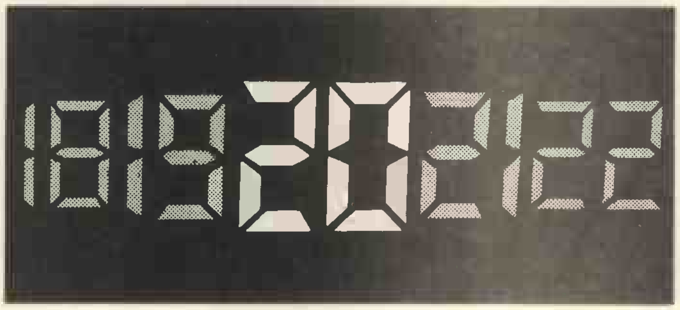
issue!



WAVEFORM DIGITISER

Able to store a waveform in memory and replay it for analysis or troubleshooting. It is particularly useful for capturing transient events such as musical instrument waveforms, power supply glitches, etc. Another application is the recording of daily temperature variation, the result of which can be retraced on an oscilloscope at much higher frequency to provide a time compressed record.

C.B. SCANNER



This design provides push button up/down single step or channel scan with pause on channels in use. Simply key the mic to stay on any channel. The neat p.c.b. can be fitted inside most rigs and, with the option of all controls on the mic, provides and easy to use system—especially when driving.

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PRACTICAL

ELECTRONICS

SEPTEMBER ISSUE ON SALE FRIDAY, AUGUST 13th

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ZX81 16K in homemade case with proper keyboard and built-in power supply £110. F. R. Barros, 35 Rectory Lane, Tooting, London SW17 9PZ.

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SINCLAIR ZX81 Personal computer, plus fifty programs, plus two books, plus p.s.u. all for £55 C.W.O. R. Wood, 35 Criffel Road, Bellevue, Carlisle, Cumbria CA2 7QP. Tel: 0228 28412.

WANTED service manual or circuit diagram Tektronix Oscilloscope Type 502A to buy or loan, small fee? A. Bouskill, 129 Lyminster Road, Birley Carr, Sheffield, S. Yorks. Tel: 0742 311191.

TI 58, 58C, 59 owners, for sale, one PC-100C printer as new, £95 ono. Mr. G. Bearzot, 294 Hitchin Road, Lower Stondon, Beds. Tel: Hitchin 815417.

WOULD like to correspond with Atom owner. Raanan Herrmann, 6 Barkai Street, Ramat-Gan 52-376, Israel.

PYE 24 INCH monitors, four at £30 each or £100 the lot. Good working order. A. D. Woodcock, 12 Valescourt Road, West Derby, Liverpool L12 9EX. Tel: 051 228 5678.

SINCLAIR ZX81, p.s.u. manual leads, etc. plus two cassettes for sale £40. G. Potter, 7 Oxford Road, Birstall, West Yorkshire WF17 9JR. Tel: Batley 440389.

AVO CT446 transistor analyser, v.g.c. in carry case, battery power supply, 8 Nicads and PP9, £15. R. Garas, 147 Seaforth Avenue, New Malden, Surrey.

ELECTRIC typewriter, serial or parallel input with tape reader and punch inc. manual and tape £65. Tel: Melksham (0225) 707164 (after 7.0 p.m.).

WANTED Etel 3AZP31 tube for Hartley CT436 Oscilloscope. G. Cox, 18 Barnfield Road, Bollington, Cheshire. Tel: 0625 73003.

SINCLAIR built ZX-81, 16K RAM, software only 5 months old. Only £95 ono. Tel: Norwich 810662.

ZX81 (16K) Sinclair computer, in packing with adaptor, leads and manual, £100. S. Mathie, 185 Glasgow Road, Dumbarton G82 1DW. Tel: 0389 61308.

SPEAKERS, pair of Wharfedale Denton HiFi with metal stands. Tel: Basingstoke 781032.

ZX81 computer and 16K RAM, p.s.u. and extras, £110 ono, owner moving abroad soon. T. G. Kua, 95 Cedar Walk, Hemel Hempstead, Hertfordshire HP3 9ED.

ZX81 16K external keyboard, books and cassettes, £100. 4½ inch black and white video monitor, £35. Tel: Roger (evenings) 0702 67453.

WANTED, any books on the Z80. Programming, Interfacing, etc. Good price paid (Sargo Chess perhaps?). E. Ball, 49 Brandearth Hey, Cantril Farm, Liverpool L28 1SB. Tel: 051 489 9708.

TRANSFORMERS, 330/0/330V, 300mA, 4V2A, 5V2A, 6·3V7·5A, and 600/0/600V, 260mA, 5V3A, encased, both 200/250Vin, £5 each. G. Jordan, 60 Thorndon Gardens, Stoneleigh, Epsom, Surrey. Tel: 01-393 9870.

HEATHKIT oscilloscope model 10-103 10MHZ, 5 inch single beam. Perfect condition, new mains transformer, £90. Offers considered. Mr. P. Metcalfe, 36 Quarry Bank Road, Market Drayton, Shropshire TF9 1DT. Tel: M/Drayton 3535.

AVO electronic test meter, ohms, dc/ac, volts, dc amps, capacitance, watts, very good order, offers. D. R. Halsall, 6 Lincoln Drive, Littleborough, Lancs OL15 ONE. Tel: 76590.

PRACTICAL Electronics magazines for sale. 1969 to 1980. 125 copies. Any reasonable offer accepted. G. W. Pretty, Church Farm, Broughton, Nr. Stockbridge, Hampshire. Tel: Broughton (079430) 239.

VIC-20, plus VIC tape deck. Books £200, swop Olympus, Tamron photo gear, UK101, etc. w.h.y. write. M. A. Saunders, 7 Drumcliff Road, Thurnby Lodge, Leicester LE5 2LH.

ZX81, plus 16K RAM, plus large software library and machine code primers, was £150+ now £65. Hugh Reynolds, 10 Lingfield Avenue, Kingston-on-Thames. Tel: 01-546 1997.

TAPE-DECK, Garrard portable, 9V, new. Mains h.t. transformers, chokes, valves. CRTS VCR139A 2½ inch VCR 522 1½ inch. Collect. Tel: Odiham 2224.

TRS80 Video monitor, 12 inch green screen, perfect working order, little used, cost £100, accept £70 ono. Paul C. O'Neil, 187 Main Street, Chapelhall, Airdrie, Strathclyde M26 DSF. Tel: Airdrie 51476.

NASCOM 1, 32K, NAS-SYS 3, DE-BUG, Disasssembler, toolkit, graphics in ROM, 8A p.s.u. sound, software, 300/600/1200/2400 Baud. £345 ono. S. Haque, 99 Durlston Road, Clapton, London E5 8RP. Tel: 01-806 5995.

ZX81 with custom built case and loads of periferals, including monitor, fantastic offer, £110 (worth £210+). M. Read, The Old Punch Bowl and Grapes, Adstock, Buckingham, Bucks. Tel: Winslow 2757.

MULTIMETER for radio t.v. incl. case, £16. Tel: 01-554 2913 (evenings).

WANTED all types of unused radio/amplifier valves and bases. Urgent are: PM4, PX25, MP-PEN, 41-MP. Mr. Covington, 41 Western Way, Letchworth, Herts SG6 4SE. Tel: Letchworth 79681.

ZX80 with manual and circuit, £30, MK14 with video board and extras, £35. Mr. J. W. Walsh, 29 Crompton Avenue, Bolton BL2 6PG. Tel: 382796.

SOLARSCOPE CD.513 'Scope. Not working but repairable. No manual, hence price only £10. Break value. G. Hunt, 22 Usk Road, Tilehurst, Reading. Tel: Rdg 21119.

MAPLIN 5600S Synth. ready to play in Maplin case reasonable offer accepted. Mr. R. Massey, 7 Ivy Road, Northampton. Tel: Northampton (0604) 27644.

ZX81 +16K complete, Sinclair built. Books: ZX81 Companion, Mastering m/c. Programs: Assembler, Games, Home, Business, £85. D. Farrance, 24 Prestbury Road, Cheltenham, Glos. Tel: Cheltenham 36461.

ZX81 Sinclair built + Inverse Video, white characters on Black background + joystick, £70. 16K ZX81 memory, £35. S. Thickett, "Edgeside", Church Road, Brown Edge, Stoke-on-Trent, Staffs ST6 8RA.

WANTED, circuit diagram for solid state automatic pulse generator to h.t. transformer. Gene Hetherington, Ballinamore, Co. Leitrim, Ireland.

QUANTITY small components new or used once only, all serviceable list, large s.a.e. G. A. Noble, 50 Croft Hill Road, Slough, Berks SL2 1HF.

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PE BAZAAR AUGUST '82

Automatic Photographer

M.J.A. Turner

THE PRODIGIOUS invasion of photography by electronics has resulted in the automation of almost every function of the modern camera, including focussing. Now, even the *photographer* can be replaced by this electronic robot!

MOVING IMAGE DETECTOR

As the name suggests, the Moving Image Detector is a device for detecting the presence of moving objects. It can be used in applications where a light gate would usually be required. But unlike a light gate, it does not require a beam. The M.I.D. is a versatile self-contained unit.

The M.I.D. unit described here is designed to operate the shutter of cameras which have an *electrical* release socket, such as most Contax/Yashica models. This type of release fires the shutter when shorted.

However, with the addition of a servo unit to fire the mechanical release, almost any camera could be used.

GENERAL DESCRIPTION

An image is focussed by lens 1 (see Fig. 1), on to two photosensitive elements 2 and 3, which form a potential divider. These elements occupy only a small central area of the total scene.

Under normal circumstances, the two elements are of approximately equal resistance and so about half the supply voltage will exist at point A.

This condition is maintained indefinitely, despite ambient light fluctuations, clouds obscuring the sun for instance. The reason for this is that both photo-elements would be affected equally, which means that the potential divider ratio would remain the same and therefore, so would the voltage at point A.

If now, something moves across the scene being monitored and affects the amount of light falling on the elements consecutively, the ratio will be unbalanced and the voltage at point A will change.

This triggers the voltage change detector 4, the output of which is used to fire the shutter of the camera.

PRACTICAL CIRCUITS

The most simple circuit that it is possible to build is shown in Fig. 2.

The two photo-transistors TR1 and TR2 are extremely small devices, measuring just a few millimetres across. They only have two leads, as the base connection is not made. The anode lead has a small tag on it.

Resistors R1 and R2 limit the current flowing through TR1 and TR2. Two are necessary to maintain balance under fluctuating light conditions.

C1 blocks the d.c. level at the junction of TR1 and TR2 and transmits any a.c. pulses to the thyristor SCR1. This is the Voltage Change Detector, although of course it will only fire on reception of a positive going pulse. This is perfectly adequate, as the moving object will produce a positive going pulse sooner or later, regardless of whether it be lighter or darker than the background.

Objects that contrast poorly with the background may escape detection, but this is a surprisingly rare event.

The 2N5062 is a very sensitive thyristor. Other types might not be suitable.

The circuit works well in fairly bright daylight. The following circuits, however, will operate in bright sunlight down to quite dim domestic lighting.

In Fig. 3, a comparator is used to detect changes in the voltage at point A. When this rises above a reference voltage at the inverting input of IC1, the output goes positive and fires SCR1.

The fine control VR2 is initially set at its central position. Then the coarse control VR1 is adjusted so that D1 is just on. Finally VR2 is readjusted until D1 just goes out.

Capacitors C1, C2 and C4 provide transient suppression. The circuit will be prone to repetitive triggering if they are omitted.

The circuit in Fig. 4 uses the same i.c., but connected in the "follower with gain" mode, which amplifies the pulses before feeding them to the thyristor.

It does not require adjustments of any kind and also has the advantage of negative feedback at 50Hz and above via C2. This prevents the circuit from being triggered by mains interference, especially from fluorescent lighting. Fig. 7 shows the pattern for a p.c. board suitable for the circuit of Fig. 4. Fig. 8 shows the component layout.

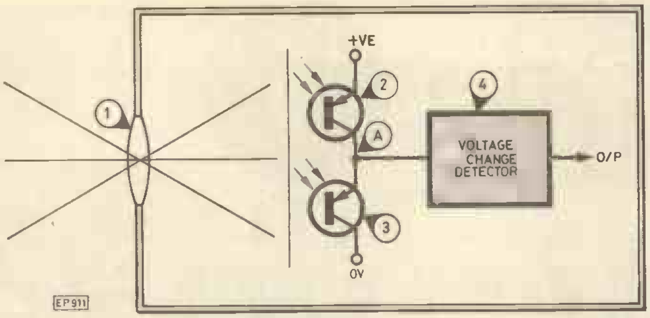


Fig. 1. Differential light detection system. Ambient changes common to the whole field are cancelled out

Fig. 5. Without 50Hz rejection. (Natural light)

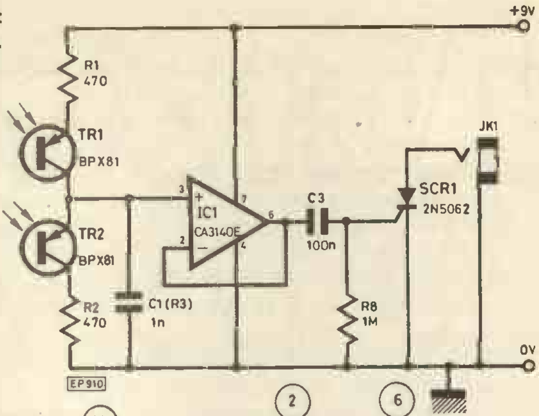
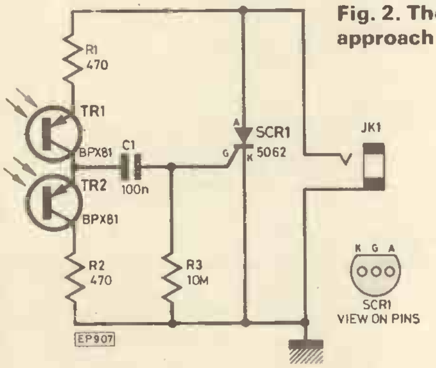


Fig. 2. The simple approach



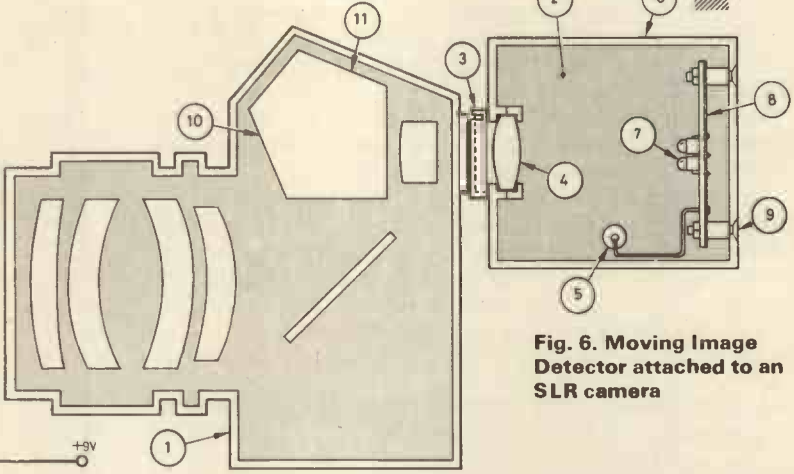


Fig. 6. Moving Image Detector attached to an SLR camera

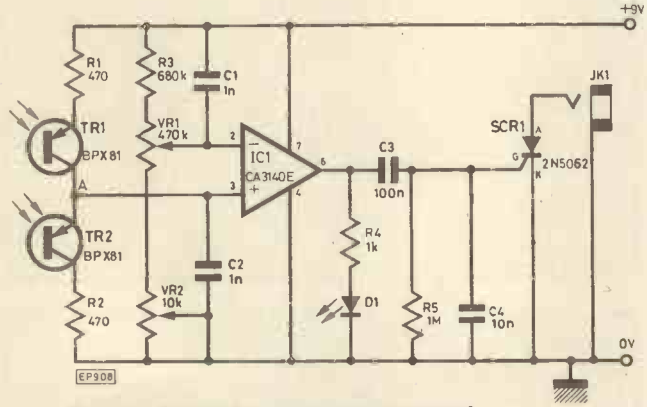


Fig. 3. Adjustable comparator approach

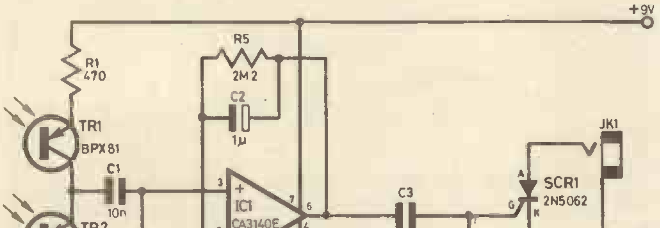


Fig. 4. Full circuit, including l.f. rejection to exclude artificial light "flicker"

Diodes, for protecting the thyristor from excessive back e.m.f., are not required in the preceding circuits if they are used for operating automatic cameras directly, as these include such a diode internally.

CONSTRUCTION

It is recommended that the two photo-transistors are soldered to the board first. Avoid overheating the leads. The encapsulation should be polished with a soft cloth. A small piece of black card may be placed between the photo-transistors to cut down reflections, but this is not absolutely vital.

The completed circuit board is housed in a small box. This is made of aluminium to provide screening and must be lightproof. Fig. 6 shows a M.I.D. unit (2) attached to an SLR camera (1).

The lens (4) need not be an expensive one. Any single element lens with a focal length of between one and three inches can be used.

For maximum picture brightness however, the lens should be a short focus type, and its diameter should be equal to the diagonal length of the camera viewfinder.

The prototype used a two inch lens, taken from an inexpensive 35mm slide viewer. The lens should be focussed at infinity if it is intended to look through the viewfinder. The detachable eyeshade of the author's camera was used for the bracket (3). This unscrews into two parts, so is easily fixed to the M.I.D. unit.

The output from the unit is connected to a coaxial socket (5), which is coupled to the electrical release socket of the camera by a short length of coaxial cable bearing corresponding plugs.

The metal housing (6), is connected to the negative rail of the printed circuit board (8) by way of the fixing pillar and screw (9).

TESTING

The completed circuit may be tested by connecting a 6V bulb and battery, wired in series, between the output and 0V terminals of the board, the negative terminal of the battery going to 0V. The 9V separate supply needs to be connected also. Passing a shadow or light source across the photo-transistors should light the bulb.

Now all that remains is to install the board inside its box and test it on your camera.

Initially, the unit does not have to look through the view-finder. Just plug it in and walk in front of the lens. Don't stand too close, as the M.I.D. tends to ignore subjects that are out of focus!

Switching the M.I.D. on or off while connected to the camera may fire the shutter. So to avoid wasting film, always switch on before plugging in and unplug before switching off. Moving the camera will also fire the shutter.

Where >50Hz rejection is not required, then the buffer circuit of Fig. 5 is recommended.

Here, the 3140 is used to match the high output resistance (at low light levels), of the photo-transistors to the relatively low input resistance of the thyristor.

The circuit of Fig. 4 can be readily converted to the buffer circuit, using the same p.c.b. Referring to the component overlay, Fig. 8, the necessary changes are: Remove R4, R6, R7, C2 and C4. Replace R5 and C1 with links. Replace R3 with a 1n capacitor. ★

COMPONENTS...

(for the circuit of Fig. 3)

Resistors

R1, R2	470 (2 off)
R3	4k7
R4	1k
R5	1M

Potentiometers

VR1	470k linear
VR2	10k linear

Capacitors

C1, C2	1n (2 off)
C3	100n
C4	10n

Semiconductors

D1	l.e.d. red
SCR1	2N5062
TR1, TR2	BPX 81 (2 off)
IC1	CA3140E

Miscellaneous

P.C.B. or strip board
JK1 jack socket (sub min)
PP3 battery and stud

COMPONENTS...

(for the circuit of Fig. 4)

Resistors

R1, R2	470 (2 off)
R3	10M
R4	1k
R5	2M2
R6	4k7
R7	5k6
R8	1M

Capacitors

C1, C4	10n (2 off)
C2	1n elect.
C3	100n

Semiconductors

SCR1	2N5062
TR1, TR2	BPX81 (2 off)
IC1	CA 3140E

Miscellaneous

P.C.B. or stripboard
JK1 sub. min. jack socket
PP3 battery and stud

CONSTRUCTORS' NOTE

The BPX81 photo-transistors are available from:
Synchro Services,
High Street, Harrold, Bedford.
✆ 0234-720575.
The 2N5062 thyristor is available from:
Macro Marketing Ltd.,
396 Bath Road, Slough, Bucks.
✆ 06286-4422

COMPONENTS...

(for the circuit of Fig. 5)

Resistors

R1, R2	470 (2 off)
R8	1M

Capacitors

C1	1n
C3	100n

Semiconductors

SCR1	2N5062
TR1, TR2	BPX81 (2 off)
IC1	CA3140E

Miscellaneous

P.c.b. or stripboard

JK1 sub. min. jack socket
PP3 battery and stud

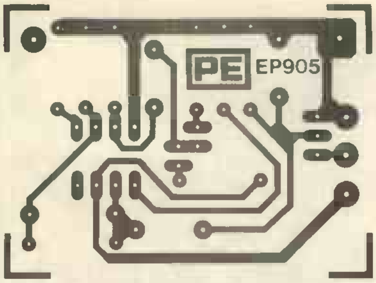
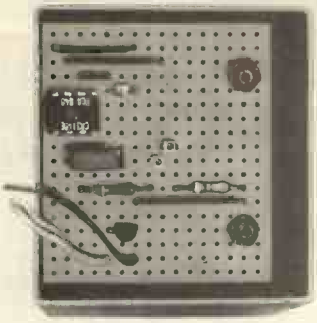
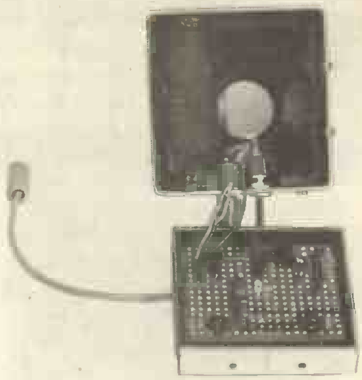


Fig. 7. Printed circuit board (actual size)





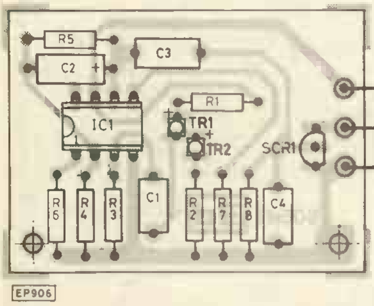
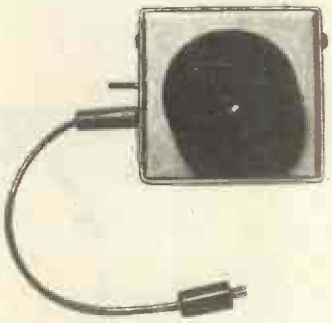


Fig. 8. Component layout



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SEMICONDUCTOR UPDATE

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FEATURING CY360 TL068 SAB8256A

MICRO SYNTHESISER

Some time ago I reported on a device coded CY500 produced by a newcomer to the Semiconductor scene called Cybernetic Micro Systems of Los Altos, California. The CY500 is being sold as a CMS product, and it performs the task of an intelligent stepper motor controller which can be instructed by either a microprocessor or by a simple ASCII keyboard. The most interesting thing about the CY500 is that it is *not* a special chip design and it is not even made by Cybernetic Micro Systems!

The secret behind this apparent sleight-of-hand is, as if you hadn't guessed, a single chip microprocessor from a source not acknowledged by CMS but probably a member of the Intel 8048 family. This device was an exciting development because it demonstrated that it is possible for a second party to produce a brand new functional building block based on its own software which is frozen into someone else's microprocessor chip at manufacturing stage, for sale to third parties. The CY500 was such a success that it was soon joined by a more powerful version coded the CY50!

But Cybernetic Micro Systems are not resting on their laurels by any means, and we can expect from them a number of other useful building blocks based on single chip micros before long.

First on the list is the CY360 which performs the useful function of waveform synthesis and function generation. Like the CY500 this device is controlled via a parallel ASCII interface from either a keyboard for simple systems, or a microprocessor for the bells-and-whistles applications. Also like the CY500, the CY360 has its own on-chip high level language interpreter for its set of generation and synthesis functions which come complete with Jumps and Loops so that a complete synthesis program or Macro can be coded with a very few steps and stored in the on-board RAM space.

At this point the similarities with the CY500 end, because, of course, the CY360 has a totally different purpose in life. Its instruction set is based on single alphabetic characters which may be mixed where necessary with numeric data describing waveform parameters such as amplitude, phase, frequency and delay. Readily available from the CY500 are sine, triangle, sawtooth and square waveforms with programmable frequency and number of cycles per burst. It is also possible to synthesise pseudo-random (i.e. noise) signals and to generate linear approximations of many arbitrary functions—for example exponential delay.

The CY360 is a digital processor of course so it does not output analogue voltages directly. Instead, it outputs numeric data on two eight-bit ports which can be connected directly to Digital to Analogue converters to recover the analogue waveform. These ports can be used to provide two separate phase-different signals, or they can be used together for a single higher resolution signal if necessary.

Because of the digital synthesis used by the CY360, there are of course some disadvantages. If the generated waveform is examined closely enough it will be seen to be made up of a stair-step approximation to the desired function, a fact which may not be a problem in many applications and which can anyway be reduced by filtering. Also, because of the need for the processor to execute code between waveform steps, the device is limited to low frequency applications.

The CY360 draws 100 milliamps from a single 5 volt supply and is housed in a 40 pin plastic package.

VOLTAGE FOLLOWER

A voltage follower can be made with a single transistor with an input to the base and an output from the emitter. Its job is to provide impedance transformation so that the input voltage from a high impedance source can drive a low impedance load: a current amplifier if you prefer. In these days of integrated circuits people have tended to forget the simple approach and use instead an Operational Amplifier with unity gain feedback (equals a piece of wire!). In some cases this is the proper thing to do because the OP AMP solution does not suffer from the base-emitter offset voltage of the transistor which makes all output voltages from the emitter 700 millivolts or so less than the input voltage. In other applications, particularly small signal amplification, the transistor may be better as it contributes much less noise than the multi-transistor OP AMP.

In future it seems there will be a third choice in the shape of the TL068 from Texas Instruments. This device is a sort of OP AMP-in-transistor-clothing, because although it lives in an innocuous looking 3-pin plastic transistor package, internally it contains an f.e.t. input amplifier with a ready made feedback connection to provide the voltage follower configuration. This device provides a number of improvements over the transistor scheme because it has an extremely high input impedance, an input bias current of less than 400 picoamps, and an offset voltage of less than 15 millivolts. In addition it has a 1MHz bandwidth, can draw as little as 125 microamps from its supply, and will operate with input signals of 3 to 36 volts.

The three pins of the TL068 are labelled INPUT, OUTPUT and VEE (ground), with the connection of this device into a practical circuit being as easy as you might expect from such a simple package. The lack of a positive supply pin is overcome by obtaining bias from the driven load via a bias resistor.

The TL068 will be most useful as a buffer amplifier for remote transducers which have to drive long lines, but its extremely high impedance also makes it suitable as a charge amplifier for capacitive devices such as electret microphones.

The main advantages it has over the use of standard OP AMPs are its simplicity and low cost.

MUART

Most mcroprocessor systems need extra peripheral circuits to provide the essential system facilities which cannot easily be placed on the processor device because of the extra cost incurred or because of a lack of package pins. The usual "extras" required are a UART (Universal Asynchronous Receiver Transmitter) to provide serial communication to a system console or a modem, a parallel port to drive a line printer or accept data input from panel switches, a few timer/counters to provide pulse generation and the ability to measure the time taken by external events, and an interrupt controller to ensure that all those other devices get a fast response from the processor when they need attention.

Until now you needed to buy as many as four additional and expensive chips to provide these functions, and these chips may have had many fancy features which the average system did not need, not to mention the extra system complexity caused by all the necessary interconnections. Now Siemens have decided to come to the rescue of the small systems builder by combining all the required features onto one relatively inexpensive chip. The new device is coded SAB8256A and is called a MUART by its designers, although how that M manages to convey the provision of a parallel interface, five timer/counters and an interrupt controller in addition to the UART I really don't know! I personally think that the MUART is the best development to appear in microprocessor peripherals for a long time, and it seems that I am not alone, because no less a manufacturer than Intel has decided to act as an alternative source for the chip.

The SAB8256A is basically 8080 system orientated and is therefore easy to hook up to 8085 and Z80 systems, but this device is so attractive that it will almost certainly be in demand for 6800 or 6502 based systems too. Interface to these processors can be easily achieved with the addition of a few external gates.

The MUART comes in a 40-pin plastic package and will operate from a single 5 volt supply.

AUDIO TEST SET PART TWO

MICHAEL TOOLEY B.A. & DAVID WHITFIELD M.A. M.Sc.

THIS final part sets out initial tests, calibration and examples from the wide range of measurements possible.

INITIAL TESTS

Before connecting to the supply the front and rear panel controls (shown in Figs. 8 and 9, respectively) should be set as follows:—

Front Panel	Function	'Voltage out'
	Voltage Range	'1V'
	Voltage Calibration	'Pk-Pk'
	Frequency Range	'1kHz–10kHz'
	Frequency Fine	Fully clockwise—'Min'
	Output Level Range	'2V'
	Output Level Fine	Fully anticlockwise—'Off'
	Monitor	'Out'
	Waveform	'Sine'
Rear Panel	Monitor Volume	'Min.'
	Supply	'a.c.'

The pre-set resistors on the p.c.b. should all be set to mid-position. An 8 ohm loudspeaker should be connected to the headphone/loudspeaker socket. The a.c. supply should then be connected and the instrument should be switched 'on' using the output level control which should be advanced to about 30% of its full travel.

A d.c. voltmeter should be used to check the voltage at the positive connection of C38. This should be in the range 16V to 18V. If there is no voltage at this point check the a.c. supply connections, mains transformer and fuse. Now transfer the d.c. voltmeter to measure the voltage at the link (LKA). This should be in the range 11·5V to 12·5V. If this is not the case check IC2. Transfer the d.c. voltmeter to the emitter of TR8 and adjust VR7 to obtain a reading of approximately 6·5V at this point. If this cannot be obtained check the wiring and connections to the p.c.b. in the vicinity of TR6, TR7 and TR8. Advance the monitor volume control to about 30% of its full range and adjust VR6 until a relatively pure tone (at about 1kHz) is heard from the loudspeaker. If necessary adjust the monitor volume to obtain a comfortable listening level from the loudspeaker once oscillation has commenced. Observe the indication on the meter and note the effect of (a) changing the calibration to 'r.m.s.' and (b) switching from the '1V' to the '3V' range. Both should cause the deflection on the meter to fall to about one-third of its previous reading. If necessary adjust VR4 to provide a sensible indication on the meter before carrying out this test. Now switch to 'square' wave and change the function to 'Frequency Out'. The meter reading should increase as the frequency-fine control is turned anti-clockwise. (The tone

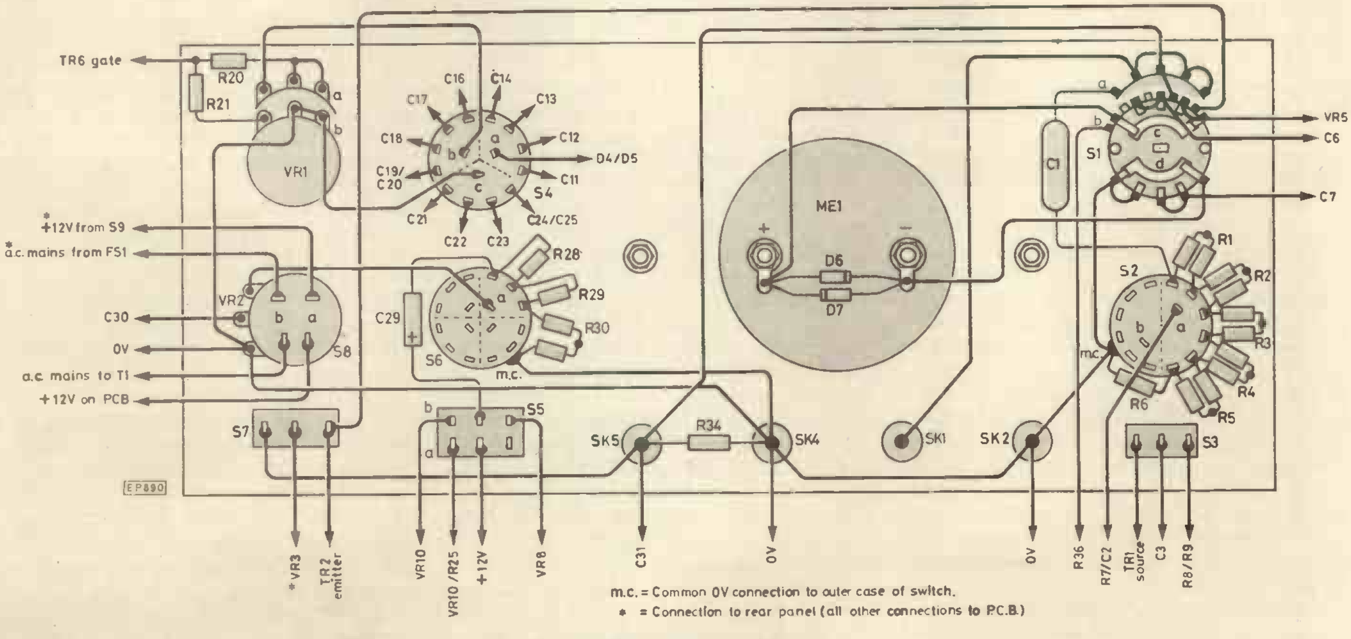


Fig. 8. Showing wiring of front panel

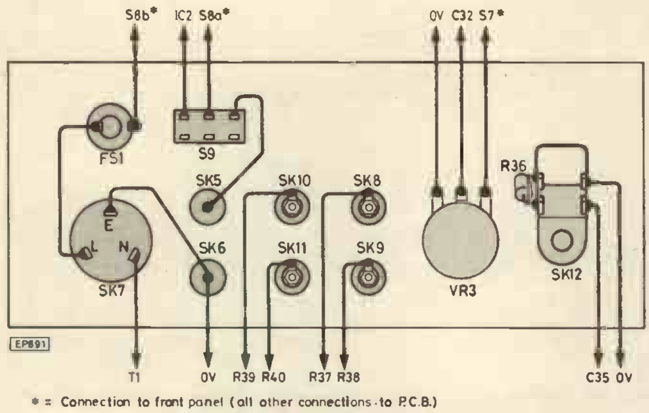


Fig. 9. Showing wiring of rear panel

from the loudspeaker should also increase in frequency.)

The foregoing tests establish that, in the order given, the power supply, signal generator, monitor amplifier, a.c. voltmeter, and frequency meter sections are functional. If, at any stage, the required indications are not produced, reference should be made to the d.c. voltage table. The presence of unusually high or low voltages will rapidly pinpoint the area of a fault. Note that a difference of about 10% can be expected without indicating that a fault is definitely present. When a fault has been identified the p.c.b. and associated wiring should be checked in the appropriate area. Full calibration cannot be carried out without the aid of additional test equipment. This should consist of a digital frequency meter and an oscilloscope. An accurate r.m.s. reading a.c. voltmeter may also prove to be useful.

CALIBRATION

Connect an oscilloscope and digital frequency meter in parallel to the signal output socket. Adjust the signal generator to produce a sine wave output at 1kHz (use the 1kHz to 10kHz frequency range). Adjust VR6 for a pure sine wave output as viewed on the oscilloscope. This may be close to the position at which oscillation just ceases and it may be necessary to confirm that oscillation continues over the full frequency range of the instrument. With the output attenuator controls set at maximum, adjust VR8 and VR10 respectively for 2V pk-pk sine and square wave outputs as observed on the oscilloscope. Now set the frequency of the signal generator output accurately to 5kHz (again using the 1kHz to 10kHz frequency range). Set the function switch to 'Frequency Out' and adjust VR5 for a reading of exactly '5' (on the '0–10' meter scale). Vary the frequency over the full range and check that the meter indication agrees with the digital frequency meter reading. Repeat this check over the full range of the instrument and check that the accuracy is within 5% of full-scale on each range. Re-set the output frequency to 1kHz and check that the output is still 2V pk-pk. Set the function switch to 'Voltage Out' and select the '3V' range with 'pk-pk' calibration. Adjust VR4 for a meter indication of '2' (on the '0–3' meter scale). Finally switch to 'square' wave output and adjust VR9 for a perfectly symmetrical square wave as displayed on the oscilloscope. This completes the calibration of the instrument and it is now ready for use.

USING IT

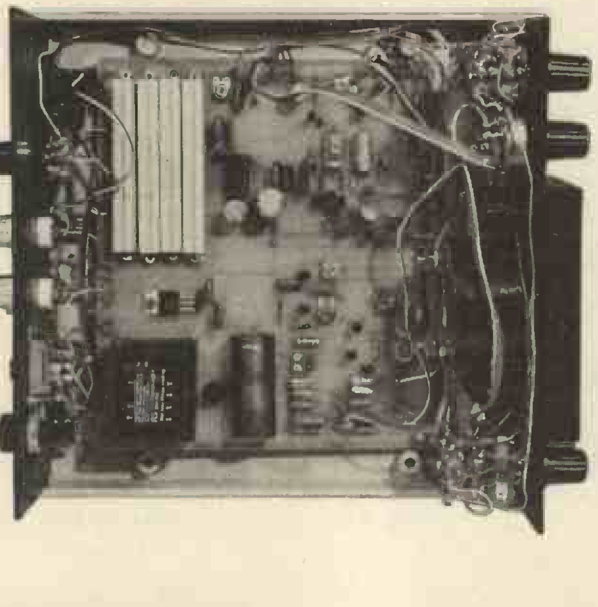
The Audio Tester is an instrument which allows the user to make a wide range of measurements on items of audio equipment and on whole systems. The capabilities of the constituent modules within the tester (signal generator, frequency meter, voltmeter, monitor amplifier, and load) do not, however, restrict their use solely to conventional audio applications. Individual modules, or combinations, may be used in a wide range of general applications which involve repetitive waveforms at frequencies up to 100kHz.

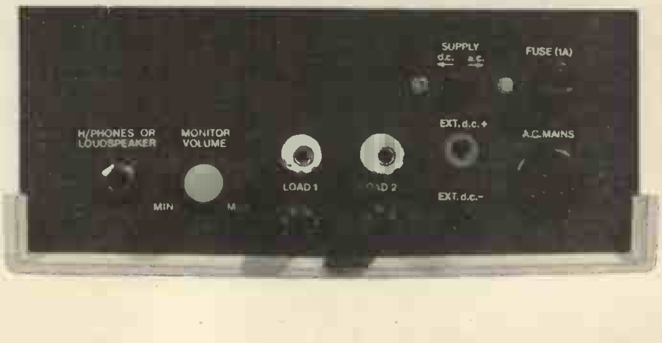
An example of this alternative use is in generating test signals for digital circuits. This requires the use of the signal generator and the monitor amplifier, with the frequency meter used to set the output frequency. The signal generator is capable of producing a signal of maximum amplitude of 2V pk-pk. The monitor amplifier can be used to boost the level to a maximum of approximately 9·5V pk-pk; the output is then taken from SK12 rather than SK3/4. Similarly, the frequency meter may be used directly to measure the frequency of digital signals.

When used in fault finding in audio systems, the Audio Tester modules can be used to replace system components when trying to identify the faulty unit. The signal generator is used to substitute for programme sources, the amplifier may be replaced by the monitor amplifier, and the dummy loads may be used in place of the loudspeakers. Continuity of leads can be checked using the signal generator as a signal source, and the voltmeter.

The mainstream purpose of the Audio Tester, however, remains the testing of audio circuits. The following section gives some examples of typical audio measurements which may be made using the Audio Tester.

The output of an audio amplifier is normally quoted in terms of the maximum power which it is capable of delivering continuously into a stated load at a particular frequency before the onset of any significant distortion. The actual values given will vary from model to model, and the method of quoting the performance usually varies among manufacturers. Typically, however, the output power is quoted in terms of the number of watts r.m.s. which can be delivered into an 8 ohm load at 1kHz at the onset of waveform clipping.





The loudspeaker, which forms the normal load in a hi-fi system, has an impedance which shows an often significant variation across the audio range (see Fig. 10). In addition, the impedance which is presented to the amplifier is rarely a purely resistive quantity, and this only serves to further complicate the measurement of output power when attempting to use a loudspeaker as a test load. The dummy loads in the audio tester, however, provide test loads which have substantially constant resistive impedances across the audio range. The impedances available (4 ohms, 8 ohms and 16 ohms) are suitable for the vast majority of contemporary audio equipment, and the various load connection arrangements are shown in detail in Fig. 12.

Where it is intended to carry out sustained high power testing, care should be taken to avoid the possibility of overheating of either the dummy loads (rated at a minimum of 30 watts r.m.s.) or the output stages of the amplifier under test. It may be advantageous, therefore, to increase the ventilation in the audio tester if sustained testing is envisaged since the load resistors will reach a temperature of 70°C at maximum dissipation. Driving both 8 ohm loads at full power simultaneously will require the dissipation of 60 watts of heat! It should also be borne in mind that the efficiency of the amplifier under test may fall significantly at frequencies above the audio spectrum (i.e. above approximately 20kHz), and this can lead to the possibility of unexpected amplifier over-heating. For this reason, a check that correctly rated line and output fuses have been fitted is a very worthwhile precaution before any prolonged high power testing; prevention is always cheaper than cure.

Fig. 13 shows an arrangement which can be used to measure the output power characteristics of an audio amplifier. The Audio Tester's dummy loads are used here in place of the loudspeaker, the signal generator provides the input signal, and the oscilloscope (or distortion meter, etc.) is used to detect the onset of waveform clipping. Fig. 14 shows the type of oscilloscope trace which is obtained when waveform clipping occurs; users who wish to observe these waveforms before testing an amplifier may do so by connecting the generator output, set to maximum sine wave output, to the monitor amplifier, and turning up the volume control while observing the output. In the test set-up the signal generator output should be connected to an 'auxiliary' or 'radio' amplifier input since these inputs should have a nominally flat frequency response. The generator output level should be set in accordance with the amplifier specifications (to typically 250mV or 500mV r.m.s.), and the frequency to 1kHz in sine wave mode. Starting at low amplifier volume control settings, the output power may be found by measuring the r.m.s. voltage across the load and then converting to power with the following equation:

$$\text{Power in watts r.m.s.} = \frac{(\text{r.m.s. voltage across the load})^2}{\text{Load impedance in ohms}}$$

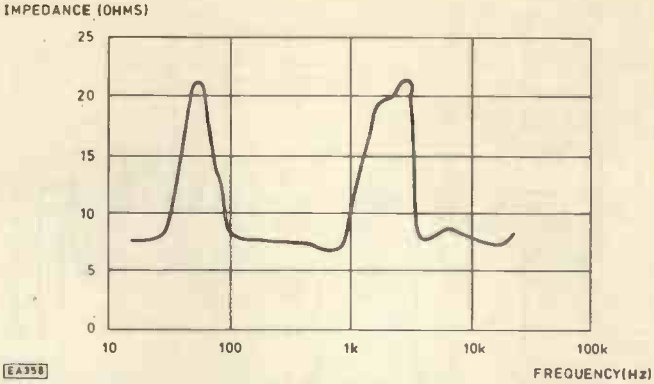


Fig. 10. Variation of impedance with frequency for a typical two speaker system

Alternatively, the conversion from voltage to power may be performed using either the graphs in Fig. 15 or the figures given in Table 3. These give conversions for the three different load impedances catered for by the audio tester. Conversions for other loads may be prepared using the equation given above.

An interesting measurement which is easily made is to determine how the output power varies according to the setting of the volume control on the amplifier. The result, which is usefully plotted on a graph, can also be compared for different load impedances. It is a good idea to adjust the level from the signal generator so that, at maximum volume setting, the amplifier's rated power is achieved or clipping commences, whichever is sooner. The results can then be

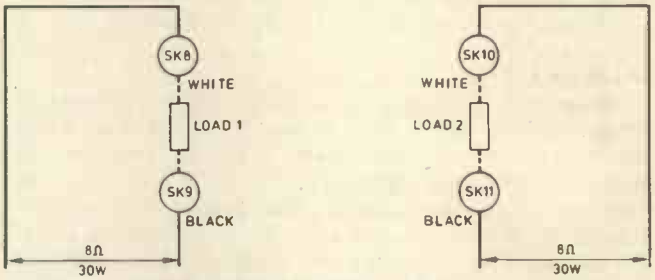


Fig. 12(a). Stereo load arrangement rated at 8 ohm/30W per channel

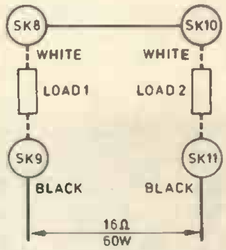
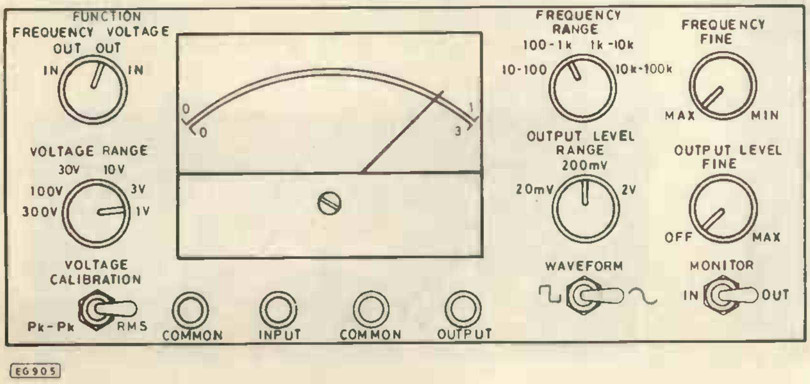


Fig. 11. (Lower left) Layout of the front panel controls

Fig. 12(b). Mono load rated at 16 ohm/60W



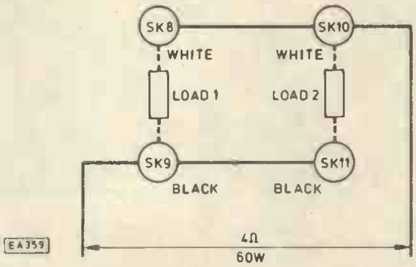


Fig. 12(c). Mono load rated at 4 ohm/60W

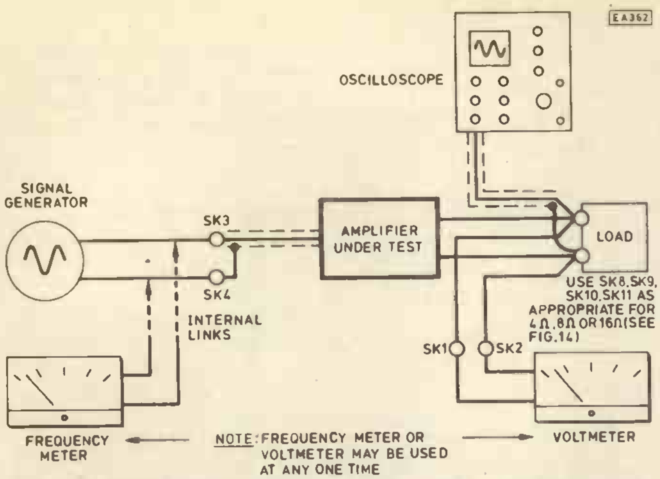


Fig. 13. Arrangement for measuring amplifier output power characteristics

presented in terms of the percentage of maximum power which is attained at various control settings. The amplifier under these conditions is much less likely to overheat at maximum level, but load impedances lower than the minimum specified for the amplifier should not be used.

The measurement of the input sensitivity of an amplifier involves finding the lowest signal level at which it is still possible to achieve the maximum rated power into the stated load. This is a relatively simple test to perform and uses the same arrangement as before. The signal generator output is initially set to minimum and the amplifier's volume control to maximum. The signal generator's output level is then slowly increased until the rated power is developed across the load, as determined by measuring the equivalent r.m.s. voltage. The signal generator output at this point is then equal to the amplifier input sensitivity. Measurements on more sensitive inputs may be simplified by the use of an additional attenuator, but care should be taken to avoid hum pick-up in the wiring.

FREQUENCY RESPONSE

An 'ideal' audio amplifier has a gain which is constant for all frequencies across the audio range. The DIN 45-500 standard specifies a range of 40Hz to 16kHz over which the gain should not vary by more than ±1·5dB, although this standard is usually considered by hi-fi enthusiasts to be a bare minimum requirement. The frequency response characteristic of a real amplifier shows how its gain actually varies across the audio spectrum. A typical response characteristic is shown in Fig. 16.

Measurement of the frequency response characteristic is usually carried out at full output power. The frequency range between the upper and lower −3dB points (where the output power falls to 50% or the voltage across the load falls to 70·7% of the maximum) is known as the full power bandwidth of the amplifier. An equally useful measurement, and probably more appropriate to normal listening, is to measure the amplifier bandwidth at a level which is more representative of average listening levels. The high power level which is available from most systems is provided to allow programme peaks to be handled without distortion. The average level of even 'loud' music can be surprisingly low, and speech typically has a 'peak factor' (ratio of the peak to the r.m.s. value) over a period of time of 20dB. For these reasons, therefore, it is often of interest to measure both the full power bandwidth and the low power (typically 1 watt r.m.s.) bandwidth in order to fully characterise an amplifier; anyone in any doubt about power levels is invited to

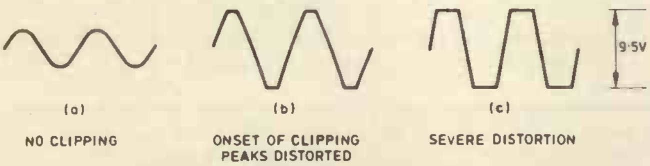


Fig. 14(a). Output waveforms from the signal generator plus monitor amplifier as the gain is increased

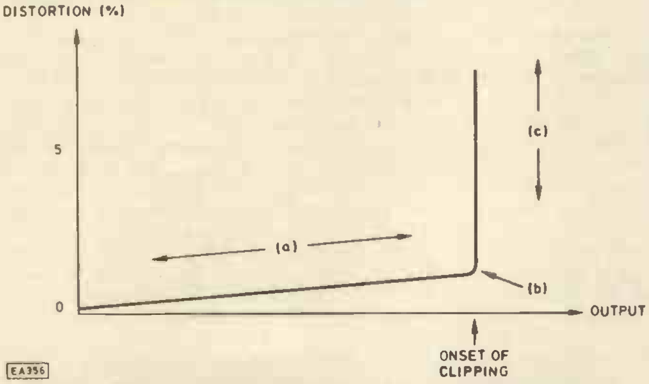


Fig. 14(b). Response of amplifier as the output level is raised through the onset of waveform clipping

Table 3 Voltage developed across a load and power

Voltage across load (Volts r.m.s.)	Power (watts r.m.s.) 4Ω load	8Ω load	16Ω load
1	0·250	0·125	0·063
2	1·00	0·500	0·250
3	2·25	1·13	0·563
4	4·00	2·00	1·00
5	6·25	3·13	1·56
6	9·00	4·50	2·25
7	12·3	6·13	3·06
8	16·0	8·00	4·00
9	20·3	10·1	5·06
10	25·0	12·5	6·25
11	30·3	15·1	7·56
12	36·0	18·0	9·00
13	42·3	21·1	10·6
14	49·0	24·5	12·3
15	56·3	28·1	14·1
16	* 64·0	*32·0	16·0
17	* 72·3	*36·1	18·1
18	* 81·0	*40·5	20·3
19	* 90·3	*45·1	22·6
20	*100	*50·0	25·0

*Testing at this power level will require the use of alternative loads.

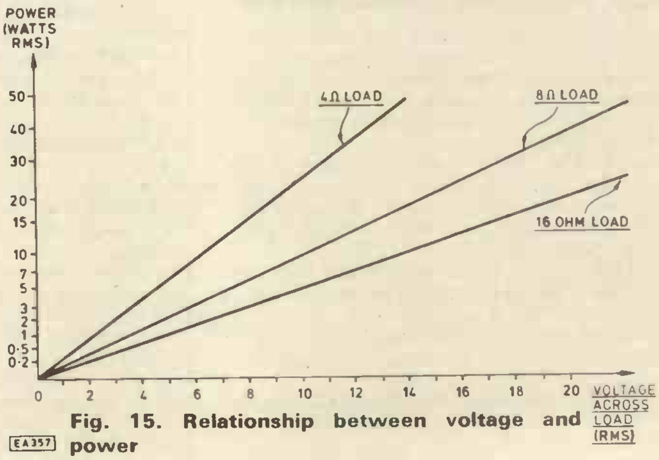


Fig. 15. Relationship between voltage and power

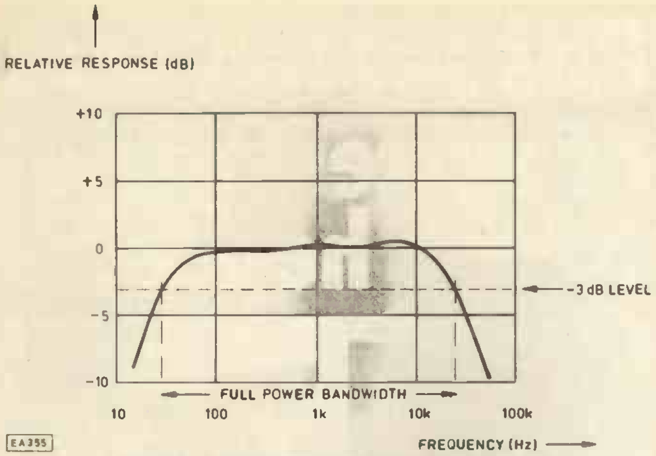


Fig. 16. Frequency response at full power

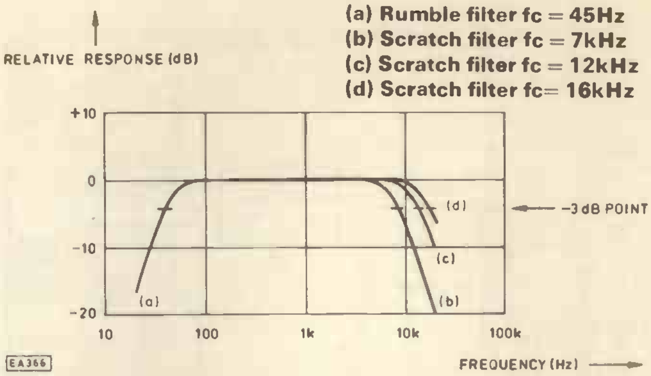


Fig. 18. Response characteristics for an amplifier with a rumble and three scratch filters

listen to 1 watt of 1kHz sine wave output from a loudspeaker system, and then imagine 40+40 watts!

The frequency response characteristic of an amplifier may be measured using the arrangement previously described in Fig. 13. The signal generator is set to a frequency of 1kHz and the tone controls on the amplifier, and any filters, are set to the 'flat' positions. The input level is set in accordance with the amplifier's specifications, and the volume control is then adjusted to produce the required power dissipation in the selected test load. The generator frequency is then varied, keeping the other generator and amplifier controls constant, over the audio range and beyond. The output level will typically show some variation across the audio range,

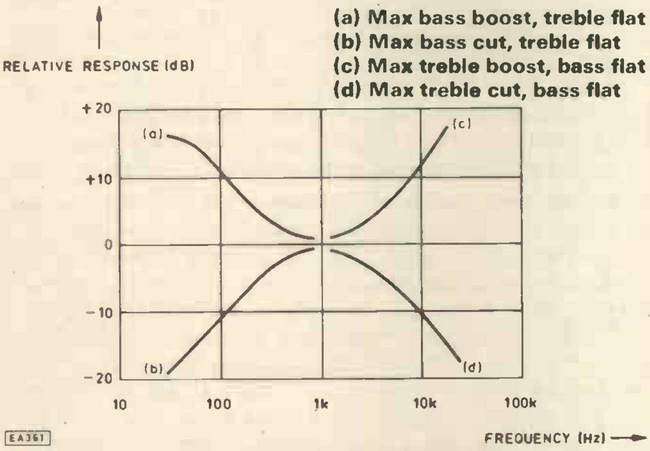


Fig. 17. Tone control characteristics

with noticable roll-off at very high and very low frequencies and a substantially flat response between the two extremes.

Once the basic frequency response characteristic has been measured, the effects of the amplifier's tone controls can be investigated. Setting each of the tone controls to the extremes in turn, and then re-measuring the frequency response, will show the total range of bass and treble boost and cut which is available. Fig. 17 shows the type of response which can be expected in any amplifier, but the exact rates of boost and cut, and the associated frequencies will vary. The measurements on tone controls are best made at a level of around 1–2 watts in order to allow for the wide range of boost and cut provided on most amplifiers. Similar measurements may then be made on any fixed frequency filters which may be provided on the amplifier. Typical responses for an amplifier fitted with a 'rumble' filter at 45Hz and three 'scratch' filters at 7kHz, 12kHz, and 16kHz are shown in Fig. 18.

It is quickly apparent from a brief look through the specifications for any item of hi-fi equipment that the range of possible tests is almost inexhaustible. The measurements described above are a few examples of the range of amplifier tests which are possible with the Audio Tester. These tests provide useful and meaningful results without the need for an abundance of additional and sophisticated equipment. As such, they serve to demonstrate the usefulness of the Audio Tester as an item of general purpose test equipment. The constructor will doubtless be able to find a wide range of situations where the Audio Tester alone will suffice in place of what would normally require a number of separate instruments.

BAZAAR

GRUNDIG GMU3 four-channel audio mixer unit, valve, plus 4 dynamic mikes. £25 inc. postage. Oxford (0865) 779855.

TPA30 EAGLE P.A. Amp, £20. Heatkit OSC2 Scope with book, £10. Post extra or collect. Tel: 01-591 4248.

SINCLAIR ZX81 with 16K RAM, plus keyboard, graphics board, books and some software tapes, £110. M. Broom, 19 Nally Drive, Woodcross, Coseley, West Midlands. Tel: Segeley (83) 61323.

UK101 32 x 48 screen, cased, 24K RAM with room for 16K more, Cegmon, Wemon monitors, software, £170. Tel: Sedgley 74804.

AMPLIFIER or kit suitable deaf aid. Firm with address wanted. G. H. Reeson, 23 Lealands, Lesbury, Alnwick, Northumberland.

DIGITAL multi-meters. Philips PM 2522 mains, PM 2517E battery. Good condition. Offers. Tel: 074 785 397.

R.S.C. 5 watt practice amp for guitar as new, £20. A. Hallas, Tottlebank, Manor Way, Wrea Green, Preston, Lancs.

WANTED. Goldring Lenco GL69 record deck. Mr. A. Henderson. Tel: Great Harwood 0254 884658.

LOW COST printer. Data Dynamics 80 column, 10 CPS, current loop interface. Genuine sale, £90 ono. Chris Swift, Crowthorne 03446 77426.

TRANSENDENT 2000, £200 ono; also ZX80, £35 ono. L. Faragher, 17 Lyndene Close, Earl Shilton, Leics. Tel: 0455 46354.

2708 EPROM's, little used, erased, £1.50 each. Tel: Ilkeston (Derbyshire) 304339 (evenings and weekends).

ZX81 16K RAM with full size keyboard plus software under guarantee. V.g.c. a bargain at £90. Dave Elliott, 13 Chiltern Road, Wendover, Bucks HP22 6DR. Tel: Wendover (0296) 622527.

ORANGE 120W graphic valve bass amp plus 200W "White" bass Bin with electrovoice speakers, £280 ono. Mr. J. Henderson. Tel: Gt. Harwood 0254 885129.

ELKA 20 Organ, 15 months old, £800. New price £1250. Tel: 0473 218392.

PRINTER IBM Selectric "Golfball" Wait/Output Typewriter, Tractor/Friction Feed, with manual and interfacing details—£90. Philip J. Tait. Tel: Hampreston (Dorset) 7463.

R.A.E. Correspondence Course, complete £25 o.n.o. McCallum, "The Limes", South Willingham Road, Hainton, Lincoln LN3 6LU.

KSR 35 Heavy-duty teletype (uncased) plus 110V Transformer and driver circuit. 110 Baud. Works very well. £100. Brian Candler, 32A Grosvenor Avenue, Sawley, Long Eaton, Nottingham NG10 3FQ.

8K MICROSOFT Basic Reference Manual £4.50. Nick Hardy, Tel: Leeds 781532.

WANTED urgently RS Components panel meter: 100uA–1·25K, dual scale; 0–10 & 0–3. RS part No. MR31S. P. Faccenda, 5/5 Murrayburn Gardens, Edinburgh EH14 2PZ, Scotland.

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WD1397 kit	45.50
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MC3487	2.95
MC14411	6.94
MC14412	7.99
RD-3-2513L	6.99
RO-3-2513U	5.99
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ZN450E DVM Kit	17.35
LINEARS	
LM301AN	0.25
LM308N	0.89
LM311N	0.69
LM319N	2.14
LM324N	0.30
LM348N	0.59
LM555CN	0.16
LM556CN	0.45
LM725CN	3.20
LM741CN	0.14
LM747CN	0.64
LM748CN	0.34

Device	Price
REGULATORS	
7805	0.39
7812	0.39
7815	0.39
78L05	0.29
78L12	0.29
78L15	0.29
7905	0.55
7912	0.55
7915	0.55
LM309K	0.99
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LM323K	4.95
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Z80A CPU	3.99
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Z80A SIO-1	11.99
Z80A SIO-2	11.99
MK3886	11.00
MK3886-4	14.47
6800 FAMILY	
6800	2.99
6802	3.99
6803C	12.10
6809	9.99
6810	1.12
6821	1.25
6840	4.20
6845	9.50
6850	1.50
6880	1.07
6887	0.80
68488	9.11
6875	5.62
6843	13.99
68B00	6.30
68B02	19.11
68B21	2.29
68B10	2.00
68B40	4.70
68B50	2.86
6500 FAMILY	
6502	3.45
6520	2.99
6522	4.75
6532	6.65
8080 FAMILY	
8085A	5.20
8212	1.70
8216	0.60
8251	3.19
8255	3.90
CMOS 4000 'B' SERIES	
4000	0.11
4001	0.11
4002	0.13
4007	0.15
4011	0.12
4012	0.15
4013	0.29
4015	0.58
4016	0.25
4017	0.45
4020	0.58
4023	0.17
4024	0.35
4025	0.16
4027	0.30
4028	0.55
4040	0.54
4042	0.54
4046	0.68
4047	0.68

Device	Price
4049	0.26
4050	0.26
4051	0.59
4052	0.68
4060	0.79
4066	0.34
4069	0.17
4070	0.17
4071	0.17
4073	0.19
4075	0.17
4081	0.14
4093	0.39
4508	1.90
4511	0.89
4512	0.60
4518	0.40
4520	0.69
4526	0.70
4528	0.70
4541	0.99
4543	0.99
74LS SERIES	
74LS00	0.10
74LS01	0.11
74LS02	0.12
74LS03	0.12
74LS04	0.12
74LS05	0.13
74LS08	0.12
74LS09	0.12
74LS10	0.12
74LS11	0.12
74LS12	0.12
74LS13	0.22
74LS14	0.37
74LS15	0.12
74LS20	0.12
74LS21	0.12
74LS26	0.15
74LS27	0.12
74LS28	0.15
74LS30	0.12
74LS32	0.12
74LS37	0.15
74LS38	0.15
74LS40	0.12
74LS42	0.33
74LS47	0.39
74LS51	0.14
74LS54	0.15
74LS74	0.19
74LS74	0.16
74LS75	0.24
74LS76	0.20
74LS83	0.44
74LS85	0.60
74LS86	0.15
74LS90	0.28
74LS92	0.33
74LS93	0.33
74LS109	0.21
74LS122	0.39
74LS123	0.39
74LS125	0.24
74LS126	0.25
74LS132	0.44
74LS136	0.28
74LS138	0.33
74LS139	0.35
74LS148	0.90
74LS151	0.39
74LS153	0.28
74LS155	0.38
74LS156	0.36
74LS157	0.29
74LS158	0.31
74LS161	0.37
74LS163	0.38
74LS164	0.45
74LS165	0.75
74LS166	0.84
74LS173	0.69
74LS174	0.45
74LS175	0.45
74LS191	0.49
74LS192	0.49
74LS193	0.45
74LS194	0.39
74LS195	0.39
74LS221	0.54
74LS200	0.69
74LS241	0.69
74LS242	0.78

Device	Price
74LS243	0.79
74LS244	0.60
74LS245	0.88
74LS251	0.40
74LS257	0.43
74LS259	0.78
74LS266	0.22
74LS273	0.70
74LS279	0.39
74LS283	0.44
74LS365	0.34
74LS366	0.36
74LS367	0.34
74LS368	0.35
74LS373	0.70
74LS374	0.70
74LS377	0.70
74LS390	0.54
74LS393	0.59
DIL SOCKETS LOW PROFILE-TIN	
8 pin	0.07
14 pin	0.09
16 pin	0.09
18 pin	0.13
20 pin	0.14
22 pin	0.17
24 pin	0.19
28 pin	0.25
40 pin	0.29
LOW PROFILE - GOLD	
8 pin	0.22
14 pin	0.29
16 pin	0.31
18 pin	0.33
20 pin	0.35
22 pin	0.40
24 pin	0.42
28 pin	0.54
40 pin	0.81
DIL JUMPERS	
24" Cable Single Ended 14 pin	1.40
24" Cable Single Ended 16 pin	1.60
24" Cable Single Ended 24 pin	2.35
24" Cable Single Ended 40 pin	3.25
6" Cable Oouble Ended 14 pin	1.90
6" Cable Double Ended 16 pin	2.05
6" Cable Double Ended 24 pin	3.10
6" Cable Double Ended 40 pin	4.85
12" Cable Double Ended 14 pin	2.00
12" Cable Double Ended 16 pin	2.15
12" Cable Double Ended 24 pin	3.25
12" Cable Double Ended 40 pin	5.10

Device	Price
18" Cable Double Ended 14 pin	2.05
18" Cable Double Ended 16 pin	2.25
18" Cable Double Ended 24 pin	3.40
18" Cable Double Ended 40 pin	5.25
ZERO-INSERTION FORCE DIL	
24 pin	6.30
28 pin	7.40
40 pin	8.80
CRYSTALS	
1 MHz	2.90
1.008 MHz	2.90
1.8432 MHz	2.20
3.6864 MHz	2.95
4 MHz	1.65
6 MHz	1.90
8 MHz	1.95
UHF MODULATORS	
6 MHz	3.70
8 MHz	4.40
BBC MICRO-COMPUTER UPGRADES (Please phone for delivery date).	
BBC 1 RAM Upgrade Kit	26.00
BBC 2 Printer User I/O Kit	9.50
BBC 4 Analogue I/P Kit	9.50
BBC 5 Serial I/O and RGB Kit	11.45
BBC 6 Expansion BUS Kit	7.95
BBC 4/4 Connectors	2.25
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Strictly Instrumental

by K. Lenton-Smith

CASIO, makers of those ingenious and reliable calculators, started to add musical bleeps to their machines a few years ago. Thus you could programme in a short, simple melody to annoy office colleagues! Perhaps we should have guessed what was coming next . . .

The idea was extended to something more musical when the Casio VL-Tone was introduced and featured in 'Tomorrow's World' early last year.

VL-TONE

Everything in this two-octave instrument derives from a 64-pin LSI chip which provides 5 pre-programmed voices. It is also possible to choose waveform, envelope parameters, vibrato and tremolo and programme these variables. Auto-rhythm, 100-note sequencing, stepping and a calculator are featured, the latter's display doubling for numerical readout of pitches entered from the keyboard.

The price of this keyboard, considering its many facilities, is very reasonable: the instrument is suitable for a young and enquiring mind getting used to music and its technicalities. Unfortunately, the keyboard is composed of press-buttons, its size is roughly one half of the standard and it *only* suits a small hand as a result.

My reaction at the time was that this instrument was an interesting toy (because of its keyboard) but that it might be the start of something big. It certainly seems that the VL-Tone was a test-bed and its popularity has been such that new and improved keyboards have followed.

It is fitted with a pitch control but, oddly enough, somewhat larger keyboards (M-10, CT-201 and MT-30) lack this important feature and keyboards were still non-standard. Even so, they were often extremely close to concert pitch as supplied.

I suppose that these problems are inevitable when a concern—even as experienced as Casio—breaks into a new field. More recent additions to the Casio keyboard range have seen improvements to the point that we now have really interesting and totally playable instruments.

COMPUTER

These keyboards are occasionally described as polyphonic synthesizers. One immediately thinks of voltage-controlled circuitry but the heart of these instruments is a CPU so 'computer keyboard' may well be a better term. The attraction of the current keyboards, especially to those who have engaged in synthesizer construction in the past, is polyphony: eight notes may be keyed simultaneously.

It is probably unnecessary to add that it would be impossible to build similar keyboards—and at the price—because of the use of special purpose LSI chips!

Using computer principles is not new: the computer organ has been with us for some years and the RMI Computer Keyboard was described in this column six years ago. What *is* new is the value for money aspect and the neat but rugged design of these compact keyboards.

Let us look briefly at just three of the current keyboards:—

MODEL 202

This instrument and Model 403 are similar in price and the choice between them will depend on musical requirements.

The 202 has 49 preset sounds, their names being inscribed above the keys of the four-octave polyphonic manual. Four Tone-Memory keys allow recall and changes of registration, the capture system operating as follows: in 'Set' mode, a tone-memory switch is pressed, followed by pressing the key representing the chosen tone-colour; after returning the mode switch to 'Play', the playing keys operate normally and the musician can make changes between the four memories as he wishes.

Sustain, Volume and degrees of Vibrato may be altered by means of controls on the left hand cheek. Alternatively, Sustain and Volume may be foot-controlled from jack sockets on the rear panel, which also include 'line out' for external amplification and a phone jack. A fine tuning control completes the back panel line-up.

An internal 4" speaker delivers up to 10W and the instrument weighs about 16lb. The preset sounds are varied and include various pianos and pipe organs and their electronic varieties. The usual orchestral instruments are featured and there are several harps and guitars. Certainly, it could be said that some of these sound similar to others, but there is still plenty of variety. With four octaves of polyphonic sound, the 202 could be used equally well by a choirmaster or pop musician.

OPERATION

Naturally, circuitry differs from model to model as do the LSI chips involved. Taking model 202 as being a typical and uncomplicated member of this keyboard family, a clock feeds one of the main LSI chips. This runs at a nominal 1.134MHz and is effectively voltage controlled by means of varicap diodes altered by the pitch control. The output is squared before being fed to the CPU, which generates key common signals. These are matrixed by conductive rubber contacts under the playing keys onto key input lines and the signals are decoded by flip-flops before being fed back into the two main chips.

Digital signals emerging from the LSIs are passed through D/A Convertor blocks. The process of converting from digital to analogue can cause serious 'glitches' as the most significant bit changes: Casio engineers have gone to great lengths to remove these unmusical spikes and ensure that the analogue waveform is totally musical.

The two Convertor Blocks in Model 202 are known as the consonant and vowel blocks and each has its associated set of high and low pass filters, with electronic switching operated by the LSI.

Consonants have their own electronic volume control circuit before the various signals are combined in a Mixer. Because operation of the tone memory switches causes a transient, a special 'cut' circuit momentarily mutes as the memory switches are changed.

MODEL 403

In this case there are 25 preset sounds and capture, but still the 8-note polyphonic facility across the four octave keyboard and a simplified vibrato and sustain. As a trade-off, there are sixteen built-in rhythms, automatic chords and bass synchronised to the rhythm unit. Chords that are fingered may simply be triggered by the rhythm pattern.

The keyboard in this case is split, the lower 1½ octaves being reserved for chords. Automatic chords are normally major but may be changed to minor and dominant seventh by pressing additional keys. The rhythm and chords can be switched in with the start/stop control, when a red l.e.d. indicates beats. Alternatively, Synchro Start will produce a green l.e.d. indication of tempo in stand-by and the accompaniment will start in response to playing a note on the lower part of the keyboard.

One LSI is used for the Melody section of the keyboard, followed by the D/A Convertor Block and filters—a rather simplified version of the 202 circuitry. Another CPU handles the accompaniment and there are additional chips for its I/O port and the chord generator. The rhythm unit, tempo oscillator and the eight instrument generators are mainly discrete circuitry.

MODEL 701

It seems to be Casio policy to offer models with similar *basic* features but one having extra facilities. Both Models 601 and 701 are five-octave 8-note polyphonic instruments with 20 preset sounds, 16 rhythms and fill-in, chords, arpeggio, sustain and vibrato. The 701, however, has very advanced programming features.

Introduced only a month or so ago, Model 701 has a programmable memory play function with storage capacity of 345 steps of notes and 201 steps of chords. It can be programmed by manual entry through the keyboard or by means of Casio bar-code music. Once the keyboard has been programmed, the performer can play along with the pre-programmed sound.

A light pen is used to read the bar-codes, which supply the memory with information on pitch, duration and chords. These codes look similar to those printed on grocery packets. A 3-digit display at the right hand end of the keyboard counts the program steps as the light pen is moved from left to right along the bar-code score: chord information is read in a similar manner. Audible indications tell the user whether the information has been accepted, or an error has arisen. Editing allows for changes in taste or error correction.

The chosen chords can be fingered or used in Autochord mode when the memory is being recalled. For the beginner, 'Melody Guide' can be used. This function causes the stored music to light l.e.d.s fitted above each playing key, inviting the learner to press the key: when he has done so, the next l.e.d. in the sequence lights. The usual jack sockets are fitted to the 701's back panel, including connection for the light pen. Two books of music and a wire stand are supplied with the keyboard: an optional pedalboard is available.

It is not possible to cover adequately all the features of these keyboards in this article. Take a look at them locally and I am sure you will agree that they are excellent value musically. And, unlike many VCOs, the tuning of the computer system is something easy to live with—in short accurate!

Casio has not entered the field of organ manufacture—which is already overcrowded—so far, but it is interesting to note the optional pedal board for Model CT-701. Bearing in mind what has already been achieved in a short time, the Casio organ may not be that far distant.

BAZAAR

VIDEOGRAPH William Stuart eight changing background colours amazing visual effects on colour t.v. £45. (0772) 24463 (6.00 p.m.).

EXPANDED Atom with extra sound board. Plenty articles and software, £180. K. Miller, 19 Skye Place, Seafar, Cumbernauld, Glasgow. Tel: 02367 23650.

24GHz Rank Precision slotted line SWR meter including dial gauge, boxed instructions, £95. M. Mann. Tel: 0223 860150.

ZX81 Computer and 16K RAM. As new, £85. Stan Desnos, 37 Devonshire Road, Sherwood, Nottingham. Tel: 609548.

WANTED old oscilloscope with 5 inch tube, any condition considered. R. Rowland, 31 Ashby Close, Coventry CV3 2LN. Tel: Coventry 456096.

UK101 16K, cased, 1-2MHz, 300/600 Baud, inverse video, lots of software, £120. 20-2114, 400ns, £10. Jamies Oriel, 138 Small Gains Avenue, Canvey Island, Essex SS8 8LW.

4600 Synthesiser, almost finished, needs wiring and setting up. All parts included, £375 ono. Mr. A. Pettitt, 2 Caburn View, Firle, Nr. Lewes, Sussex. Tel: Glynde 492.

TERMIPRINTER RS232 300 Baud upper/lower case friction feed, plain roll paper, very quiet. Can be demonstrated. £85 ono. S. Higgins, 138 Lower Farnham Road, Aldershot, Hants. Tel: Aldershot 28796.

ALMOST TWO electronic organs stripped down two consoles, three keyboards, many p.c.b.s and units, £50. D. Green, 27 Elleray Court, Ash Vale, Nr. Aldershot, Hants. Tel: Aldershot 314713.

UK101, cased, 8K RAM, new monitor separated power supply, inverse video programs, cables, etc., £120 ono. H. S. Cook, 11 Normandy Avenue, Burnham-on-Crouch, Essex. Tel: Maldon 0621 784065.

TRANSCENDENT D.P.X., working, £400. ZX81 with Rampack and tapes, £90. Amstrad stereo tuner, £15. Post paid. Richard Rix, 76 Ber Street, Norwich, Norfolk NR1 3ES.

SINCLAIR ZX81, plus 16K RAM, manual, 4 books, 4 tapes, software. £75 or offer. David Brook, 113 Leigham Vale, London SW2.

ROTEL 1000 Hi-Fi system, cost £900, exchange for good quality computer with hardware, approx. value £550. Mr. Mike Cooper, 409 Holcombe Road, Helmshore, Rossendale, Lancs BB4 4NF.

SWAP Elektor H.B. from N1, P.W., P.E., E.T.I., E.E., W.W., 200 Philips 1501 for communic. radio. J. A. N. Ferreira, 13 Danehurst Street, London SW6. Tel: 01-731 1509.

PE RANGER CB 6 Chs., pair £80, National Panasonic stereo radio cassette RX5300F, £50. Tel: 01-505 9137.

ZX81 16K RAM built kit, working perfectly. No p.s.u., £70. N. Johnston, P.O. House, Longforgan DD2 5EW. Tel: Longforgan 200.

MOTHERCARE baby alarm, £4.00; Curzon player-recorder, £6.00. Mr. A. C. Holdway, Flat 9, 10 Westwood Road, Portswood, Southampton, Hants.

OK1 CP110 Upper case matrix printer RS232 + parallel interfaces, suitable for UK101, video genie, etc. £175. Peter Vince, 19 Links Road, Ashtead, Surrey KT21 2HB. Tel: 03722 72713.

MIZUHO 5B2M two metre SSB transceiver, £50. Creed teleprinter with interface, £5. WW2 38 sets, offers. L. Fletcher, 21 Shakespeare Avenue, Andover, Hants. Tel: Andover 65368.

ZX81 computer with 16K RAM plus 4 books, cassettes and software. Only 6 months old, £95. Mark Chidlow, 22 Glen Rise, King's Heath, Birmingham. Tel: 021 777 5635.

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UK101 8K cased, R.T.C. TV, new monitor, tapes, books, £150 ono, cash only. Write or phone. Mr. R. Griffiths, 5 St. James Mansions, McAuley Close, London SE1. Tel: 01-928 5013.

TELETYPE model 32, ASR, 75 Baud, paper tape punch/reader, £35 ono. R. Munson, 16 Woodcote Way, Benfleet, Essex. Tel: South Ben. 2998.

FOR SALE. Pye record maker radiogram model P117 RM with magnetic disc, offers. D. Moore, 24 Beaufort Close, Guisborough, Cleveland TS14 7PW. Guisborough 35349.

WANTED. Hameg scope dual trace preferred though single trace considered. J. G. Grieve, Makerhouse, Dounby, Orkney KW17 2JE. Tel: 085 677 279.

ACORN Atom 12K + 12K Flt. Pt. ROM, VIA, p.s.u. magic book, space invaders, asteroids, £199. M. Stainsbury, 1B The Oaks, Billericay, Essex. Tel: 57527.

FOR SALE new GSC LPK-1 assembled logic probe, £11.50. K. Y. Chang, 70 1-up, Ashley Street, Glasgow G3 6HW.

SMALL quantity uni-selector switches, 10 bank, 25 way, ex telephone equipment, £5 each. M. Greenslade, 11 Cherry Road, Chipping Sodbury, Bristol BS17 6HJ.

COLOUR graphics board for UK101/Nascom. Cost £60. Accept £45. M. McNinch, 16 Fifth Avenue, Bangor, Co. Down BT20 5JP, N.I.

WANTED circuit and details of PW push button multimeter. M. J. Kerridge, 73 Ampleforth Grove, Willerby Road, Hull.

ZX81, 16K RAM, plus £30 of software including ZXChessII and OS-Asteroids, £85 ono. David Bell, 56 Cradlehall Park, Westhill, Inverness. Tel: 0463 791349.

ZX81 WANTED in good condition, preferably with power supply and leads. R. S. Matheson, Aviemore, Gwydry Road, Crieff, Tayside PH7 4BS. Tel: 0764 3582 (after 4.00 p.m.).

ELEKTOR Junior computer, p.s.u., Harvard 410T 40-channel walkie talkie, SWR meter, boomerang, matcher, offers. Mr. K. Y. Leong, 104 Gretney Walk, Moss Side, Manchester M15 5ND. Tel: 061 226 0791.

SUPERBOARD II 300/600 Baud, case, 10 issues OSIUK User Group Magazines, £180. 5V 6A PSU, £30. Both £200. Nicholas Brasier, 32 Henley Drive, Frimley Green, Camberley, Surrey. Tel: Deepcut 7487.

Z81 16K RAM software, £100, plus 17 inch TV b/w £50, used with above. F. B. Miles, 131 Dudley Road, Kenilworth, Wark's CV8 1GR. Tel: Kenilworth 54086.

POWERTRAN. Vocodor Calibrated by Circolec Electronics. Never used, £270 ono. P. McGeechan, 113 Old Mill Road, Uppingston, Glasgow G71 7JB. Tel: Uppingston B1 5565.

2 KILO multicore solder £5, plus carriage. Resistance wire, one ohm per inch £1 p/order per 20 yds. J. S. Hind, 7 Carlyle Road, West Bridgford, Nottingham.

WANTED. Cheap! Secondhand! Transcendent DPX. Write with details to: D. Wood, 16 Donnington Grove, Portswood, Southampton, Hants SO2 1RW.

SERVISCOPE Minor Oscilloscope, £40. Signal generators advance H1 A.F., £30. Heatkit RF-1U R.F., £25. D. Russell, 9 South Beach Road, Ardrossan, Ayrshire KA22 8AX. Tel: Ardrossan 64144.

PRINTER. Olivetti TE318 complete with RS232 interface seen working with PET, £50. Tel: High Wycombe 0494 33164.

AUDIO-GENERATOR. BECCO AG 761 Sine/Square wave, £35. Tel: 051 734 0987.

POWER supplies: 5V/35A (switch mode), £20, 5V/20A (transformer), £15, 24V/1A (transformer), £10 or w.h.y. computer bits? John Cartwright, 96 Cranberry Lane, Alsager, Cheshire. Tel: Alsager 6513.

6800 77-68 CPU card, 4K RAM card, 16K Eprom card, 32K Dynamic RAM card. Offers. 051 653 6918.

UK101 8K wood/aluminium case, integral cassette recorder. Room for internal expansion boards, £170. R. W. Hillman, 79 Pope Road, Underhill Estate, Wolverhampton WV10 8LU. Tel: Wolverhampton 734448.

PET 2001 8K with manual, v.g.c also dust cover and various cassettes, £300. Tel: Hornchurch 72222.

ZX81 computer and 16K RAM plus full size keyboard, £90. Gordon Clarke, 37 Gladstone Grove, Heaton Moor, Stockport SK4 4BX. Tel: 061 432 2189.

ZX81 1K built with everything. V. good condition, £50 of books, Sinclair tape, only £90. Buyer collects. Monsur Miah, 27 Highcroft Gardens, Golders Green, London NW11 0LY. Tel: 01-458 7567 (after 6 p.m.).

SINCLAIR ZX81 1K RAM + Games cassette. Offers Ring 0782 625989.

MICRO PROMPT

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INSTANT SOUND DEVELOPMENT

The use of the AY–3–8912 or AY–3–8910 sound chip with the UK101 adds a new dimension particularly to games. Being such a versatile device employing 14 registers can sometimes mean that producing the exact sound you want is a lengthy process bogged down with bit-patterns and binary to decimal conversions to give the values to be POKEd into the registers. Ideally for sound development one would like to be able to call upon the resources of the device in a straightforward manner.

To this end a program has been written which uses the keyboard to control the sounds in much the same way as an audio mixer. Each of the three channels can be independently selected to contain tone, noise and envelope effects. Frequency sweeps can be carried out until the required sound has been produced. At this point another keypress gives a printout of register contents so that the same sound can be produced in any program. For, complex sweeps the start and finish sounds can be printed out separately. It will be clear from the printouts how to program the sweep with a FOR . . . NEXT loop.

Recapping on what the chip is capable of: Each of the three channels can independently produce tone and/or noise. The tone generators can give different frequencies on each channel but there is only one noise generator which all channels must share. The amplitude of each channel can be set unless control of that channel is given to the envelope generator. The shape and period of the envelope can be specified.

Fig. 1 shows a simplified diagram of the generator showing the effect of selecting the various options in the program (T1, E1, N1 etc.). It also indicates where the period and amplitude controls fit into the system.

At program startup, all of these options are deselected and all the periods and amplitudes are set to zero. A single keypress will select an option and a second press will deselect again. A printout on the VDU shows the status of the device after each selection.

Envelope shape selection is by means of an increment key which steps through the ten profiles returning eventually back to the first again.

The use of the keyboard is shown below right. Below, right, are some examples which demonstrate how quickly different sounds can be demonstrated:

```
1 REM *** SOUND DEVELOPMENT **
2 REM *** PETER BECKETT JAN 81 **
3 REM ****************************
4 Y1=256:Y2=61808:Y3=61809
5 FORI=0TO13:POKEY2,I:POKEY3,0:NEXT
6 POKE530,1:DP=4:DIMX(13)
8 Y4=0:Y5=4095:Y6=31
9 Q1=1.01:Y7=15:Y8=65534
10 FORI=0TO9:READNV(I):NEXT
11 DATA0,4,8,9,10,11,12,13,14,15
12 FORI=0TO16:PRINT:NEXT:PRINT"SOUND DEVELOPMENT-P.BECKETT":PRINT
20 KB=57088
30 T1=-1:T2=-1:T3=-1:N1=-1:N2=-1:N3=-1:E1=-1:E2=-1:E3=-1
100 POKEKB,127:A=PEEK(KB):IFA=255THEN200
110 IFA=127THENT1=-T1:GOTO1000
120 IFA=191THENT2=-T2:GOTO1000
130 IFA=223THENT3=-T3:GOTO1000
140 IFA=239THENN1=-N1:GOTO1000
150 IFA=247THENN2=-N2:GOTO1000
160 IFA=251THENN3=-N3:GOTO1000
170 IFA=253THENE1=-E1:GOTO1000
180 GOTO1000
200 POKEKB,191:B=PEEK(KB):IFB=255THEN300
210 IFB=127THENE2=-E2:GOTO1000
220 IFB=191THENE3=-E3:GOTO1000
230 IFB=223THENES=ES+1:GOTO1000
240 IFB=239THENEP=1.1*EP+1:IFEP>Y8THENEP=Y8
241 IFB=239THEN5190
250 IFB=247THENEP=1/1.1*EP-1:IFEP<Y4THENEP=Y4
251 IFB=247THEN5190
260 IFB=251THEN3000
270 GOTO1000
300 POKEKB,239:C=PEEK(KB):IFC=255THEN400
310 IFC=127ANDE1=-1THEN6000
320 IFC=191ANDE2=-1THEN6100
330 IFC=223ANDE3=-1THEN6200
340 IFC=239ANDE1=-1THEN6300
350 IFC=247ANDE2=-1THEN6400
360 IFC=251ANDE3=-1THEN6500
370 IFC=253THEN6600
380 GOTO1000
400 POKEKB,247:D=PEEK(KB):IFD=255THEN100
410 IFD=127ANDE1=-1THEN6002
420 IFD=191ANDE2=-1THEN6102
430 IFD=223ANDE3=-1THEN6202
440 IFD=239ANDE1=-1THEN6302
450 IFD=247ANDE2=-1THEN6402
460 IFD=251ANDE3=-1THEN6502
470 IFD=253THEN6602
480 GOTO1000
```

cont. opposite

Lines	
4–30	Set up constants. Sound = 61680, 61681.
4–30	Set up constants.
100–220	Scan keys 1–9 and select/deselect options
230	Increment evelope shape if "Ø" pressed.
240–251	Increase/decrease envelope period.
300–380	Scan keys W to I.
400–480	Scan keys S to K.
1000–1099	Status printout.
2000	Delay to prevent too rapid response to option select.
3000–3031	Register printout of array X.
5000–5300	Put current values in array X prior to output to PSG.
5400	Output to PSG.
6000–6610	Calculate periods and amplitudes and output.

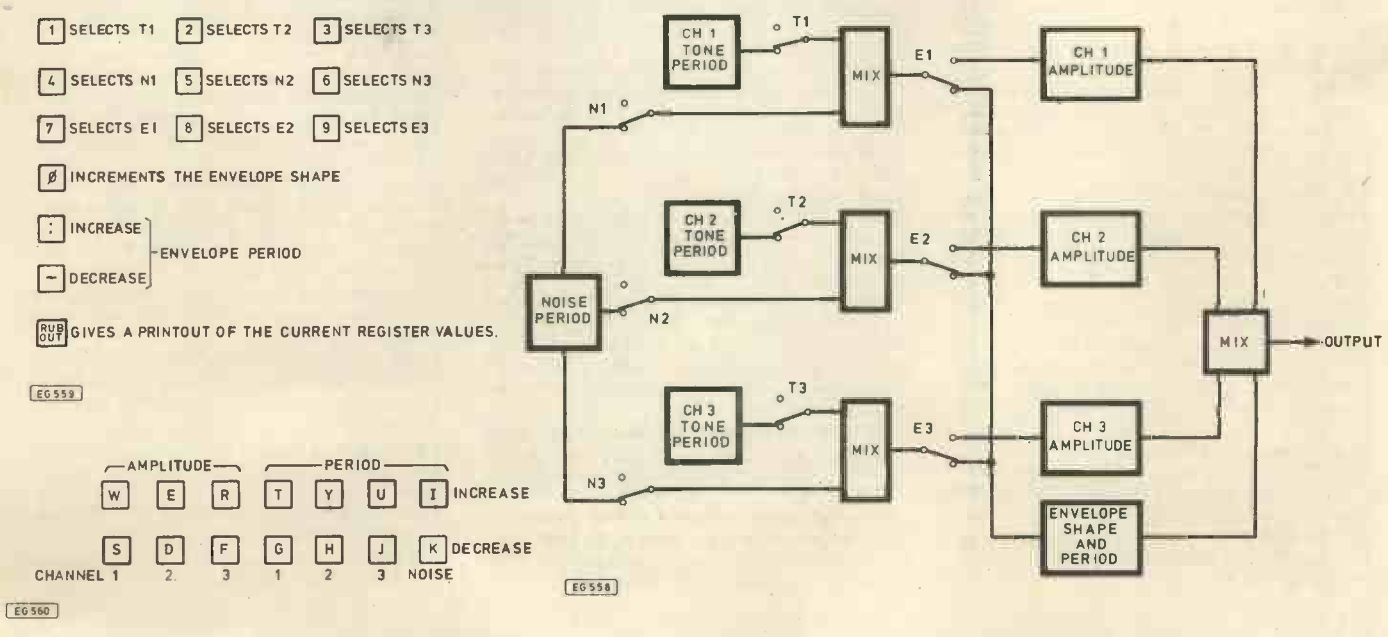
Three Examples

a) 5 second press on [:], N1, Two presses on [Ø], E1. This gives you an ancient aeroplane whose engine speed can be controlled by [:] and [−].

b) 15 second press on [:], T1, N2, 10 second press on [I], 2 or 3 second press on [I]. Now press [W] until a faint whistle is heard. Press [S] if it's too loud. Hold down [I] to hear the bomb fall, To explode the bomb press [Ø].

c) 7 second press on [:], N1, 4 presses on [Ø], E1 and you have a train which can be heard to pass by if [I] is held down. Fine tune the speed of the train with [:] and [−].

Fig. 1. Simplified diagram of the Sound Generator, and the key functions related to it.



```
1000 IFT1=1THENPRINT"T1 ";
1020 IFT2=1THENPRINT"T2 ";
1030 IFT3=1THENPRINT"T3 ";
1040 IFN1=1THENPRINT"N1 ";
1050 IFN2=1THENPRINT"N2 ";
1060 IFN3=1THENPRINT"N3 ";
1070 IFE1=1THENPRINT"E1 ";
1080 IFE2=1THENPRINT"E2 ";
1090 IFE3=1THENPRINT"E3 ";
1092 IFES=10THENES=0
1099 PRINT"ENV SH=";ES
2000 FORI=1TO500:NEXT
2010 GOTO5000
3000 REM REG PRINTOUT
3005 PRINT
3010 FORI=0TO4:PRINT"R"+RIGHT$(STR$(I),1)+"="+STR$(X(I))+" ";:NEXT
3011 PRINT" "
3012 FORI=5TO9:PRINT"R"+RIGHT$(STR$(I),1)+"="+STR$(X(I))+" ";:NEXT
3013 PRINT" "
3014 FORI=10TO13:PRINT"R1"+RIGHT$(STR$(I),1)+"="+STR$(X(I))+" ";:NEXT
3015 PRINT" "
3020 PRINT
3030 GOTO100
5000 REM ENTER REGS
5010 X(1)=INT(P1/Y1)
5020 X(0)=P1-X(1)*Y1
5030 X(3)=INT(P2/Y1)
5040 X(2)=P2-X(3)*Y1
5050 X(5)=INT(P3/Y1)
5060 X(8)=A1:IFE1=1THENX(8)=X(8)+16
5070 X(9)=A2:IFE2=1THENX(9)=X(9)+16
5080 X(10)=A3:IFE3=1THENX(10)=X(10)+16
5090 X(12)=INT(EP/Y1)
5095 X7=64+128
5097 IFT1=-1THENX7=X7+1
5100 IFT2=-1THENX7=X7+2
5110 IFT3=-1THENX7=X7+4
5120 IFN1=-1THENX7=X7+8
5130 IFN2=-1THENX7=X7+16
5140 IFN3=-1THENX7=X7+32
5150 X(7)=X7
5160 X(8)=A1:IFE1=1THENX(8)=16
5170 X(9)=A2:IFE2=1THENX(9)=16
5180 X(10)=A3:IFE3=1THENX(10)=16
5190 X(12)=INT(EP/Y1)
5200 X(11)=INT(EP-X(12)*Y1)
5300 X(13)=NV(ES)
5400 FORI=0TO13:POKEY2,I:POKEY3,X(I):NEXT
5500 GOTO100
5999 REM AMPL AND PERS COME HERE
6000 A1=A1+1:IFA1>Y7THENA1=Y7
6001 GOTO6010
6002 A1=A1-1:IFA1<Y4THENA1=Y4
6010 X(8)=A1:POKEY2,8:POKEY3,A1:GOTO100
6100 A2=A2+1:IFA2>Y7THENA2=Y7
6101 GOTO6110
6102 A2=A2-1:IFA2<Y4THENA2=Y4
6110 X(9)=A2:POKEY2,9:POKEY3,A2:GOTO100
6200 A3=A3+1:IFA3>Y7THENA3=Y7
6201 GOTO6210
6202 A3=A3-1:IFA3<Y4THENA3=Y4
6210 X(10)=A3:POKEY2,10:POKEY3,A3:GOTO100
6300 P1=INT(P1*Q1+1):IFP1>Y5THENP1=Y5
6301 GOTO6310
6302 P1=INT(P1/Q1-1):IFP1<Y4THENP1=Y4
6310 X(1)=INT(P1/Y1):X(0)=P1-X(1)*Y1
6311 POKEY2,0:POKEY3,X(0):POKEY2,1:POKEY3,X(1):GOTO100
6400 P2=INT(P2*Q1+1):IFP2>Y5THENP2=Y5
6401 GOTO6410
6402 P2=INT(P2/Q1-1):IFP2<Y4THENP2=Y4
6410 X(3)=INT(P2/Y1):X(2)=P2-X(3)*Y1
6411 POKEY2,2:POKEY3,X(2):POKEY2,3:POKEY3,X(3):GOTO100
6500 P3=INT(P3*Q1+1):IFP3>Y5THENP3=Y5
6501 GOTO6510
6502 P3=INT(P3/Q1-1):IFP3<Y4THENP3=Y4
6510 X(5)=INT(P3/Y1):X(4)=P3-X(5)*Y1
6511 POKEY2,4:POKEY3,X(4):POKEY2,5:POKEY3,X(5):GOTO100
6600 NP=NP+1:IFNP>Y6THENNP=Y6
6601 GOTO6610
6602 NP=NP-1:IFNP<Y4THENNP=Y4
6610 X(6)=NP:POKEY2,6:POKEY3,NP:GOTO100
```

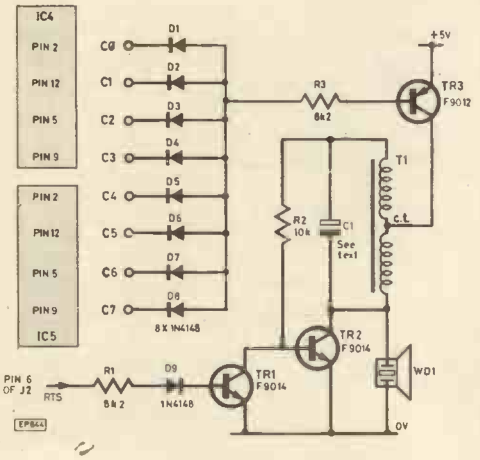
P. Beckett,
Blackpool.

KEYBOARD ANNUNCIATOR

Sir—When typing a program into the computer, I found it convenient to have the solid state annunciator "bleep" to show that I had correctly entered a figure or letter, this saved me having to continually view the monitor screen for missed characters. It also proved useful in some animated games to have the "beep" function sounding for added interest.

The annunciator may be switched off by two methods. Firstly, by a switch in the 5 volt rail to the unit. If this is done, then R1, D9 and TR1 are not needed. The second method is to make use of the RTS line at Pin 6 of J2 on the rear of the computer board. For the RTS line to function, IC68 and associated components need to be fitted on the computer board.

On first switching on the computer the "beep" will not sound until the screen is cleared of the garbage with the Reset key, thereafter it will be actuated by any keystroke. To disable the "beep", the RTS line is actuated by typing POKE 61440,81. To return to "beep" mode just type POKE 61440,17.



The circuit is very simple, TR2, T1, R2, and C1 form the oscillator circuit which drives the flat, disc-like, piezo-electric buzzer. Operating the keyboard puts a lower voltage on the cathode of one of the diodes D1 to D8, this switches TR3 on and puts about 4 volts on to the centre tap primary of a small audio output transformer, the secondary winding is not used. Capacitor C1 need not be fitted and is only fitted if the tonal quality does not suit the user's ear. A typical value of 100n or less may be used.

TR1 is switched on by the command POKE 61440,81 and damps the oscillator circuit so that all that can be heard is a faint click from the piezo stripboard buzzer. The circuit was built on a small piece of stripboard and stuck on to the computer board close to the "Q" key with the piezo buzzer glued to a clear spot on the computer board.

Anthony Green A.S.M.
Hong Kong.

PRINT WITH FN

Sir—here is a short routine which works on my UK101 with Wemon:

```
10 DEF FNA(A)=53194+X+(Y*64)
15 DEF FNB(A)=INT(FNA(A)/256)
20 DEF FNC(A)=FNA(A)–FNB(A)*256
100 POKE 549, FNB(A):POKE 512, FNC(A)
```

It demonstrates how you can PRINT on to any part of the screen using X/Y coordinates. Lines 10–20 need only be written once and the contents of line 100 need to be written just before each PRINT statement. Here is an example:

```
10 DEF FNA(A)=53194+X+(Y*64)
15 DEF FNB(A)=INT(FNA(A)/256)
20 DEF FNC(A)=FNA(A)–FNB(A)*256
30 PRINT CHR$(12);
50 PRINT "[CTRL A] ENTER X AND Y";
60 INPUT X, Y
70 POKE 549, FNB(A):POKE 512, FNC(A)
80 PRINT "UK101"
90 GOTO 50
```

X and Y should be integers between 1-48 and 1-16 respectively. No test for range is made so characters can be PRINTed off the screen.

This routine is especially useful for PRINTing onto the top line which is normally protected from PRINTing by the Wemon. If X and Y are set to one it will PRINT on the top line. Whatever is PRINTed will not scroll with the rest of the screen and will remain there until Clear Screen is executed. If the routine is to be used exclusively for PRINTing on to the top line, line 10 can be changed to:—

```
10 DEF FNA(A)=53259
```

(CTRL A executes HOME CURSOR)

David A. Rogerson,
Morpeth.

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

FREE SOUND

Sir—For those who may not have the skill or the money to build a programmable sound generator, I have found a cheap and easy alternative. A great many weird and wonderful sounds can be heard by placing a small Medium Wave radio beside, or carefully on the computer itself and tuning it for the best results.

I myself use a cheap radio which I have placed on top of the Basic and Monitor ROMs which give excellent results on fast games such as Space Invaders and Gremlins. The different cycles set up for different routines inside the ROMs appear as audio signals on the radio.

Y. Gilihan,
Sittingbourne,
Kent.

INITIAL SNAGS

Sir—I think your readers might be interested in the following modifications to the UK101, if recently bought from Compshop with 2716 substitute chips, for the BAS 2 and CHR GEN.

1) CHR GEN
Pins 18 and 20 should be connected to ground, if this is not done only half the characters are available. (None if the pins are still in the sockets.)

2) BAS 2
(a) Pin 18 should also be connected to ground; or invalid Syntax errors appear if even the simplest program is executed.
(b) A note supplied suggests linking a wire link between pin 6 of 1C17 and pin 8 of 1C16; this converts the BS2 pulse to a NOT BS1 pulse necessary for the 2716, all good stuff, but it doesn't work! Errors still persisted.

The above can be solved by the following method, this either inserts a necessary buffer or presents a slight delay to the pulse, but it certainly works.
Connect pin 8 of 1C16 to pin 9 of 1C18
Connect pin 8 of 1C18 to pin 20 of 1C10 [BAS 2].
Cut the track on the top side of the board leading to pin 20 of 1C10. Pins 8 and 9 on 1C18 are a spare NOT gate.

The chips were supplied with the pins bent outward but there were no notes saying why, so of course I bent them in again thinking they were bent because they were not packed properly, after all i.c. pins usually have to go somewhere!

Although I feel the UK101 is an excellent introduction to Micro Computing, I find it slightly disconcerting that a brand new machine should need so much extra work through lack of Technical Proving.

A. Jones,
RAF North Luffenham.

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

Software and hardware designs submitted should be accompanied by a declaration to the effect that it is the original work of the undersigned. and that it has not been accepted for publication elsewhere.

E/MONITOR HELP

Sir—In reply to Mr. J. Walton's letter requesting information on relocation of the extended monitor.

To relocate the extended monitor:

1) Use the relocate command (R) to relocate the monitor.

2) Change look up table between $0960 + d and $0999 where d is the displacement of the new monitor location from the original.

If for example the monitor is moved to the top of 8K ie. $1800 – $2000 the table will be between $1960 and $1999.

Some of the addresses in the table will have been changed by the relocate command. The first value to be changed is in $1961 this is $0B and must be changed to $1B proceed through the table changing alternate values if they start with a zero i.e. $0B, $0C, etc.

These values are the high bytes of the addresses and if the monitor has been moved $1000 bytes ie. moved to the top of 8K then $10 will have to be added to these values.

You can now save the relocated monitor using the checksum save. ie. $1800, 2000.

R. Webster,
Sutton Coldfield.

UK101 KEYBOARD GRAPHICS

Sir—The program opposite enables the total range of characters to be accessed easily and directly from the keyboard, thereby greatly simplifying graphical display design and more importantly, saving valuable user RAM space.

eg. **1Ø PRINTCHR$(216); CHR$(218); CHR$(216); CHR$(218)** *= 33 bytes*
1Ø PRINT "HH" *= 12 bytes*

The graphics program occupies 163 bytes and one zero page address at ØØE7; and is located at Ø235–Ø2D8. Unfortunately, the programming of the UK101's ROMs masks the MSB of all characters whilst loading, so a simple load routine must also be used, and occupies 24 bytes of RAM from Ø2D9–Ø2FD. Both routines reside in an otherwise unused and protected area of RAM and are consequently unaffected by "Cold Starts".

The graphics routine is entered by changing the Input Vectors from FFBA to Ø235. i.e. **POKE536,53: POKE537,2** *(Note: both POKEs must be executed together).*

The keyboard will still function as before, but on pressing CONTROL G, a display block will appear in the top right-hand corner of the screen. Any graphic character may now be obtained by a two-stage operation:

1) *Select a letter (A–Z), which will be displayed within the display block. RUBOUT will delete this letter.*
   (The letters actually correspond with the vertical column of the UK101 character set published in the March 1980 edition of PE.)
2) *Select a number (Ø–9). The corresponding graphic character will be displayed. RUBOUT will delete the last entry.*

Return will commit the BASIC line to memory and automatically exits the graphics routine. CONTROL C also exits the routine but enables the user to continue the program line using a "standard" keyboard. However, the input vectors remain unaffected and CONTROL G can be operated at any time.

Certain characters such as CR and LF can be used within program lines but they will produce error messages when loaded and should therefore be avoided unless a different form of load routine is used. Also, NULL is not displayed and causes subsequent characters to be deleted from that particular line.

As already stated, an additional LOAD routine must be used to retrieve recorded programs, due to the character mask of the UK101.

To place the routine in a LOAD mode enter:

POKE536,217: POKE537,2

The data from the cassette will be loaded as normal, but at the end of the listing the Reset keys must be operated and Warm Start selected. (A Warm Start resets the Input Vectors to FFBA.)

It has already been mentioned that although CR/LF can be used within program lines, these lines will be rejected when loaded from cassette.

However, if we assume that CR/LF characters are always correctly enclosed by character string inverted commas, then loading is possible.

A suitable routine is provided and is located at Ø235–Ø26B plus a zero page address at ØØEØ. The program initially searches for at least 12 consecutive NULLS, placed at the beginning of a program listing on tape, in order that the character string flag may be correctly set.

From then on, after every other inverted comma, the routine accepts every character as a string rather than a control. Therefore, if the tape is halted within the program or a string exists without a terminating inverted comma, the LOAD routine may then be out of step with the character strings and subsequent error messages will result.

The routine is entered by:

POKE536,53: POKE537,2

and RESET must be operated at the end of the LOAD cycle.

In order to SAVE a program containing control characters, one must ensure that all character strings have their associated terminating inverted comma and the following line is added to the program.

1 SAVE: FORI = 1TO2Ø: PRINTCHRS(Ø); :NEXT: LISTN-

(where N is the 1st program line to be SAVEd)

Then enter RUN, start the tape recorder and press RETURN to execute the SAVE.

A. J. Jameson,
Ross Shire.

Graphics Routine

```
0235  LDA  AD  2AD0
0238  CMP  C9  0C               Graphics Block Present
023A  BEQ  F0  07      (0243)
023C  JSR  20  00FD             Get Key
023F  CMP  C9  07
0241  BNE  D0  6D      (02BO)   Control "G"?
0243  JSR  20  C202             Display Graphics
0246  LDA  A9  20               Blank Space
0248  STA  8D  74D0             in "Graphics" Block
024B  JSR  20  00FD             Get Key
024E  CMP  C9  1C
0250  BEQ  F0  5E      (02BO)   Rubout?
0252  CMP  C9  20
0254  BEQ  F0  41      (0297)   Space?
0256  CMP  C9  03
0258  BEQ  F0  4D      (02A7)   Control "C"?
025A  CMP  C9  0D
025C  BEQ  F0  45      (02A3)   Return?
025E  CMP  C9  41
0260  BMI  30  E9      (024B)   Key Valid?
0262  CMP  C9  5B
0264  BPL  10  E5      (024B)   Key Valid?
0266  STA  8D  74D0             Display Key
0269  SEC  38
026A  SBC  E9  40               Determine
026C  TAY  A8                   Correct
026D  LDA  A9  F5               Key
026F  ADC  69  0A               Weighting
0271  CLC  18
0272  DEY  88
0273  BNE  D0  FA      (026F)
0275  STA  85  E7               REM Key Value
0277  JSR  20  00FD             Get Key
027A  CMP  C9  1C
027C  BEQ  F0  C8      (0246)   Rubout?
027E  CMP  C9  20
0280  BEQ  F0  15      (0297)   Space?
0282  CMP  C9  03
0284  BEQ  F0  21      (02A7)   Control "C"?
0286  CMP  C9  0D
0288  BEQ  F0  19      (02A3)   Return?
028A  CMP  C9  30
028C  BMI  30  E9      (0277)   Key Valid?
028E  CMP  C9  3A
0290  BPl  10  E5      (0277)   Key Valid?
0292  SBC  E9  2F               Determine
0294  CLC  18                   Correct
0295  ADC  65  E7               Key Weighting
0297  STA  95  13               Store Key Code
0299  JSR  20  E5A8             Display
029C  INX  E8                   Cursor Pointer
029D  LDA  A9  00
029F  CPX  E0  47
02A1  BNE  D0  0D      (02B0)   Max. Line Length?
02A3  LDA  A9  0D
02A5  BNE  D0  02      (02A9)   Branch
02A7  LDA  A9  00
02A9  PHA  48
02AA  LDA  A9  20
02AC  JSR  20  B302             Clear Graphics Block
02AF  PLA  68
02BO  RTS  60
02B1  LDA  A9  0C
02B3  LDY  A0  0C
02B5  STA  99  29D0
02B8  STA  99  69D0             Graphics Block
02BB  STA  99  A9D0
02BE  DEY  88
02BF  BNE  D0  F4      (02B5)
02C1  RTS  60
02C2  JSR  20  B102
02C5  LDY  A0  08
02C7  LDA  B9  D002
02CA  STA  99  6AD0             Graphics Message
02CD  DEY  88
02CE  BNE  D0  F7      (02C7)
02DO  RTS  60
02D1  47 52 41  50 48 49 43 53  GRAPHICS ASCII Characters
```

Simple Graphics Load Routine

```
02D9  LDA  AD  00F0             Cassette Port
02DC  ROR  6A
02DD  BCC  90  FA      (02D9)   Data Ready?
02DF  LDA  AD  01F0             Get Data
02E2  CMP  C9  0A
02E4  BEQ  F0  F3      (02D9)   LF?
02E6  CMP  C9  00
02E8  BEQ  F0  EF      (02D9)   NULL?
02EA  CMP  C9  0D
02EC  BEQ  F0  0F      (02FD)   CR?
02EE  STA  9D  CDD3             Display
02F1  STA  95  13               Store
02F3  INC  EE  0002             Cursor Position
02F6  INX  E8                   Cursor Pointer
02F7  CPX  E0  47               Max. Line Length?
02F9  BNE  D0  DE      (02D9)
02FB  LDA  A9  0D
02FD  RTS  60
```

REM To call Graphics Routine:
POKE536,53: POKE537,2
REM To call Graphics Load:
POKE536,217: POKE537,2
To enter Graphics Mode—Control G
To exit Graphics Mode—Control C
RETURN automatically exits and executes LF/CR
RUBOUT either deletes 1st letter entry or backspaces
SPACE continues to function correctly

Graphics Load Routine
(CR/LF+ other control characters)

```
0235  LDY  A0  0C               Set Tally
0237  DEY  88                   Tally-1
0238  BNE  D0  02      (023C)   Tally=Ø?
023A  STY  84  E0               Clear CR/LF Flag
023C  LDA  AD  00F0             Cassette Port
023F  ROR  6A
0240  BCC  90  FA      (023C)   Data Ready?
0242  LDA  AD  01F0             Get Data
0245  BEQ  F0  F0      (0237)   NULL?
0247  TAY  A8
0248  CPY  C0  22
024A  BNE  D0  06      (0252)   "?
024C  LDA  A5  E0
024E  EOR  49  01               EX-OR CR/LF Flag
0250  STA  85  E0
0252  LDA  A5  E0
0254  BNE  D0  08      (025E)   CR/LF Flag Set?
0256  CPY  C0  0A
0258  BEQ  F0  DB      (0235)   LF?
025A  CPY  C0  0D
025C  BEQ  F0  0B      (0269)   CR?
025E  TYA  98
025F  STA  95  13               Store Data
0261  JSR  20  E5A8             Display Data
0264  INX  E8                   Cursor Pointer
0265  CPX  E0  47
0267  BNE  D0  CC      (0235)   Max. Line Length?
0269  LDA  A9  0D               CR
026B  RTS  60
```

REM To call Graphics Load Routine:
POKE536,53: POKE 537,2
REM To Save Programs:
Line No.
SAVE: FORI=1 TO 2Ø: PRINTCHR$(Ø);:
NEXT: LIST N—
e.g. (where N is the 1st Prog. Line)
1Ø SAVE: FORI=1 TO 2Ø: PRINTCHR$(Ø);: NEXT:
LIST2Ø—

Space Watch...

SHUTTLE ORBITER

A new problem of natural science has shown itself on the last shuttle mission. Photographs show that the vehicle glows in the dark. It was an unexpected phenomenon and could give rise to adverse conditions when carrying out observation on the dark side of the vehicle. There are a number of planned optical payloads for observations on the dark side of each orbit. Also there are scheduled tasks involving infrared techniques, low level light sensors and astronomical tasks.

The glow appears on the edges of the manoeuvring systems, the vertical stabiliser and other edged parts. The theory is that this is a chemicoluminescent effect caused by atomic oxygen. It is thought that the atomic oxygen impacting the vehicle builds up into molecules of oxygen and when these are shed they may give off photons as they slow down when separating from the vehicle. It is believed that all parts of the spacecraft which are covered with tiles give off this glow when facing into the velocity vector.

INSAT 1A SATELLITE TESTED IN ORBIT

The first pictures from the Indian satellite, a multipurpose spacecraft, indicated weather patterns over India and the surrounding oceans and land mass. This satellite will enable India to make observations for detailed forecasts of flooding. The image is provided by a very high resolution radiometer operating in the range 0·55–0·75 micrometres. There is also infrared imagery capability in the range 12·5 to 10·5 micrometres.

Most systems seem to be working according to the planned programme. It is however a disappointment that the solar sails were not able to be successfully deployed.

SOVIET ACTIVITIES

The Soviet Union have been active in orbits which can monitor happenings in the South Atlantic. It has been the custom by the Soviet Union to regularly use this region in order to replace spacecraft which become degraded. The task of surveillance is thus kept in continuing operation. A particular vehicle Cosmos-1355 was launched at 0953 GMT from Tyruatom on the 29th April. It was put into a 402 x 128-km orbit at an inclination of 65·1 deg. After the initial orbit was satisfactorily achieved it was put into a higher orbit of 459 x 438-km but in the original inclination. This would take it over the Falkland Islands.

SHUTTLE CREWS

In accordance with the new policy to be adopted by NASA for the Shuttle Missions of the future, the next three crews have been named. For Mission 7 the commander will be Robert L. Crippen with Frederick H. Hauck as pilot. The Mission specialists will be John M. Fabian and the first woman astronaut Sally K. Ride. She has already gained much experience as a key communicator for shuttle crews from her post at the Johnson Spaceflight Centre. This shuttle will be named Challenger and is due for launch on a date in April 1983.

The payloads will be a pallet satellite from Germany, a Canadian communications satellite, Telesat-F, a second instrument package from the Office of Space and Terrestrial Applications and an Indonesian communications satellite, Palapa-81. The Mission will be for six days.

In July 1983 shuttle Mission 8 will be launched with Richard H. Truly as commander and Daniel C. Brandenstein as pilot. The Mission specialists will be Dale A. Gardner and Guion S. Bluford, Jr. This will be a three day mission. On this flight there will be an Indian communications satellite, Insat-B, and a satellite from NASA for tracking and data relay named TDRS-B. This is the second and final part of a system for advanced voice control and data control between the orbiting shuttles and the mission control centres.

Mission 9 will be the European Spacelab. The date is set at September 1983. This will be a seven day mission. The commander will be John W. Young and the pilot Brewster H. Shaw, Jr. The two specialists will be Owen K. Garriot and Robert A. Parker. The payload specialists for this mission have not yet been released.

SALYUT ACTIVITIES

Another cycle in the Soviet manned space station missions began with Salyut 7. This is probably intended for the Soviet-French joint cosmonaut team which has been expected in June or July 1982. The orbital parameters are apogee –278km, perigee –219km, with a revolution period of 89·2 min. The inclination of the orbit is 51·6 deg. A Soviet team may visit the station before the joint mission takes place.

Meanwhile, Salyut 6 remains docked with Cosmos 1,267 and will remain in orbit as a back-up for the joint mission. A progress supply vehicle is expected to visit the station between the inspection team and the final joint Soviet-French team.

Salyut-7 will continue to test systems and space station equipment. This mission is controlled from the Moscow control centre and tracked by the research ship Sergey Korolev somewhere in the Atlantic.

It is worth remembering that the Soviet approach was, from the early days of space research, geared to space station technology. On the many occasions that invitations came from Kensington Gardens to attend film shows and discussion sessions there was always the same question put by the hosts 'which do you consider the best way to plan visits to the Moon and other planets'. Many of us were of the opinion that the two step method seemed the most economical. The concept is still the same but the method now is the Shuttle. Alas there are fewer invitations for such discussions now. The early dreams are somewhat later than was expected yet perhaps the improvements in the techniques have been worth it.

There is however another side to all this. At the moment the financial restraints are beginning to bite. The bite is indeed so great that there is a danger that a great deal of expertise and valuable data will be thrown away at a time when quite exceptional new knowledge is available for collection. Yet these so very successful units are to be axed. Axed for the want of funds so small when considered against the background of the whole of industry. Half a century of endeavour will be jettisoned at the very moment when the object of that endeavour is within reach.

Is it that the world has become so blasé that a football match is of more importance than an achievement which can contribute to the eradication of problems? Is it perhaps too much to expect that every thinking person should have some regard for the future and be willing to learn that their peace of mind and well being can be assured by wise use of the resources of the solar system? The exploitation of these resources for the benefit of the people of the solar system is, surely, a worthwhile goal. The sum of money required to continue is the cost of the annual operations to collect and analyse data which cannot be repeated perhaps for as much as a hundred years, yet that cost is less than the cost of an airplane for weather research.

PIONEER 10 AND 11

The principal objects which technology has put into space and which have given returns so far which exceed by a great margin the design expectations, are the spacecraft Pioneer 10 and 11. The chronicle of what has been achieved and the impact made on even general knowledge is immense. Part of the next SPACEWATCH will be devoted to a survey of the accomplishments such as the accurate survey of the magnetic field of Jupiter; determination of the distribution of high energy particles in Jupiter's magnetosphere (including an explanation of the source of Jupiter's previously known decimetric radio emission); discovery of absorption effects of the Gallilean satellites; discovery of the planet's magnetodisc and many contributions to understanding the sources; and the physical dynamics of charged particles trapped in the planet's magnetic field.

At the present time both these craft are in the outer areas of the solar system and moving out in opposite directions. By 1990 Pioneer 10 will be in the interstellar medium and still healthy.

Frank W. Hyde

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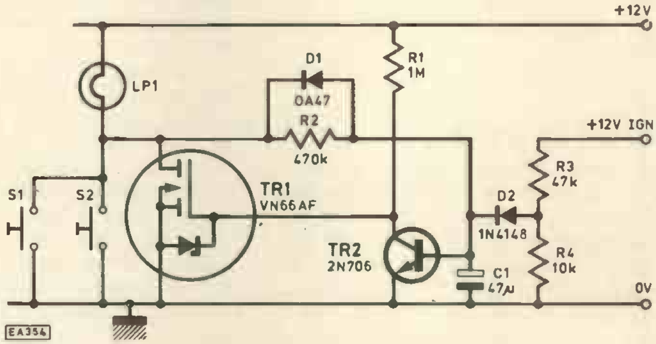
Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not in the text.

COURTESY LIGHT DELAY



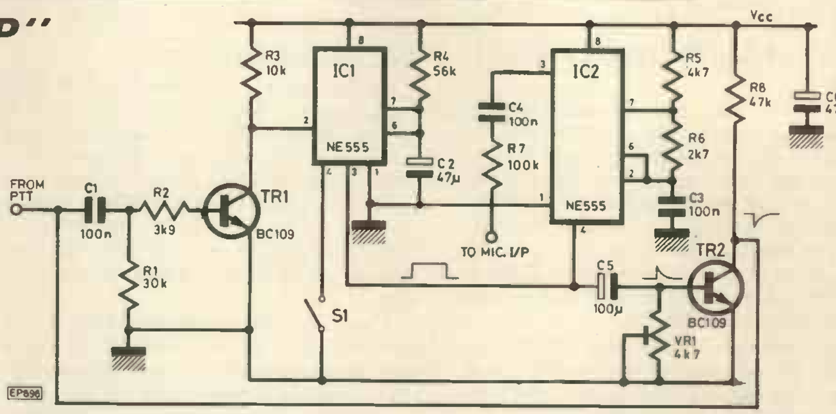
WITH this circuit, when a door is opened and the ignition turned off, in either order, capacitor C1 is discharged through switch S1 via diode D1 and transistor TR2 is turned off. When the door is closed, switch S1 opens and transistor TR1 conducts the lamp current since its gate is held at +12V via resistor R1. The potential drop across transistor TR1 causes capacitor C1 to charge through resistor R2. As the potential across capacitor C1 increases transistor TR2 begins to conduct and the potential at the gate of transistor TR1 is reduced. This reduces the current through transistor TR1 which increases the potential drop across it and therefore increases the charging rate of capacitor C1, so that the lamp is turned off rapidly. Consequently the power dissipated in transistor TR1 is very low and there is no real need for a heatsink.

Transistor TR2 can also be turned on by the ignition supply through resistors R3 and R4 and diode D2, hence starting the car will extinguish the light.

The time delay can be altered by varying capacitor C1 and resistor R2. Check that diode D2 does not have a significant reverse leakage current as this could prevent capacitor C1 from charging sufficiently. The circuit should be tested using a lamp of the same rating as that in the vehicle to which it is to be fitted as this will affect the potential drop across transistor TR1 and hence the charging rate of capacitor C1. If too large a value is chosen for resistor R1 the unit may never turn the light off. The reason for this is that the potential at the base of transistor TR2 is determined by resistor R1 and the leakage resistances of capacitor C1 and diode D2 and this could be too low for transistor TR2 to conduct. A germanium diode is preferable for D1 because capacitor C1 will then discharge faster when switch S1 is closed. This ensures that the full time delay is obtained even if the door is only opened for a short time.

G. H. Wostenholm,
Manchester.

CB "ROGER BLEEP"

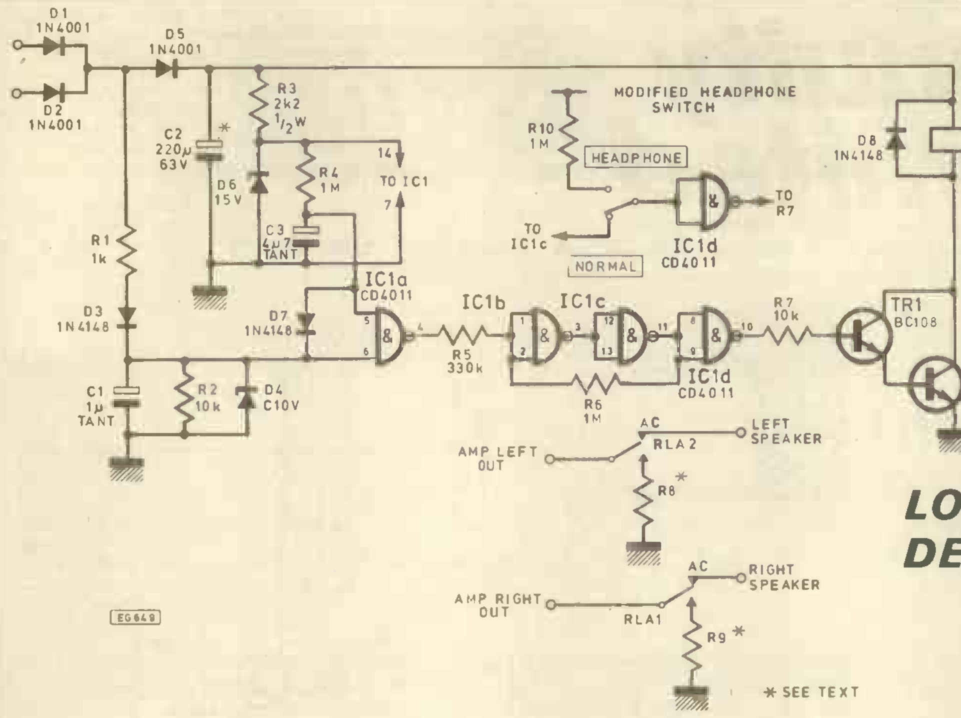


THIS circuit has been used in conjunction with my CB radios for some three months now. It produces a short burst of tone, on releasing the transmit switch, whilst also holding the radio in the transmit mode for the duration of the tone. I have found it very useful for communicating over a distance when the signals are weak and barely audible in that it gives a positive indication of when one party has ceased transmission.

Apart from supply and ground, there are two connections to the radio. One is the 'press to talk' (ptt) line and the other is the microphone input to the radio. In order to transmit, the ptt line is grounded. On releasing the transmit switch the line moves to nearly V_{cc}. TR1 and its CR input converts this voltage change into a pulse, inverts it and triggers the monostable IC1. The output of IC1 goes high releasing the reset hold on the oscillator IC2. The tone output of this is fed, via C4 and R7, to the microphone input. TR2 inverts IC1 output and uses it to hold down the ptt line. C5/VR1 ensure ptt goes high again, switching off the transmitter, just before IC1 completes its monostable action, thus ensuring it does not retrigger itself.

R4/C2 will set the monostable time. R5/R6/C3 set the frequency of the tone. Finally, VR1 is set to maximum then backed off, whilst keying the transmitter on and off, until IC1 stops retriggering itself. S1 (on/off) holds down the reset on IC1 disenabling the circuit. I rewired the channel 9/off switch on my radios to accomplish this. V_{cc} may vary from radio to radio so some experimentation may be necessary with the CR times.

C. J. Lawrie,
Norwich, Norfolk.



LOUDSPEAKER DE-THUMP

THE thumps, hisses and crackles that emerge from the speakers as most audio amplifiers are switched on and off are annoying and probably damaging. These noises arise from several sources, although the biggest offenders are capacitors which give rise to current surges as they charge and discharge.

It is desirable to prevent these from reaching the speakers and the easiest way to do this is to connect a relay in series with the amplifier outputs. This relay should close (connecting the speakers) about five seconds after switch on and open immediately after switch off. The circuit described here performs this function at a reasonably low cost, and is, above all, easy to connect to an existing amplifier. Apart from the relay only three connections are required, these being two a.c. lines and a centre tap.

An unrectified a.c. supply with a centre tap is required from the amplifier. The exact voltage is unimportant, but at least 15 volts must be available.

The a.c. supply is rectified by D1 and D2. The unsmoothed d.c. is passed via the current limiting resistor R1 to the power down detector. D3 allows C1 and R2 to develop a very rough d.c. voltage clamped by D4 at 10 volts. This d.c. voltage decays very rapidly (in less than 15 ms) when the power is removed. As a result pin 6 of the i.c. is high when power is applied and falls very quickly once the power is removed. It is worth noting that 10 volts is well above the threshold for a CMOS gate with a 15 volt supply but obviously decays more quickly than 15 volts would under the same circumstances.

The rectified d.c. is also passed via D5 to C2 which forms the circuit's power supply. D5 is necessary to prevent the smoothed d.c. from affecting the operation of the power down detector. The voltage available on C2 is then fed to a simple resistor/Zener network to generate a 15 volt supply for the i.c.

R4 and C3 form the switch on delay. Initially C3 will be discharged and pin 5 of the i.c. will be low. When power is applied C3 will charge up by means of R4, taking pin 5 above the gate threshold some 5 seconds after switch on. D7 removes the charge from C2 immediately the power is removed by forming a discharge path through the power down detector's resistor, R2. This ensures that a delay will occur even if the power is removed for a very short period.

The i.c. contains four NAND gates, details of which are easily available—suffice to say a NAND gate's output will be low if both inputs are high, otherwise the output will be high. So far then, the output of IC1a will be high for five seconds after switch on and immediately after switch off. A Schmitt trigger follows because the inputs to the gate are slow edged and the output will be prone to jitter. The Schmitt trigger is composed of gates b and c, R5 and R6. The values of resistor have been chosen to give hysteresis between $\frac{1}{3}$ and $\frac{2}{3}$ of the gate threshold.

The output from the trigger is inverted by gate d and drives the relay by means of the Darlington pair TR1 and TR2. Any back e.m.f. from the relay is caught by D8.

The relay used is a 2-pole heavy duty continental type. This relay will be suitable for all amplifiers with up to 27 volt a.c. supplies (indicating an amplifier of greater than 33 watts per channel output). A printed circuit board socket must be purchased with the relay.

For larger amplifiers a member of the Octal series is recommended, and the 48 volt version is generally suitable. This relay will not fit onto the circuit board and must be connected using flying leads from the relay drive points marked on the p.c.b. If R8 and R9 (see below) are not required either, the end of the p.c.b. is redundant and may be cut off.

If the d.c. voltage on C2 is likely to exceed 63 volts, a 100 volt version must be used for C2 and a 560 ohm 1 watt resistor connected in series with the relay coil. It is assumed that if this is the case the "Octal" style relay will be used as a matter of course.

If the amplifier is d.c. coupled (i.e. has no output capacitor) then R8 and R9 may be omitted. However, an a.c. coupled amplifier must be provided with a means to allow the output capacitors to charge up. In this case R8 and R9 must be installed—a value of 8 ohms will do for all amplifiers. The resistors should be at least 3 watt wire wound types.

It is quite probable that the amplifier will have some resistors already present to attenuate the headphone signals. It is quite convenient to use these. Indeed, a small modification to the circuit allows the relay to be used as a headphone switch or a convenient mute system.

I. C. Lare, B.Sc., M.Sc.,
Hartford, Cheshire.

Patents Review

Copies of Patents can be obtained from:
the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price £1·60 each.

ICE WARNING

British patent application 2 083 244, from Damien McDonnell of Malvern, Worcestershire, gives full technical details of a new development from the Royal Signals and Radar Establishment in Malvern. The idea is to replace existing road cat's eyes with a new type which use the temperature sensitivity of a liquid crystal material to give a tell-tale of road conditions. For instance above 0°C the cat's eye reflects blue light, but as the temperature drops to 0°C and below the colour changes through green and yellow to red. In this way a car driver knows whether there is likely to be black ice on the road. The invention is particularly interesting because it ties in with other work on liquid crystals which is going on at Malvern.

Much of the pioneering work on liquid crystal displays was carried out at Malvern. Even now many Japanese companies buy their liquid crystal raw materials from British companies, such as BDH of Poole. (It is a tragedy that Britain, having developed liquid crystal technology, never took advantage of the lead and left the mass production of finished liquid crystal displays to Japan.) Several Japanese companies, for instance Hitachi and Toshiba, have already demonstrated prototype pocket tv sets which use a liquid crystal display for the screen. Until recently it had been supposed that l.c.d.s, which modify ambient light rather than generated light, could not be used to produce colour tv pictures. But Professor Hilsum of RSRE recently demonstrated a liquid crystal display which changes colour in an electric field and hinted that the technology could be used to make colour tv screens of l.c.d. type. British patent application 2 083 244 gives a detailed insight into Malvern's work on l.c.d. materials that change colour with temperature. Hopefully patents on the colour tv technology will eventually be published.

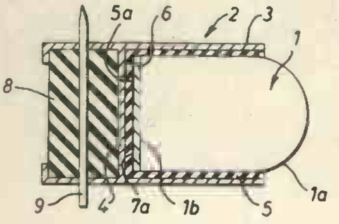


Fig. 1

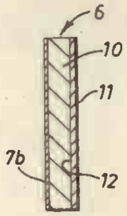


Fig. 2

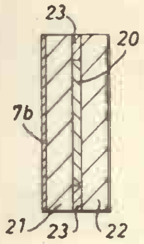


Fig. 3

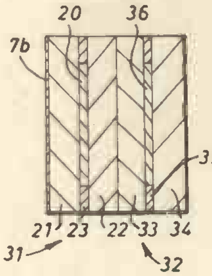


Fig. 4

Light which falls on the cat's eye shown in Figure 1 is focused by lens 1 onto reflector 6. This can take the form shown in Figure 2. A transparent substrate 10, of Mylar plastics, has a front surface layer 11 of cholesteric liquid crystal material and is backed with layer 7b of light absorbing material, such as graphite. The wavelength, and thus the colour, of the light reflected back through lens 1 depends directly on the temperature of the cholesteric material.

In the alternative construction shown in Figure 3, layer 20 of cholesteric material is sandwiched between two pieces of Mylar 21, 22. Again the colour of the light reflected back through the lens 1 depends on the temperature of the cholesteric layer. The patent gives the formula for a material which changes from violet to red, through blue turquoise, green and yellow across the temperature range of 24°C down to −2·2C.

Figure 4 shows a clue to the future. In this case two separate liquid crystal layers 20 and 36 are sandwiched between Mylar sheets. Front layer 36 is clear above 0°C, but turns red below freezing point. The rear layer 20 changes its colour at temperatures above 0°C. So coloured light from the rear layer 20 is seen through layer 36 while it remains clear. Then the front layer takes over as the active element. In this way a much wider range of colour changes can be produced. This suggests one line of approach towards producing a full spectrum of colour from an l.c.d. tv screen.

FM NOISE ELIMINATION

The Clarion Company of Tokyo patents (BP 1 573 160 filed under the Old Laws and dating back to 1976) a circuit which is claimed to eliminate noise from an FM radio receiver. The Japanese inventors say they are seeking an alternative to the conventional system in which an impulsive noise switches a low pass filter for a few tens of microseconds. The problem is that in such circuits the 19kHz pilot tone and 38kHz sub-carrier are lost unless the circuit is peaked to let these frequencies through; in which case 19kHz and 38kHz noise is not eliminated.

Figure 5 shows the patented Clarion circuit. The output of low pass filter 1 is branched and one half of the split signal fed through phase inverter 2 to stereo blocking circuit 3, amplifier 4 and combining potentiometer 5. Circuit 3 includes 19kHz parallel resonance circuit 7 and 38kHz parallel resonance circuit 8. Gate 10 can short circuit 3 to earth under the control of circuit 9 which detects impulsive noise. The second signal path branched from filter 1 goes direct to combiner 5.

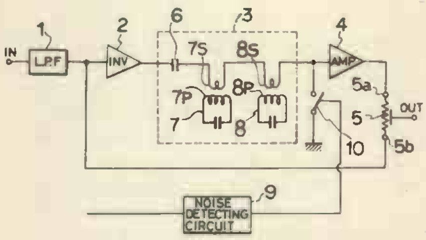
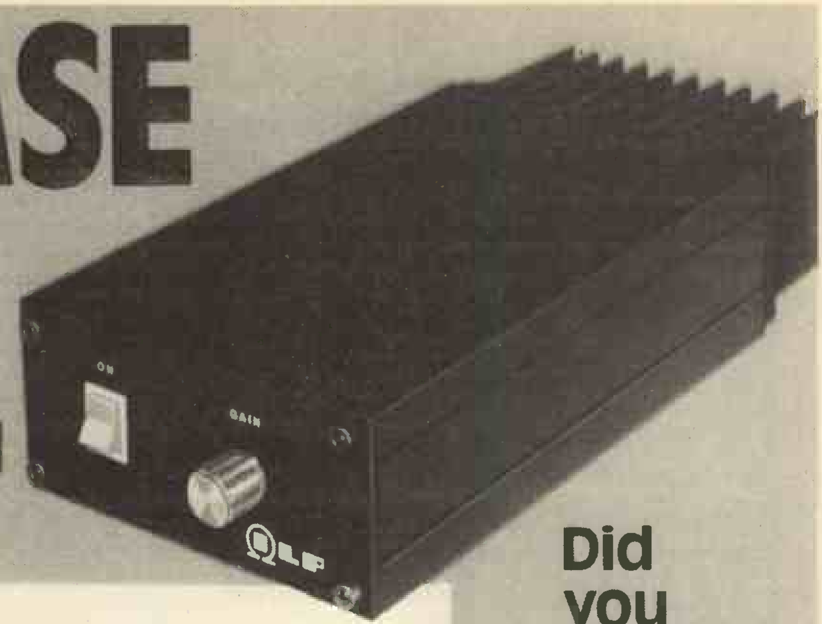


Fig. 5

In the absence of noise the first signal path is earthed by gate 10. Capacitor 6 charges with L+R, and current flows through resonance circuits 7 and 8 which store the pilot tone and carrier signal energy. Only the signal from the second path reached combiner 5. When noise is detected at 9, gate 10 changes state and the charge on capacitor 6 is cancelled by the phase—inverted signal from circuit 2. Simultaneously, resonance circuits 7, 8 release their stored energy to cancel the pilot tone and sub-carrier. Hence only the noise components are faithfully transmitted to input 5*a* of the combiner 5 while the complete stereo signal is applied to terminal 5*b*. Because the noise is phase inverted it is cancelled out across resistor 5 and a noise-free output is derived. There is no circuit element connected to the second signal path so the noise reduction circuit should have no effect on phase and amplitude of the stereo signal.

THE CASE FOR ILP



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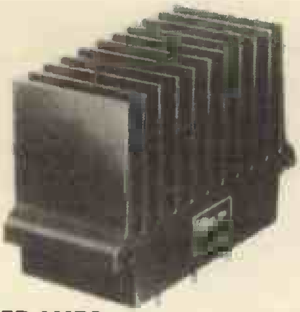

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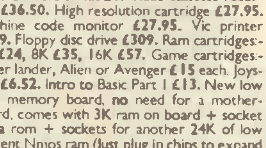

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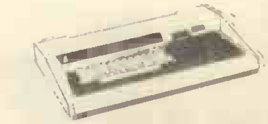

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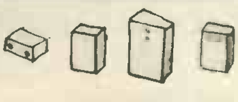

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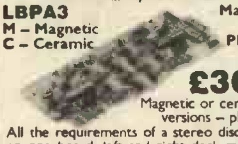

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Each module is manufactured from the highest quality components, fully tested, supplied with a connection diagram and guaranteed for twelve months.
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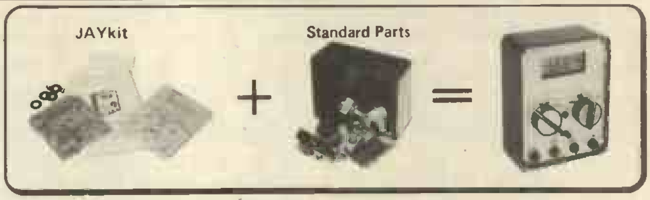
OVERSEAS DISTRIBUTORS Enquiries are invited from overseas companies interested in distributing our high quality products.

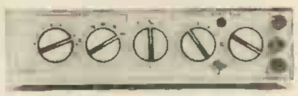


DM-2

DIGITAL MULTIMETER

- DC Volts . . . . 1mV to 1000V
  AC Volts . . . . 1V to 500V
  DC Current . . . . . . 0.1mA to 0.2A
  Resistance . . . . 1Ω to 20MΩ
- 3½ digit LCD
- Auto Low Battery Indication
- Auto Polarity & Zero
- 1% accuracy (DC volts)
- Designed around Intersil 7106 IC
- Total cost around £30 (incl. case)

FG-1a



FUNCTION GENERATOR

- 30mV to 10V pk-pk
- 1Hz to 100kHz
- DC coupled
- Sine, Square & Triangle
- Separate TTL output
- Designed around Intersil 8038 IC
- Total cost around £30 (incl. case)

Provided in a JAYkit is a Printed Circuit Board, a punched and lettered Front Panel overlay, a Circuit Diagram and Instruction Sheet and a comprehensive and up to date Component List showing suppliers and current prices. Difficult to obtain pieces of hardware are supplied with the kit.

Jayen Developments, 12B Milton Road, Highgate, London N6 5QD

To: JAYEN Developments
12B Milton Road,
Highgate,
London N6 5QD.
Tel. 01-348 3538

Name ____________

Address ____________

Please send:
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☐ FG-1a @ £4.95
(Incl. VAT and P&P)

Money to be refunded if the kit is returned within 10 days.
Goods by return subject to stock.

JAYkits

INDEX TO ADVERTISERS

MAIL ORDER ADVERTISING

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Advertisements in this publication are required to conform to the British Code of Advertising Practice. In respect of mail order advertisments where money is paid in advance, the code requires advertisers to fulfil orders within 28 days, unless a longer delivery period is stated. Where goods are returned undamaged within seven days, the purchaser's money must be refunded. Please retain proof of postage/despatch, as this may be needed.

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If you order goods from Mail Order advertisements in this magazine and pay by post in advance of delivery, PRACTICAL ELECTRONICS will consider you for compensation if the Advertiser should become insolvent or bankrupt, provided:

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The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognise the advantages toroidals offer in size, weight, lower radiated field and, thanks to I.L.P., PRICE.

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★ ORDERS DESPATCHED WITHIN 7 DAYS OF RECEIPT FOR SINGLE OR SMALL QUANTITY ORDERS

★ 5 YEAR NO QUIBBLE GUARANTEE

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
30 VA	1x010	6+6	2 50	£5.12
70 x 30mm	1x011	9+9	1 66	+p/p £1 04
0 45Kg	1x012	12+12	1 25	+VAT £0 92
Regulation	1x013	15+15	1 00	TOTAL £7 08
18%	1x014	18+18	0 83	
	1x015	22+22	0 68	
	1x016	25+25	0 60	
	1x017	30+30	0 50	
50 VA	2x010	6+6	4 16	£5.70
80 x 35mm	2x011	9+9	2 77	+p/p £1 30
0 9 Kg	2x012	12+12	2 08	+VAT £1 05
Regulation	2x013	15+15	1 66	TOTAL £8 05
13%	2x014	18+18	1 38	
	2x015	22+22	1 13	
	2x016	25+25	1 00	
	2x017	30+30	0 83	
	2x028	110	0 45	
	2x029	220	0 22	
	2x030	240	0 20	
80 VA	3x010	6+6	6 64	£6.08
90 x 30mm	3x011	9+9	4 44	+p/p £1 67
1 Kg	3x012	12+12	3.33	+VAT £1 18
Regulation	3x013	15+15	2 66	TOTAL £8 91
12%	3x014	18+18	2.22	
	3x015	22+22	1.81	
	3x016	25+25	1 60	
	3x017	30+30	1 33	
	3x028	110	0.72	
	3x029	220	0.36	
	3x030	240	0 33	
120 VA	4x010	6+6	10 00	£6.90
90 x 40mm	4x011	9+9	6 66	+p/p £1 67
1 2 Kg	4x012	12+12	5 00	+VAT £1 29
Regulation	4x013	15+15	4 00	TOTAL £9 86
11%	4x014	18+18	3 33	
	4x015	22+22	2 72	
	4x016	25+25	2 40	
	4x017	30+30	2 00	
	4x018	35+35	1 71	
	4x028	110	1 09	
	4x029	220	0 54	
	4x030	240	0 50	
160 VA	5x011	9+9	8 89	£7.91
110 x 40mm	5x012	12+12	6 66	+p/p £1 67
1 8 Kg	5x013	15+15	5 33	+VAT £1 44
Regulation	5x014	18+18	4 44	TOTAL £11 02
8%	5x015	22+22	3 63	
	5x016	25+25	3 20	
	5x017	30+30	2 66	
	5x018	35+35	2 28	
	5x026	40+40	2 00	
	5x028	110	1 45	
	5x029	220	0 72	
	5x030	240	0 66	

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
225 VA	6x012	12+12	9.38	£9.20
110 x 45mm	6x013	15+15	7.50	+p/p £2 00
2 2 Kg	6x014	18+18	6.25	+VAT £1 68
Regulation	6x015	22+22	5.11	TOTAL £12 88
7%	6x016	25+25	4 50	
	6x017	30+30	3.75	
	6x018	35+35	3 21	
	6x026	40+40	2 81	
	6x025	45+45	2.50	
	6x033	50+50	2.25	
	6x028	110	2.04	
	6x029	220	1.02	
	6x030	240	0.93	
300 VA	7x013	15+15	10.00	£10.17
110 x 50mm	7x014	18+18	8 33	+p/p £2 00
2.6 Kg	7x015	22+22	6 82	+VAT £1 83
Regulation	7x016	25+25	6.00	TOTAL £14 00
6%	7x017	30+30	5 00	
	7x018	35+35	4 28	
	7x026	40+40	3.75	
	7x025	45+45	3.33	
	7x033	50+50	3 00	
	7x028	110	2.72	
	7x029	220	1.36	
	7x030	240	1.25	
500 VA	8x016	25+25	10 00	£13.53
140 x 60mm	8x017	30+30	8 33	+p/p £2 35
4 Kg	8x018	35+35	7.14	+VAT £2 38
Regulation	8x026	40+40	6.25	TOTAL £18 26
4%	8x025	45+45	5 55	
	8x033	50+50	5.00	
	8x042	55+55	4.54	
	8x028	110	4.54	
	8x029	220	2.27	
	8x030	240	2.08	
625 VA	9x017	30+30	10.41	£16.13
140 x 75mm	9x018	35+35	8.92	+p/p £2 50
5 Kg	9x026	40+40	7.81	+VAT £2 79
Regulation	9x025	45+45	6 94	TOTAL £2* 42
4%	9x033	50+50	6.25	
	9x042	55+55	5 68	
	9x028	110	5 68	
	9x029	220	2 84	
	9x030	240	2.60	

IMPORTANT: Regulation – All voltages quoted are FULL LOAD. Please add regulation figure to secondary voltage to obtain off load voltage.

The benefits of ILP toroidal transformers

ILP toroidal transformers are only half the weight and height of their laminated equivalents, and are available with 110V, 220V or 240V primaries coded as follows:

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For 220V primary (Europe) insert "1" in place of "X" in type number.

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Use this coupon, or a separate sheet of paper, to order these products, or any products from other ILP Electronics advertisements. No stamp is needed if you address to Freepost. Cheques and postal orders must be crossed and payable to ILP Electronics Ltd. Access and Barclaycard welcome. All UK orders sent within 7 days of receipt of order for single and small quantity orders.

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Name ______

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DIL SWITCHES: Gold plated contact in fully sealed base – solve those programming problems.
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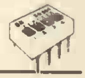

DIL SOCKETS: High quality, low profile sockets.
8 pin – **10p.** 14 pin – **11p.** 16 pin – **12p.** 18 pin – **19p.** 20 pin – **21p.**
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