An Argus Specialist Publication

electronics today

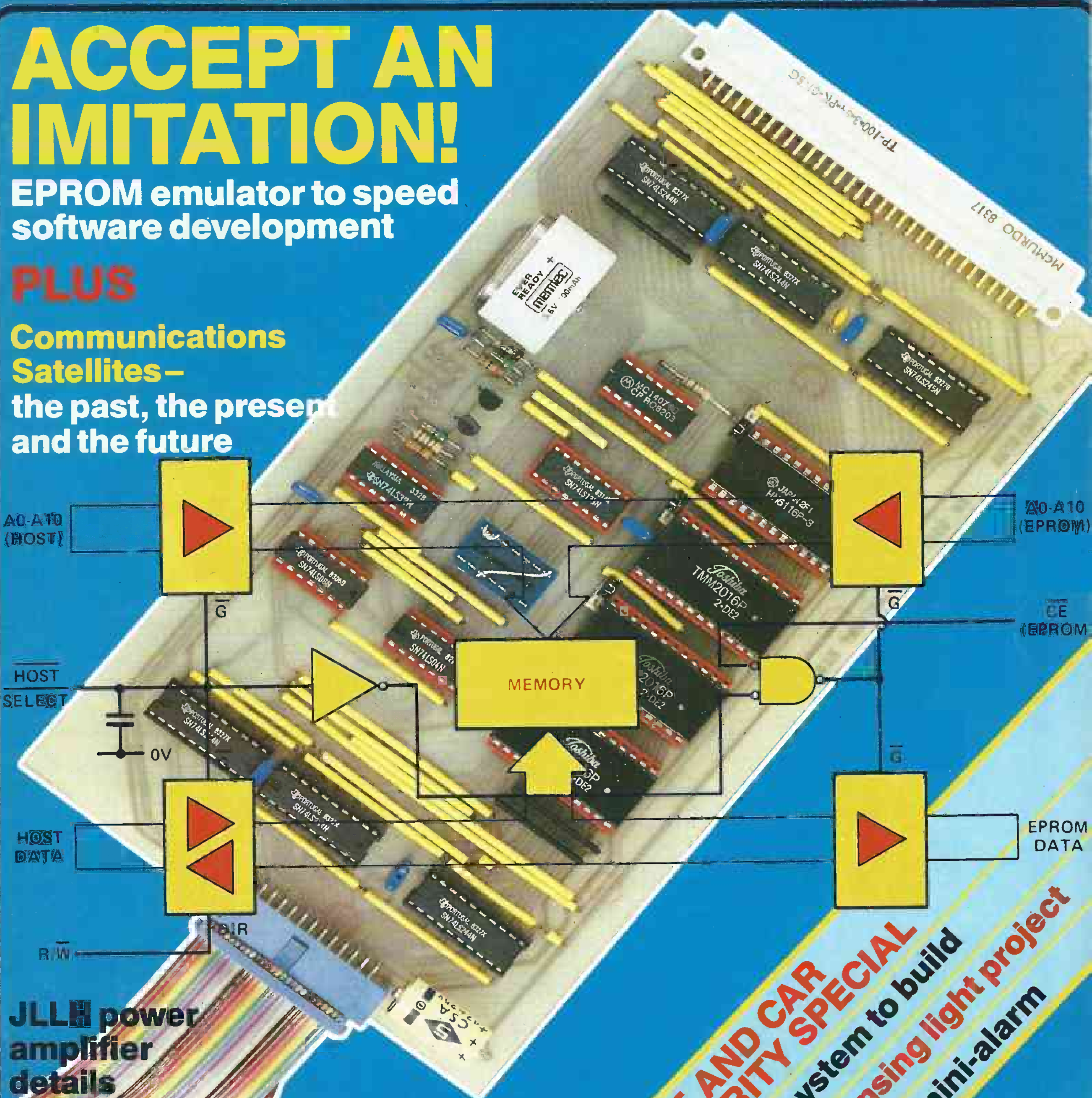
INTERNATIONAL JULY 1984 95p

ACCEPT AN IMITATION!

EPROM emulator to speed software development

PLUS

Communications Satellites – the past, the present and the future



JLLH power amplifier details

HOME AND CAR SECURITY SPECIAL

Alarm system to build

Person-sensing light project

Infra-red mini-alarm

DIO....COMPUTING....MUSIC....RADIO....ROBOTICS

High performance, low price kits for today's musicians

Credit Card Orders Accepted on 0264 64455 or ask for FREE catalogue

DIGITAL DELAY LINE

Digitall delay circuitry is an absolute necessity for high quality studio work, but usually comes with a four-figure price tag.

Powertran can now offer you digital quality for the price of a high analog unit. The unit gives delay times from 1.6mSecs to 1.6 secs with many powerful effects including phasing, flanging, A.D.T., chorus, echo and vibrato. The basic kit is extended in 400mSec steps up to 1.6 seconds simply by adding more parts to the PCB.

Complete kit (400mS delay) **£179**

Parts for extra 400mS delay (up to 3) **£19.50**

MPA 200

100 watt mixer/amplifier

Here's a rugged, professionally finished mixer amp designed for adaptability, stability and easy assembly. Using new super-strength power transistors and a minimum of wiring, it offers a wide range of inputs (extra components are supplied for additional inputs), 3 tone controls, each with 15dB boost and 15dB cut, and a master volume control.

Complete kit **£79.50**

TRANSCENDENT 2000

ETI single board synthesizer.

This professional quality 3-octave instrument is transposable 2 octaves up or down, giving an effective 7-octave range.

There is portemento pitch bending, VCO with shape and pitch modulation, VCF with high and low pass outputs and separate dynamic sweep control, noise generator and an ADSR envelope shaper. Other features include special circuitry with precision components to ensure tuning stability.

Complete kit.............................. **£150**

CHROMATHEQUE 5000

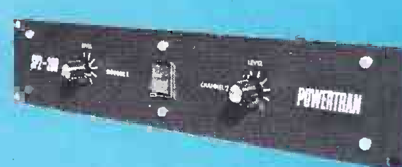
ETI 5-channel lighting effects system

Many lighting control units are now available. Some perform switching and others modulation of light output according to musical input. The Chromatheque combines both functions. It controls 5 banks of lamps up to 500W each in either analog or digital mode. And the 5 channels give more colours and more exciting linear and random sequencing than is possible with 3 or 4-channel systems. Versatile light level controls enable the lights to be partially on to suit the mood of the occasion. Wiring is minimal and construction straightforward.

Complete kit.............................. **£79.50**

SP2-200

2-channel, 100-watt amplifer



The SP2-200 uses two of the power amplifier sections of the MPA 200 (above), each with its own power supply. A custom designed toroidal transformer enables both channels to simultaneously deliver over 100W rms into 8 ohms. Each channel has its own volume control, and a sensitivity of 0.775mV (OdBm) makes this amplifier suitable for virtually all pre-amps or mixers.

Complete kit.............................. **£99.50**

Goods subject to availability. All prices exclusive of VAT and correct at time of going to press.

Access BARCLAYCARD VISA

POWERTRAN cybernetics ltd.

POWERTRAN CYBERNETICS LTD, PORTWAY INDUSTRIAL ESTATE, ANDOVER, HANTS SP10 3ET. TEL: (0264) 64455

ALL PRICES ARE EXCLUSIVE OF VAT AND APPLY TO THE U.K. ONLY – ALLOW 21 DAYS FOR DELIVERY. OVERSEAS CUSTOMERS – PLEASE CONTACT OUR EXPORT DEPARTMENT FOR THE NAME AND ADDRESS OF YOUR LOCAL DEALER.

electronics today INTERNATIONAL

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FEATURES

PROJECTS

INFORMATION

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SWITCHES

TOGGLE 2A 250V
SPST **35p**
DPDP **48p**

SUB-MIN TOGGLE
SPST on/off **58p**
SPDT c/over **64p**
SPDT centre off **85p**
SPDT biased both ways **105p**
DPDT 6 tags **80p**
DPDT centre off **88p**
DPDT biased both ways **145p**
DPDT 3 positions on/on/on **185p**
4-pole 2 way **220p**

SLIDE 250V.
DPDT 1A **14p**
DPDT 1A c/off **15p**
DPDT ½A **13p**

PUSHBUTTON 6A
with 10mm Button
SPDT latching **150p**
DPDT latching **200p**
SPDT moment **150p**
DPDT moment **200p**

Mini Non Locking
Push to Make **15p**
Push to Break **25p**

DIGITAST Switch
Assorted Colours
75p each

GAS/SMOKE DECECTORS

TGS812 or TGS813

£6 each

DIP SWITCHES

(SPST) 4 way **65p**; 6 way **80p**; 8 way **85p**; 10 way **125p** (SPDT) 4 way **190p**

ROTARY SWITCHES

(Adjustable Stop type)
1 pole/2 to 12 way; 2 pole/2 to 6 way; 3 pole/2 to 4 way; 4 pole/2 to 3 way **48p**

ROTARY: Mains DP 250V 4 Amp on/off **68p**

ROTARY: (Mak-a-switch)
Make a multi-way switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch). Mechanism only **90p**

WAFERS: (make before break) to fit the above switch mechanism 1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6p/2 Way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **6p**.

ROCKER SWITCHES

ROCKER 5A/250V SPST **28p**
ROCKER 10A/250V SPDT **38p**
ROCKER 10A/250V DPDT c/off **95p**
ROCKER 10A/250V DPST with neon **85p**

THUMBWHEEL Mini front mounting switches
Decade Switch Module **275p**
B.C.D. Switch Module **298p**
Mounting Cheeks (per pair) **75p**

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	**145p**	**185p**	**240p**	**380p**
Double ended DIP (Header Plug) Jumper				
6 inches	**185p**	**205p**	**300p**	**485p**
12 inches	198p	215p	315p	480p
24 inches	**210p**	**235p**	**345p**	**540p**
36 inches	**290p**	**370p**	**480p**	**525p**

IDC Female Header Socket Jumper Leads 36"

	20 pin	26 pin	34 pin	40 pin
Single ended	**160p**	**200p**	**260p**	**300p**
Double ended	**290p**	**370p**	**480p**	**525p**

VEROBOARD 0.1in

2½ x 3¼ **95p**
2½ x 5 **110p**
3¾ x 3¾ **110p**
3¾ x 5 **125p**
3¾ x 17 **420p**
4¾ x 17 **590p**
Pkt of 100 pins **55p**
Spot face cutter **150p**
Pin insertion tool **185p**

VA Board **195p**
DIP Board **395p**
Vero Strip **95p**

PROTO DECs
Veroblock **480p**
S-Dec **395p**
Eurobreadboard **590p**
Bimboard 1 **575p**
Superstrip SS2 **1350p**

VERO WIRING PEN
+ spool **380p**
Spare spool **75p**
Combs **8p**

DALO ETCH RESIST PEN
Plus spare tip **100p**

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

ULTRASONIC TRANSDUCER
40KHz **475 pr**

COPPER CLAD BOARDS

	Fibre glass	Single-sided	Double sided	S.R.B.P S/Speed
6" x 6"		100p	125p	9.5" x 8.5"
6" x 12"		175p	225p	110p

DILL SOCKETS

	Low Prof	Wire Wrap
8 pin	**8p**	**25p**
14 pin	**10p**	**35p**
16 pin	**10p**	**42p**
18 pin	**16p**	**52p**
20 pin	**20p**	**60p**
22 pin	**22p**	**65p**
24 pin	**25p**	**70p**
28 pin	**28p**	**80p**
40 pin	**30p**	**90p**

EDGE CONNECTORS

2x6 way	—	111p
2x12 way	—	160p
2x15 way	—	165p
2x18 way	210p	175p
2x22 way	215p	250p
2x23 way	175p	—
2x25 way	285p	275p
2x28 way	190p	—
2x30 way	310p	—
2x36 way	360p	—
2x40 way	380p	—

SIL SOCKET 0.1" Pitch 20 way **65p**

ANTEX SOLDERING IRONS

C15W **525p**; CS17W **545p**
C18W **550p**; XS25W **570p**
Spare Bits **85p**; Elements **230p**
Iron Stand **175p**; Heat Shunt **30p**

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female Card Edge Conct
10 way	**90p**	**99p**	**85p**	**120p**
16 way	**130p**	**150p**	**110p**	—
20 way	**145p**	**166p**	**125p**	**195p**
26 way	**175p**	**200p**	**150p**	**240p**
34 way	**205p**	**236p**	**160p**	**320p**
40 way	**220p**	**250p**	**180p**	**340p**
50 way	**235p**	**270p**	**200p**	**395p**
60 way	—	—	**230p**	**495p**

EURO CONNECTORS

Gold Flashed Contacts	Female Strt Pins	Socket Angle Pins	Male Strt Pins	Plug Angle Pins
DIN41617 31 way	**170p**	—	—	**175p**
DIN41612 2 x 32 A + B	**275p**	**320p**	**220p**	**285p**
DIN41612 2 x 32 A + C	**295p**	**340p**	**240p**	**300p**
DIN41612 3 x 32 A + B + C	**360p**	**385p**	**280p**	**395p**

DIL PLUG (Header)

	Solder	IDC
14 pin	**40p**	**90p**
16 pin	**48p**	**105p**
24 pin	**88p**	**178p**
28 pin	**290p**	**295p**
40 pin	**250p**	**255p**

ZIF DIL SOCKETS

24 pin **565p**
28 pin **750p**
40 pin **845p**

RIBBON CABLE

price per foot

	Grey	Color
10 way	**15p**	**28p**
16 way	**25p**	**40p**
20 way	**30p**	**50p**
24 way	**40p**	**65p**
28 way	**55p**	**80p**
34 way	**60p**	**85p**
40 way	**70p**	**90p**
50 way	**100p**	**135p**
64 way	**120p**	**160p**

'D' CONNECTORS

	9 way	15 way	25 way	37 way
Male				
Solder lugs	**80p**	**105p**	**160p**	**250p**
Angle pins	**150p**	**210p**	**250p**	**355p**
PCB pins	**120p**	**130p**	**195p**	**295p**
Female				
Solder lugs	**105p**	**160p**	**200p**	**335p**
Angle pins	**165p**	**215p**	**290p**	**440p**
PCB pins	**150p**	**180p**	**240p**	**420p**
COVERS	**80p**	**75p**	**75p**	**90p**

IDC 25 way 'D' Plug **385p**; Socket **450p**

25 way 'D' CONNECTOR (RS232)

Jumper Lead Cable Assembly
18" long, Single end, Male **475p**
18" long, Single end, Female **510p**
36" long, Double Ended, M/M **995p**
36" long, Double Ended, F/F **£10**
36" long, Double Ended, M/F **995p**

AMPHENOL PLUGS

	IDC	Solder
24 way IEEE	**475p**	**470p**
36 way Centronix	**450p**	**475p**
24 way Female	**525p**	**490p**

PANEL METERS

FSD
60 x 46 x 35mm
0–50mA
0–100mA
0–500mA
0–1mA
0–5mA
0–10mA
0–50mA
0–100mA
0–500mA
0.8A
0.2A
0.25V
0.50V AC
0.300V AC
"S"
"VU" **490p each**

CRYSTALS

32.768KHz	100
100KHz	235
200KHz	265
455KH	370
1MHz	275
1.008M	275
1.28MHz	390
1.6MHz	395
1.8MHz	515
1.8432M	250
2.0MHz	225
2.4576M	200
3.12MHz	240
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.19430M	200
4.433619M	100
4.608MHZ	200
4.80MHz	200
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.7328MHz	250
7.68MHz	200
8.0MHz	150
8.089333M	395
8.86723M	220
9.00MHz	200
10.0MHz	175
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	175
12.528M	300
14.31814M	170
15.0MHz	240
16.0MHz	220
18.0MHz	180
18.432M	150
19.968MHz	150
20.0MHz	200
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	180
38.6667M	240
48.0MHz	240
100.0MHz	295
116.0MHz	300

RELAYS

Miniature, enclosed, PCB mount.

SINGLE POLE Changeover
RL-91 205R Coil, 12V DC (10V5 to 19.5V) 10A at 30V DC or 250V AC **195p**

DOUBLE POLE Changeover. 6A 30V DC or 250V AC
RL-100 53R Coil, 6V DC (5V4 to 9V9) **190p**
RL6-111 205R Coil, 12V DC (10V7 to 19V5) **195p**
RL6-114 740R Coil, 24V DC (22V to 37V) **200p**

ASTEC UHF MODULATORS

Standard 6MHz **375p**
Wideband 8MHz **550p**

BUZZERS

miniature, solid-state 6V, 9V & 12V **70p**

PIEZO TRANSDUCERS PB2720 **70p**

LOUDSPEAKERS

Miniature, 0.3W: 8
2in, 3¼in, 2½in, 3in **80p**
2½in 40, 64 or 80 **80p**

MONITORS

- ZENITH — 12" Green, Hi-Resolution Popular **£75**
- MICROVITEC 1431 14" Colour RGB input. Connecting cable incl **£179**
- KAGA 12". Med-res. RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc **£195** (car £7)
- KAGA 12". As above but Hi-Resolution **£259** (car £7)
- Connecting Lead for KAGA **£5**

Carriage £7 Securicor

TRANSFORMERS

3-0-3V, 6-0-6V, 9-0-9V, 12-0-12V, 15-0-15V @ 100mA **98p**
pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A **235p**
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A **280p**
Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A **250p**
12VA: 2x4.5V-1.3A; 2x5V-1A; 2x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A **345p** (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A **385p** (60p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A **520p** (60p p&p)
Specially wound for Multirail computer PSUs
50VA: Outputs +5V/5A; +12V, +25V, −5V, −12V at 1A **620p** (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A **985p** (75p)

P&P charge to be added over and above our normal postal charge

VOLTAGE REGULATORS

1A TO220 Plastic Casing

	+ ve		− ve	
5V	7805	**45p**	7905	**45p**
12V	7812	**50p**	7908	**60p**
15V	7815	**45p**	7912	**45p**
18V	7818	**45p**	7915	**45p**
24V	7824	**45p**	7918	**45p**
			7924	**45p**

100mA TO92 Plastic package

5V	78L05	**30p**	79L05	**50p**
6V	78L06	**30p**	—	—
8V	78L08	**30p**	—	—
12V	78L12	**30p**	79L12	**50p**
15V	78L15	**50p**	79L15	**60p**

ICL7660	**248p**	TAA550	**50p**
RC4194	**375p**	TDA1412	**150p**
RC4195	**160p**	78H05 + 5V/5V	**550p**
LM309K	**135p**	78H12 + 12V/5A	**640p**
LM317K	**250p**	78HG + 5V to + 25V 5A	**585p**
LM317KP	**450p**		
LM323K	**450p**	79HG − 2.25V to −24V, 5A	**685p**
LM337	**175p**		
LM723 Var	**30p**		

SOLDERCON PINS

Ideal for making SIL or DIL Sockets
100 pins **75p**
500 pins **350p**

ALUM BOXES

3 x 2 x 1"	**85p**
4 x 2½ x 2"	**100p**
4 x 2½ x 2½"	**103p**
4 x 4 x 2"	**105p**
4 x 4 x 2½"	**120p**
5 x 4 x 1½"	**99p**
5 x 4 x 2½	**120p**
5 x 2¾ x 1½"	**90p**
5 x 2¾ x 2½"	**130p**
6 x 4 x 2"	**120p**
6 x 4 x 3"	**150p**
7 x 5 x 3"	**180p**
8 x 6 x 3"	**210p**
10 x 4 x 3"	**240p**
10 x 7 x 3"	**275p**
12 x 5 x 3"	**280p**
12 x 8 x 3"	**295p**

BROTHER HR15 PRINTER

High quality Daisy Wheel Printer, 18CPS. Bidirectional, 3K Buffer, Proportional spacing, Underlining, Bold print and Sh

CMOS

4000	20	4072	25	4538	80
4001	25	4073	26	4539	90
4002	25	4075	25	4541	95
4006	75	4076	68	4543	70
4007	25	4077	25	4544	150
4008	60	4078	25	4548	40
4009	45	4081	25	4549	400
4010	45	4082	25	4553	245
4011	25	4085	60	4554	160
4012	25	4086	60	4555	35
4013	60	4089	125	4556	55
4014	60	4093	37	4557	250
4015	60	4094	70	4558	120
4016	40	4095	95	4559	395
4017	60	4096	100	4560	180
4018	60	4097	275	4561	104
4019	58	4098	80	4562	350
4020	90	4099	110	4566	165
4042	43	4160	95	4568	250
4021	58	4161	96	4569	175
4022	67	4162	96	4572	45
4023	30	4163	96	4580	255
4024	50	4174	96	4581	125
4025	22	4175	105	4582	98
4026	90	4194	105	4583	100
4027	43	4408	850	4584	40
4028	45	4409	850	4585	70
4029	75	4410	725	4597	330
4030	35	4411	750	4599	155
4031	130	4412	805	40085	90
4032	70	4415	590	40097	45
4033	130	4419	280	40098	42
4034	146	4422	770	40100	215
4035	70	4435	850	40101	130
4036	275	4440	900	40102	140
4037	115	4450	360	40103	412
4038	75	4451	350	40104	120
4039	280	4490	450	40105	220
4040	60	4500	395	40106	45
4041	57	4501	38	40107	55
4042	50	4502	60	40108	325
4043	42	4503	40	40109	100
4044	50	4504	99	40110	235
4045	110	4505	385	40114	240
4046	60	4506	100	40161	194
4047	60	4507	45	40163	75
4048	55	4508	130	40174	75
4049	38	4510	55	40175	75
4050	35	4511	55	40181	220
4051	45	4512	55	40182	80
4052	60	4513	150	40192	75
4053	60	4514	115	40193	95
4054	85	4515	115	40194	70
4055	85	4516	55	40195	75
4056	85	4517	275	40244	198
4057	1000	4518	48	40245	198
4059	435	4519	32	40257	198
4060	68	4520	53	40373	220
4061	500	4521	115	40374	220
4062	988	4522	125	45106	588
4063	85	4526	60		
4066	45	4527	65		
4067	245	4528	50		
4068	25	4529	150		
4069	25	4530	90		
4070	25	4531	130		
4071	25	4532	65		
		4534	400		
		4536	275		

OPTO

OCP71	120
ORP12	85
ORP61	86
BPX25	250
BPW21	320
TIL139	225

OPTO ELECTRONICS

LEDs with clips

TIL209	10
TIL211 GRN	14
TIL212 Yel	14
TIL220 2" Red	12
2" Green, Yellow or Amber	14
0.2" Bi colour Red/Green	65
Green/Yellow	78
0.2" Tri colour Red/Green/Yellow	85
Hi-Brightness Red	58
High-Bri Green or Yel	68
Flashing red 0.2" red	55
Square LEDs. Red, Green, Yellow	30
Rectangle Stackable LEDs	
Red, Green or Yellow	18
Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	48
SFH205 Detector	118
TIL32 Infra Red	52
TIL78 Detector	55
TIL38	50
TIL100	75
BARGRAPH Red 10 segments	275

ISOLATORS

ILD74	115
ILO74	220
TIL111/2/4	70
ILCT6 Darlington	135
4N33 Photo Darlington	136

7 Segment Displays

TIL312 .3" CA	120
TIL313 .3" CC	120
TIL321 .5" CA	140
TIL322 .5 CC	140
TIL729/730	140
DL704 .3" CC	125
DL707 3" CA	125
FND357 Red	120
FND500	130
.3" Green CA	150
.6" Green CA	215
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
LCD 3½ Digits	496
LCD 4 Digits	530
LCD 6 Digits	625
Reflective Switch	170
SLOTTED Optical Switch similar to RS Comp's	195

COMPUTER CORNER

- **EPSON RX80 PRINTER: 100 CPS,** 9 x9 matrix, dot addressable graphics, condensed & double width printing, Normal, Italics & Elite Char., Tractor Feed, Bidirectional, Logic seeking **£235**
- **RX80 F/T Epson Printer.** As above but has both Tractor and Friction feed facilities **£259**
- **EPSON FX80 PRINTER** 10" Tractor & Friction Feed, 160 CPS, bi-directional Logic seeking, 9 x 11 matrix, hi-res bit image, Normal, Italic & Elite Char. Super & Subscript. Proportional spacing **£325**
- **SEIKOSHA GP100A.** 10" Tractor Feed, 80 Colmn. 30CPS, Normal and Double width Char. Dot Res Graphics **£138**
- **SEIKOSHA GP250X.** 10", 50 CPS, Normal and Double width and height Char. RS232 and Centronix Intrf. standard .... **£199 (£7 car)**
- Printer Cable for our printers and BBC MICRO **£8**
- **TEX** EPROM ERASER. Erases up to 32 ICs in 15-30 minutes **£33**
- **TEX** EPROM ERASER with a safety switch **£35**
- **SPARE** 'UV' Lamp bulb **£8**
- **C12** COMPUTER GRADE CASSETTES in library cases **36p**
- 8½" & 9½" Fan Fold paper (1000 sheets) .... **£7 + 150p carr**

Call in at our shop for demonstration. Be satisfied before you buy or write in for our descriptive Micro Peripherals Leaflet.

DISC DRIVES

(BBC Compatible)

- **CS100** — Single Cased with PSU, 40 track, 5¼" S/S 100K **£145**
- **CD200** — Twin Cased with PSU, 40 Track, 5¼" S/S 200K **£275**
- **CS200** — Single Cased with PSU, 80 Track, 5¼" S/S 200K **£210**
- **CD400** — Twin Cased with PSU, 80 track, 5¼" S/S 400K **£365**
- **MITSUBISHI 5¼" SLIM LINE DISC DRIVES** Double Sided, Double Density, Track Density 96 TPI, Track to track access time 3msec.
- **MITSUBISHI Single Slimline,** 5¼" Cased with PSU. DSDD 1 Megabyte (400 K with BBC) **£259**
- **MITSUBISHI Twin Slimline,** 5¼" Cased with PSU. DSDD. 2 Megabyte (800 K with BBC) **£425**

5¼" DISKETTES (Lifetime Warranty)

- **1D 3M Diskettes Single side Double density** **£17**
- **1D 3M Diskettes Double side Double density** **£27**

N.B Carriage on Drives £7 securicor

SPECTRUM 32K UPGRADE

Upgrade your 16K Spectrum to full 48K with our RAM Upgrade Kit. Very simple to fit. Fitting instructions supplied.

£18

KAGA KP810

This new JAPANESE printer has EPSON FX/RX compatible commands. 140 CPS Dot matrix Printer, offers NEAR LETTER QUALITY printing. 9 x 9 matrix. Friction feed, Adjustible tractor feed, Single sheet feed and built-in Paper Roll Holder. Normal, Italic, Enlarged, Condensed, Super & Subscript, Dot addressable graphics (8, 9 & 16 pin modes.) Proportional spacing (Optional extra: Down loadable character set in 8K ROM or RAM). NEAR LETTER QUALITY print, selectable at switch on. 10" maximum width, bi-directional, logic seeking. 3K Buffer. Half speed quiet mode. Convenient Paper-out sensor switch. Centronics Interface standard. All this plus our no quibble 12 months warranty.

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We stock the full range of BBC Micro peripherals, Hardware & Software like. Disc Drives (Top quality Cumana & Mitsubishi), Diskettes, Printers, printer, Paper, Interface Cable, Dust Covers, Cassette Recorder & Cassettes, Monitors, Connectors (Ready made Cables, Plugs & Sockets), Plotter (Graphic Tablet) EPROM Programmer, Lightpen Kit, Joysticks, Sideways ROM Board, EPROM Eraser, Machinecode ROM. The highly sophisticated Watford's 16K BEEB DFS, WORDWISE, BEEB-CALC, Software (Educational Application & Games), BOOKs, etc, etc. Please send SAE for our description leaflet.

NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

AUGUST IS TEST EQUIPMENT TIME

Since we last looked at test equipment in June and July 1983, certain of our competitors have duplicated — but not matched — our surveys of DMMs and 'scopes. So we're going to be looking at the other side of the coin, as it were, with a group of articles that examine the types of gear that are available, the types of gear you'll find you need, how you might go about building your own (and when it's not worth trying to build it yourself), and finally, we'll be attempting the ETI tour of de-bugging common circuits.

ALL THIS AND MORE IN THE AUGUST ISSUE OF ETI, ON SALE JULY 6th. DON'T FORGET TO GET YOUR COPY TO READ ON HOLIDAY!

CMOS Tester

Carrying on in the test equipment theme is a nifty little project for a CMOS tester. Not only can it be used to test to see if a known device is working, it should be possible to deduce what unfamiliar items with odd-looking numbers are.

Sharp Joystick Interface

For all those of you out there who think that computing should be fun (Humbug! — Editor, Computing Toady), this project should shed a little joy on one machine which is presently stick-less.

'Audio Design' Power Amp PSU

Following on from the power amp described in this issue is the PSU you need to get it going, as ever from the workshop of John Linsley Hood.

ETI is carefully designed to provide sufficient shade when placed over the readers eyes so as to permit sleeping in the strongest of sunlight.

Cirkit. A new name

This year Ambit will stop being Ambit. And become Cirkit.

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A bigger range of the best and latest products with well over 10,000 different items available.

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Cirkit is a go ahead company that believes in giving service to its customers.

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For further information send for our latest catalogue or visit one of our three outlets at: 200 North Service Road, Brentwood, Essex, CM14 4SG; 53 Burrfields Road, Portsmouth, Hampshire, PO3 5EB; Park Lane, Broxbourne, Hertfordshire, EN10 7NQ.

To: Cirkit Holdings PLC, Park Lane, Broxbourne, Hertfordshire.
I enclose 80p. Please send me your latest catalogue and 3×£1 discount vouchers!
If you have any enquiries please telephone us on Hoddesdon (0992) 444111.

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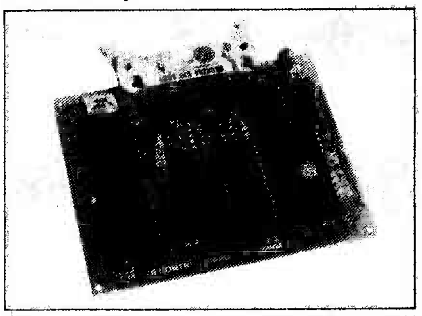
ETI 7

Computer Products

A complete range from Connectors to Board Level product



C12 Computer Cassette	21-00012	0.55
BBC to Centronics Printer	03-10019	7.25
BBC to 25 way D Male	03-10021	4.50
25 way D Socket	10-25200	1.90
25 way D Plug	10-25100	1.30
Cover for 25 way D	10-25322	0.93
20 up Eprom Eraser	40-82100	31.25
Z80 A Industrial Controller	40-82000	49.95
6802 Industrial Controller	40-68020	49.95
6502 Industrial Controller	40-65020	49.95
Z8 Basic/Debug Controller	41-00904	50.00

Nicad Batteries & Chargers

Minimum life 600 (300 PP3 size) full charge/discharge cycles. Batteries must be charged from a constant current source only. All batteries are supplied only with a residual charge and should be charged before used.

				1-9	10-49
AA	1.2V	500mAH	01-12004	0.80	0.74
'C'	1.2V	2.2AH	01-12024	2.35	1.99
'D'	1.2V	4.0AH	01-12044	3.05	2.85
PP3	8.4V	110mAH	01-84054	3.70	3.50

CH1/22 PP3 Charger 11mA for 16 hours — 01-00159 — 4.30

CH8/RX Multi-purpose Charger — 01-02204 — 9.40

Will recharge AA, C, D and PP3 size cells with automatic voltage selection. Will recharge following combination: 6×D, 6×AA, 6×C, 2×PP3, 2×D+2×C, 2×D+2×AA, 2×D+1×PP3, 2×C+2×AA, 2×C+1×PP3, 2×AA+1×PP3.

Battery Adaptor — 01-12001 — 0.96

Sold in pairs: one to convert AA size to C size and one to convert C to D size. Both may be used together to convert an AA to D size.

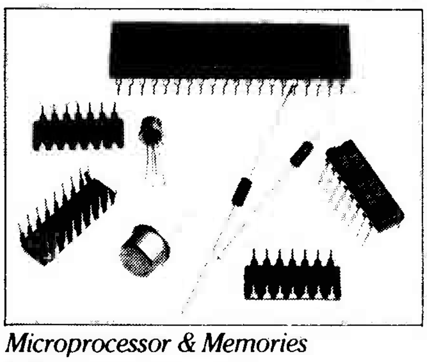
Semiconductors

Linear IC's

LM301AN	DIL version	61-03011	0.44
LM308CN	DIL version	61-03081	0.65
LM311CN	Popular comparator	61-00311	0.46
LM324	Low power quad op amp	61-03240	0.67
LM3319N	Low power quad comparator	61-03390	0.68
LM346	Programmable quad op amp	61-00346	3.72
LF347	Quad Bi-FET op amp	61-00347	1.82
LM348	Quad 741 type op amp	61-03480	1.26
LF351	Bi-FET op amp	61-03510	0.49
LF353	Dual version of LF351	61-03530	0.76
LM380N	1W AF power amp	61-00380	1.00
NE555N	Multi-purpose low cost timer	61-05550	0.45

for a better service.

NE556N	Dual version of the 555	61-05560	0.50
uA741CN	DIL low cost op amp	61-07411	0.22
uA747CN	Dual 741 op amp	61-07470	0.70
uA748CN	741 with external frequency comp	61-04780	0.40
HA1388	18W PA from 14V	61-01388	2.75
TDA2002	8W into 2 ohms power amp	61-02002	1.25
ULN2283	1W max. 3-12V power amp	61-02283	1.00
MC3357	Low power NBFM IF system and detector	61-03357	2.85
ULN3859	Low current dual conversion NBFM IF and detector	61-03859	2.95
LM3900	Quad norton amp	61-39000	0.60
LM3909N	8-pin DIL LED flasher	61-39090	0.68
KB4445	Radio control 4 channel encoder and RF	61-04445	1.29
KB4446	Radio control 4 channel receiver and decoder	61-04446	2.75
ICM7555	Low power CMOS version of timer	61-75550	0.98
ICL8038CC	Versatile AF signal generator with sine/square/triangle OPs	61-08038	4.50
TK10170	5 channel version of KB4445	61-10170	1.87
HA12002	Protection monitor system for amps, PSUx, TXs etc	61-12002	1.22
HA12017	83dB S/N phono preamp 0.001% THD	61-12017	0.80
MC14412	300 baud MODEM controller (Eduro/US specs)	61-14412	6.85



Microprocessor & Memories

Z80A	Popular and powerful 8-bit CPU	26-18400	3.40
Z80AP10	2 port parallel input/output	26-18420	2.95
Z80A CTC	4 channel counter/timer	26-18430	2.90
Z8671	Z8 Micro comp. and Basic	26-08671	17.50
6116-3	16K (2kx8) CMOS RAM 200nS	26-36116	6.68
Z6132-6	32K (4kx8) quasi RAM 350nS	26-06132	15.00
4116-2	16K (16kx1) 150nS	26-24116	1.59
2764	64K (8kx8) 450nS	26-02764	9.50
2732	32K (4kx8) 450nS	26-02732	5.70

Voltage Regulators

7805	5V 1A positive	27-78052	0.40
7812	12V 1A positive	27-78122	0.40
7815	15V 1A positive	27-78152	0.40
7905	5V 1A negative	27-79052	0.49
7912	12V 1A negative	27-79122	0.49
7915	15V 1A negative	27-79152	0.49

Transitors

BC182	General purpose	58-00182	0.10
BC212	General purpose	58-00212	0.10
BC237	Plastic BC107	58-00237	0.08
BC238	Plastic BC108	58-00238	0.08
BC239	Plastic BC109	58-00239	0.08
BC307	Complement to BC237	58-00307	0.08
BC308	Complement to BC238	58-00308	0.08
BC309	Complement to BC239	58-00309	0.08
BC327	Driver/power stage	58-00327	0.13
BC337	Driver/power stage	58-00337	0.13
MPSA13	NPN Darlington	58-04013	0.30
MPSA63	PNP Complement to MPSA13	58-04063	0.30
J310	JFET for HF-VHF	59-02310	0.69
J176	JFET analogue switch	59-02176	0.65
3SK51	Dual gate MOSFET-VHF amp	60-04051	0.60
3SK88	Dual gate MOSFET-Ultra lo noise	60-04088	0.99
TIP31A	Output stage	58-15031	0.35
TIP32A	Complement to TIP31A	58-15032	0.35
VN66AF	VMOS Power FET	60-02066	0.95
ZTX3866	E-line version 2N3866	58-03866	0.45
IN4001	Rectifier diode	12-40016	0.06
IN4002	Rectifier diode	12-40026	0.07
IN4148	General purpose silicon	12-41486	0.05

Silicon Controlled Rectifiers

BRY55-100	100V .8A	52-55100	0.50
C106D1	400V 4.0A	52-00106	0.70
C122D1	400V 8.0A	52-00122	1.45

3mm Diameter LEDs

V178P	Red	15-01780	0.15
V179P	Green	15-01790	0.16
V180P	Yellow	15-01800	0.18

5mm Diameter LEDs

CQY40L	Red	15-10400	0.12
CQY72L	Green	15-10720	0.15
CQY74L	Yellow	15-10740	0.15

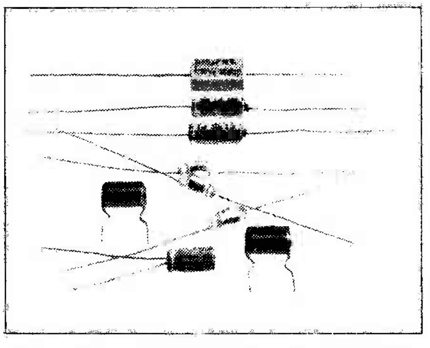
Infra-Red LEDs

CQY99	Emitter	15-10990	0.56
BPW41	Detector	15-30410	1.51

Tri Colour LED

V518	Orange-Green-Yellow	15-05180	0.60

Capacitors



Aluminium Electrolytics Radial PCB Mounting

			Pack of 4
10u	16V	05-10606	0.24
47u	16V	05-47606	0.28
47u	25V	05-47607	0.28
470u	6.3V	05-47705	0.36
470u	16V	05-47706	0.48

Tantalum Beads

			Each
1uf	35V	05-10501	0.18
10uf	16V	05-10601	0.28
47uf	6.3V	05-47601	0.45
47uf	16V	05-47602	0.92

Monolithic Capacitors

		Pack of 3
1n	04-10204	0.39
10n	04-10304	0.42
100n	04-10404	0.45

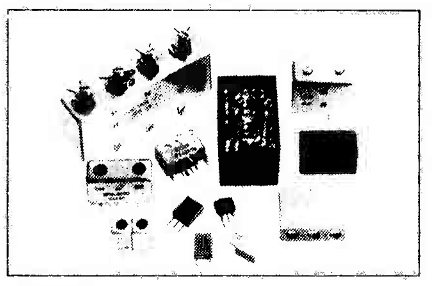
Low Voltage Disc Cermaic

		Pack of 5
1n	04-10203	0.20
10n	04-10303	0.20

Polyester (C280)

		Pack of 3
10n	04-10305	0.18
47n	04-47305	0.24
100n	04-10405	0.24
470n	04-47405	0.51
1uF	04-10505	0.66

R F Components



Filters

CFU/LFB CFW/LFH SERIES

Miniature 455kHz filters. I/P and O/P impedance 2K.

	-6dBW	-40dBW		
LFB6/CFU455H	6kHz	18kHz	16-45512	1.95
LFB12/CFU455F	12kHz	26kHz	16-45515	1.95
LFH6S/ CFW455HT	6kHz	14kHz	16-45525	2.45
LFG12S/ CFW455FT	12kHz	22kHz	16-45528	2.45
CFM2455A Mechanical IF Filters for 455kHz			19-45530	0.77

Crystal Filters 2 Pole Types

10M15A	10.7 Centre Freq.	20-10152	2.10
10MO8AA	10.695 Centre Freq.	20-11152	3.49

Inductors

We offer the complete Toko range of fixed and variable inductors. Over 500 coils from audio to V.H.F. See catalogue for details.

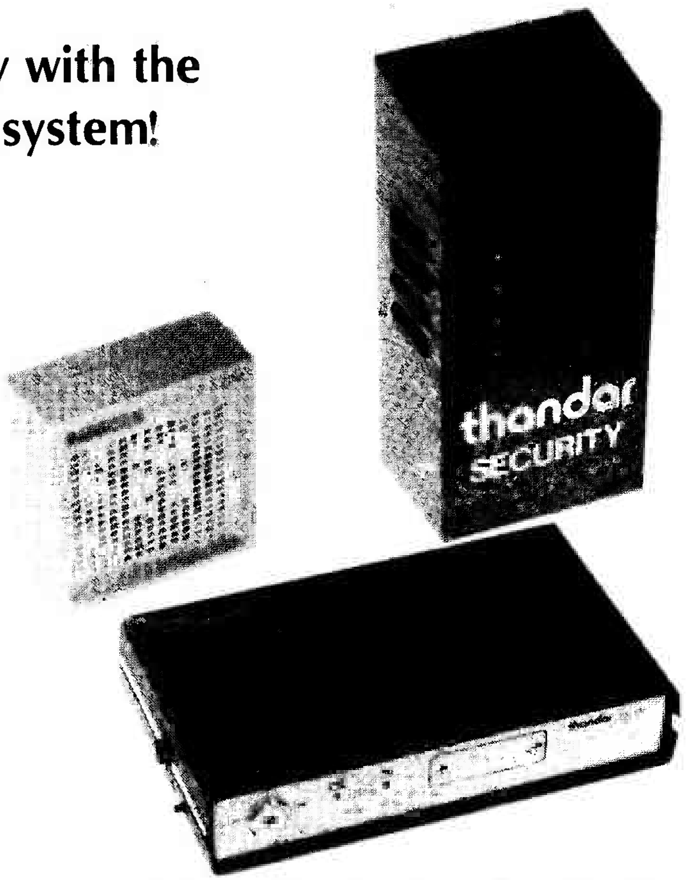
Soldering Irons (Antex)

CS240	Iron 240VAC 17 Watts	54-22300	5.20
XS-240	Iron 25W 240V High heat capacity	54-22500	5.40
SK6	Presentation pack of one XS-240 with ST4 stand	54-22510	7.20
MLXS	Handy 12V 15W soldering iron complete with crocodile clips and solder	54-20004	5.60

Please add 15% VAT to all advertised prices and 60p post and packing. Minimum order value £2 please. We reserve the right to vary prices in accordance with market fluctuation.

SPECIAL OFFER

Defend your home and property with the 'Minder' radar-Doppler alarm system!



As one would expect, this product comes very soundly and safely packaged — so we expect no problems with equipment being damaged in the post.

The equipment supplied is as follows: a main unit, with a radar sensor and key-operated switch, a small siren unit for interior mounting, which is powered from the main unit, an external siren which is normally powered from the main unit, but which has its own internal batteries capable of keeping the alarm sounding for quite some time when power is removed, connecting wire and two instruction booklets, one covering normal operation and one covering installation.

The main unit uses the Doppler effect to detect the presence of an intruder (in much the same way that the Ecolight featured elsewhere in this issue uses ultrasound). This has the great advantage that you don't have to go to the trouble of installing door switches, pressure mats, etc (although these can be added to the system if you feel it is necessary). However, you do have to obtain a licence for the unit; this is normally a formality, and the form to apply for the licence comes with the kit.

We recommend testing out the sirens with a great deal of caution — the internal siren is itself quite a lot louder than other brands of external siren, and can be positively painful to be near when it is sounding!

Ever conscious of the fact that although ETI is a technical magazine, we do have some not-so-knowledgeable readers (you wouldn't believe some of the enquiries we get — or perhaps you would!), we found a grandfather in his 60s, a proud possessor of four thumbs, incipient arthritis and plenty of spare time. His comments follow:

"Why two sets of instructions? Not being very technically-minded, I found it a little off-putting to be immediately presented with three pages of technical specification. (This is, however, obviously something many ETI readers would wish to see, and a selection of the specs is reproduced opposite — Ed.) *Let it suffice to say that whilst I found the instructions confusing, and think that they could have been better written, I did, in the end, manage to install the system correctly.*

"I have had frequent and close contact with the police during my lifetime (no, not for the reasons you immediately suspect....), and for this reason, decided to contact the local crime prevention officer before installing the alarm. This proved to be extremely useful, and besides giving me much fascinating information about the local villains, he advised me on the positioning of the control unit and the usefulness or otherwise of adding pressure sensors, door switches, etc. One definite oversight in the instructions — which we can correct here — is that you should contact your CPO before you install any alarm. Bad planning can nullify the effectiveness of any system — and anyway, we all pay the CPOs' wages through our local rates!

"A power cord of 3 metres seems a bit on the short side, especially as the best place to site the unit is 2 metres up the wall. However, if you're doing a thoroughly professional job, you may want to arrange for a special supply point right next to the unit, which besides being more elegant than having a power cord trailing about the place, might actually discourage a villain who had actually got in from thinking he can disable the alarm by removing the power.

"The other cables supplies are certainly ample, at least for my needs. However, they are grey — and all the world seems to have white coloured halls nowadays. Still, I suppose one should really be thinking about concealed wiring anyway.

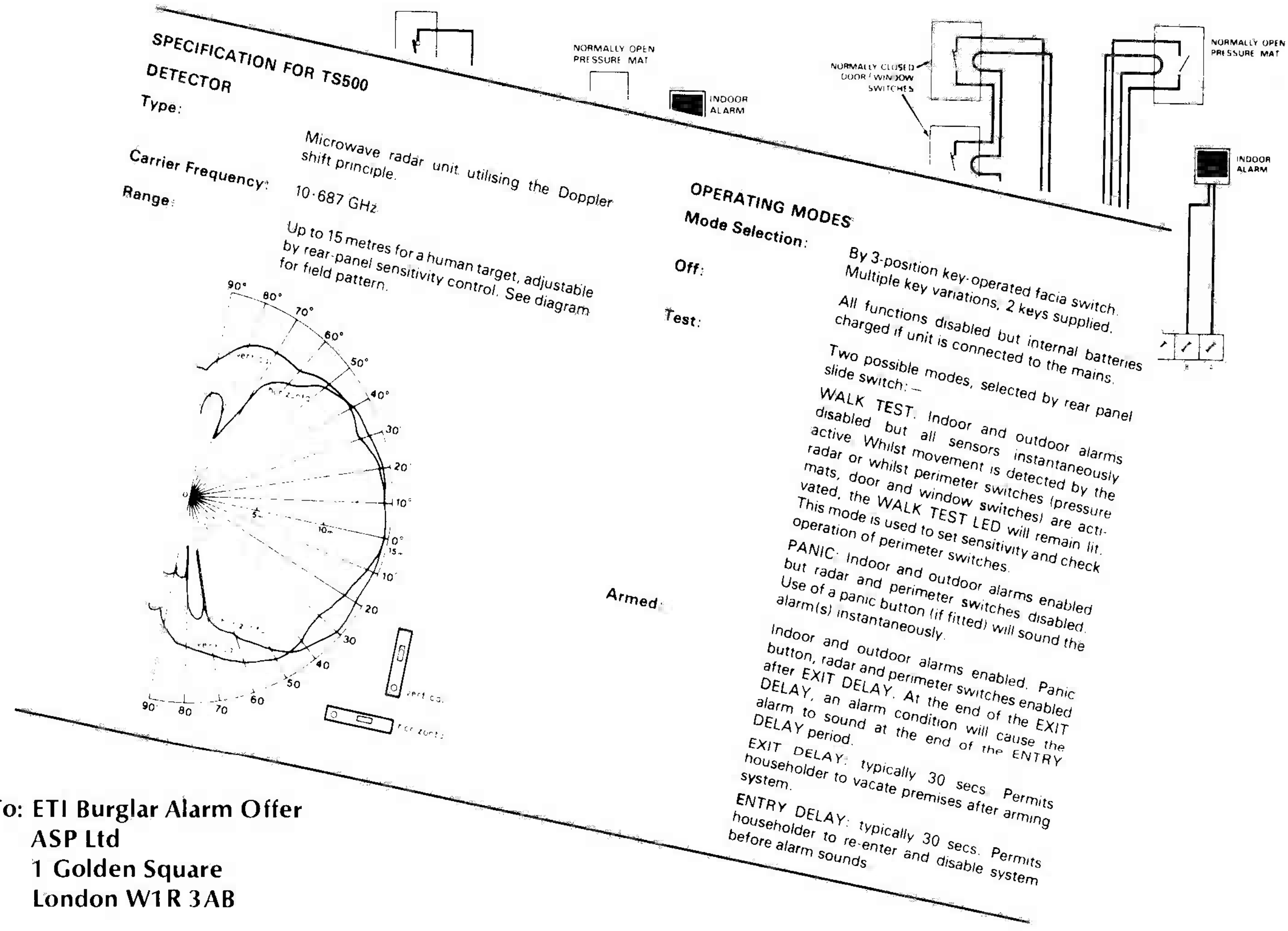
"Installation of the outside siren caused me to reach for the gin bottle and then still baffled — probably more so, if the truth were told — to seek advice from the local ironmonger. The unit is not light, and the 1" screws that came with the kit were not up to my pebble-dashed walls, especially in view of the bad weather we are prone to in my area.

"Another point on this topic — trying to hold a fairly heavy unit in one hand and mark out the drilling holes on the wall with the other, whilst teetering at the top of a ladder in a very chilly force-9 gale is not fun, even for youngsters without arthritis. It makes life a lot easier if you make a template, in cardboard, from the alarm back-panel, and use this to site the attachment holes.

"To conclude, let me say that the above are comparatively minor quibbles, as I have the alarm successfully installed and running. Perhaps it would be tempting fate to say that I am still waiting for its first, real-life test . . . "

TO ETI READERS

THANDAR 'MINDER' ALARM



SPECIFICATION FOR TS500

DETECTOR

Type: Microwave radar unit utilising the Doppler shift principle.

Carrier Frequency: 10·687 GHz

Range: Up to 15 metres for a human target, adjustable by rear-panel sensitivity control. See diagram for field pattern.

OPERATING MODES

Mode Selection: By 3-position key-operated facia switch. Multiple key variations, 2 keys supplied.

Off: All functions disabled but internal batteries charged if unit is connected to the mains.

Test: Two possible modes, selected by rear panel slide switch:—

WALK TEST. Indoor and outdoor alarms disabled but all sensors instantaneously active. Whilst movement is detected by the radar or whilst perimeter switches (pressure mats, door and window switches) are activated, the WALK TEST LED will remain lit. This mode is used to set sensitivity and check operation of perimeter switches.

PANIC: Indoor and outdoor alarms enabled but radar and perimeter switches disabled. Use of a panic button (if fitted) will sound the alarm(s) instantaneously.

Armed: Indoor and outdoor alarms enabled. Panic button, radar and perimeter switches enabled after EXIT DELAY. At the end of the EXIT DELAY, an alarm condition will cause the alarm to sound at the end of the ENTRY DELAY period.

EXIT DELAY: typically 30 secs. Permits householder to vacate premises after arming system.

ENTRY DELAY: typically 30 secs. Permits householder to re-enter and disable system before alarm sounds.

To: ETI Burglar Alarm Offer
ASP Ltd
1 Golden Square
London W1R 3AB

Please send me....'Minder' burglar alarms at the fully inclusive price of £94.88. I enclose a cheque/postal order* made payable to Argus Specialist Publications for £ .... p
OR
I wish to pay by Barclaycard/Access* Please charge my account number: | | | | | | | | | | | | | |

Signature ....

Name ....

Address ....

....

Please allow 28 days for delivery. Offer applies to UK only.
*** Please delete as appropriate**

ETI

DIGEST

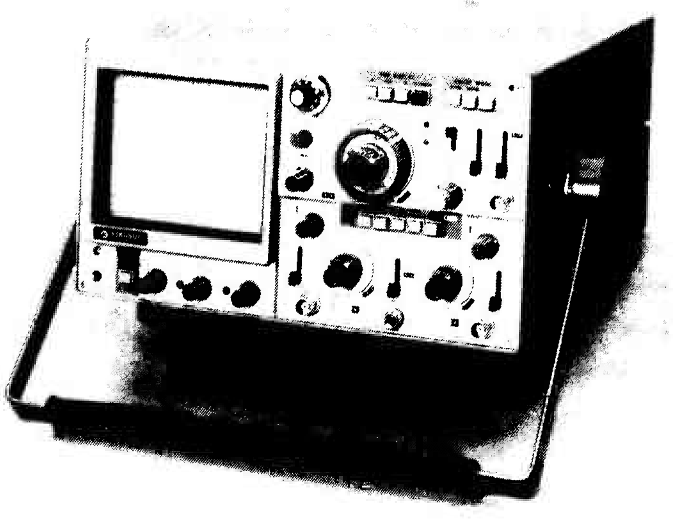
Dual Trace 100 MHz Scope

Telonic Instruments claim that the new Kikusui oscilloscope is the lowest-priced instrument of its type on sale in the UK. The COS 5100, which was shown for the first time in this country at the All Electronics Show, is a dual beam model with a bandwidth of 100 MHz and will sell for £975 plus VAT.

Features of the instrument include a third auxiliary vertical input and a sensitivity of 5 mV/div at 100 MHz or 1 mV/div at 20 MHz. Also included are sweep delay and alternate sweep capability, trigger with 'autolock', automatic trigger or manual trigger level control, and variable trigger hold-off to handle difficult variable mark space ratio pulse signals.

The COS 5100 has a 6 inch rectangular (8x10cm) flat-face CRT with internal graticule and an accelerating potential of 18 KV. Display modes are CH1, CH2, dual, CH3 or trigger view, and XY and add. Used in dual mode with CH3 and add displayed the COS 5100 will, if put into dual sweep, show 8 traces simultaneously.

The COS 5100 weighs 7.3 kilograms and measures 340x190x-450mm. For further details contact Telonic Instruments Ltd, 2 Castle Hill Terrace, Maidenhead, Berkshire SL6 4JP, tel 0628-73933.



TV Protection

Special 'Burglar Alarm' TV sets will be available in all Radio Rentals showrooms throughout Merseyside for a limited trial period from May to July 1984. Operating on an ultrasonic basis, the alarm device transmits an extremely high-pitched and piercing sound when triggered and is capable of alerting anyone and frightening off intruders.

All the householder has to do is switch off the TV and set the alarm which becomes 'armed' as soon as the room is vacated. When movement is detected the alarm is triggered. Even should the mains electricity be disconnected, either deliberately or by power cut, the alarm will continue to sound. The TV incorporates a system for overcoming false alarms which also allows the user to re-enter the room to switch off the device, but they don't seem to want to tell us how it works!

On the basis of the market trial in Merseyside, Radio Rentals will decide whether to launch the sets nationally. The 22" screen size burglar alarm remote control Teletext television can be rented for £16.00 per month or there is a 26" screen size version at £17.00 per month. The rental costs are only a little more than the monthly rental for equivalent sets without this facility.

Component Minifile

The Ship Company's Component Minifile is a plastic storage drawer which contains a continuous length of thick polythene folded to provide sixty slim pockets. Each pocket is supported by a plastic strip which spans two runners on either side of the drawer top, and a strip of paper can be inserted into each plastic support to identify the contents of the pocket. The Minifile is designed to store resistors, capacitors and other small components in conditions which allow a particular value to be located quickly and easily.

We have had a minifile on trial for a few months and have used it to store a variety of different items. It is not well suited to any but very small components, but otherwise provides an ideal storage medium. It looks as though it ought to be possible for small items to slip out of the sides of the pockets but in practice this was not a problem. Phil Walker took the Minifile home for a while and let his son use it for his stamp collection, for which it proved ideal except that static sometimes made it difficult to remove the stamps. This would, of course, make it unsuitable for many semiconductors, although it is unlikely to be used for this purpose anyway on grounds of size.

The Minifile costs £11.00 plus VAT and is also available as a multi-drawer unit in a locking, portable cabinet suitable for field use. Stockists include Watford, TK Electronics and Bradley Marshall.

The Ship Company Ltd, Macroom County Cork, Ireland.

● ElectroMusic Research have produced a MIDI (Musical Instrument Digital Interface) unit which allows any MIDI compatible instrument to be used with a BBC microcomputer. When used with their MIDItrack program it allows composition on up to six tracks with a memory assignment of 7500 notes storing details of pitch, dynamics, note length and style. Full on-screen editing features are provided and completed compositions can be saved on cassette or disk. The interface box, connection cable and MIDItrack on cassette or disk costs £109.95 from Electromusic Research, 14 Mount Close, Wickford, Essex SS11 8HG, tel 03744 67221.

● Densitron Corporation have produced a short form catalogue which covers their range of LED, LCD, DC Plasma and electromechanical indicators and display modules. The catalogue also describes their range of light pens and bar code readers and is available from Mr M. J. Monday, Densitron Europe Ltd, 50 London Road, Sevenoaks, Kent TN13 1AS, tel 0732-455 522.

● Lloyds Bowmaker Finance Group have launched an Industrial Achievement Award which offers a first prize of £15,000 to the UK small business judged to be most profitably exploiting a new idea and best placed to continue making a profit. The competition is open to all UK owned companies and unincorporated businesses with an annual turnover between £100,000 and £10,000,000, and entrepreneurial readers should contact The Secretary, Industrial Achievement Award, Lloyds Bowmaker Finance Group, Finance House, Christchurch Road, Bournemouth BH1 3LG, tel 0202-22077.

● An error appeared in the short item in last month's News Digest concerning South Warwickshire College's electronics summer school. The residential course, entitled Hobby Electronics, will run from the 23rd to the 27th July, not April as stated. The details are otherwise correct as given, and further information can be obtained from Graham Winton, South Warwickshire College of Further Education, The Willows North, Alcester Road, Stratford-upon-Avon CV37 9QR, tel 0789-66245.

● Serious Software have introduced an interpreter which allows the artificial intelligence language LISP to be run on a 48K Spectrum. It features colour 'turtle' graphics, LOAD, SAVE and VERIFY functions, user definable functions with a variable number of parameters and the ability to support machine code subroutines. The cassette containing the interpreter and a demonstration program comes with a programmer's manual and costs £15.50 including postage and packing or £20.00 if ordered from overseas. Serious Software, 7 Woodside Road, Bickley, Bromley, Kent BR1 2ES.

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VIDEO MONITORS

5" CASED Superb little unit made by **HITACHI** in ergonimcally designed free standing case. Very high definition will display small but readable 132 columns wide! 12v DC opp @ 800 ma. so ideal for mobile use. Supplied in AS NEW condition complete with data. Composite 75 ohm vid inp. Black & White CRT **£45.00** or Green CRT **£55.00** Carr & Ins £5.00

12" CASED. Made by the British KGM Co. Designed for continuous use as a data display station, unit is totally housed in an attractive brushed aluminium case with ON-OFF, BRIGHTNESS and CONTRAST controls mounted to one side. Much attention was given to construction and reliability of this unit with features such as, internal transformer isolated regulated DC supply, all components mounted on two fibre glass PCB boards – which hinge out for ease of service, many internal controls for linearity etc. The monitor accepts standard 75 ohm composite video signal via SO239 socket on rear panel. Bandwidth of the unit is estimated around 20 Mhz and will display most high def graphics and 132 x 24 lines. Units are secondhand and may have screen burns. However where burns exist they are only apparent when monitor is switched off. Although unguaranteed all monitors are tested prior to despatch. Dimensions approx. 14" high x 14" wide by 11" deep. Supplied complete with circuit. 240 volt AC operation. **ONLY £45.00 PLUS £9.50 CARR.**

24" CASED Again made by the KGM Co with a similar spec as the 12" monitor. Originally used for large screen data display. Very compact unit in lightweight alloy case dim. 19" H x 17" D x 22" W. All silicon electronics and composite video input make an ideal unit for schools, clubs, shops etc. Supplied in a used but working condition.
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RT11 ver. 3B doc kit	**£70.00**
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32 Biggin Way, Upper Norwood, London SE19 3XF
Telephone 01-679 4414 Telex 27924

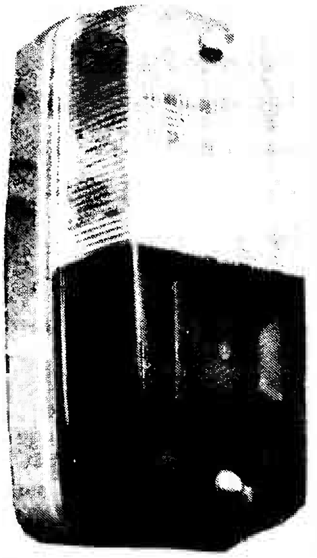
Preset Threshold Shock Sensor

A new shock sensor based on high-reliability reed-switch technology has been developed by Hamlin. The Model 5818 sensor produces a signal when a preset threshold shock force of given magnitude and direction is exceeded, and its potential applications include shock sensing and safety-device actuation in the automotive, farm-machinery, materials-handling and construction industries.

The sensor consists of a magnetic reed switch surrounded by a compression-type coil spring linked to a toroidal ferrite magnet. The mass of the magnet and the spring constant are selected so that the reed switch is actuated when a given acceleration force is applied. The switch assembly is enclosed in a rugged housing which protects the components and is also used for mounting the electrical connections. The standard Model 5818 has a threshold sensitivity of 5G, but other sensitivities are available to customer requirements.

Maximum switching voltage is 200V DC, and maximum switching current is 0.5A. The contact rating is 10W. Operating time is typically 8ms after the threshold sensitivity is exceeded, and the duration of contact closure is typically 16-22ms. The sensor measures 38mm x 13mm x 10mm, and its operating temperature range is −35°C to +85°C.

Hamlin Electronics Europe Ltd, Diss, Norfolk, IP22 3AY, tel 0379-4411.



Heat Sensing Light

Semiconductor Supplies International Ltd have introduced a 40 watt security-courtesy light which switches on automatically when it detects infra-red radiation from a heat source such as the human body. The sensing range is 12 metres, the spread 90 degrees, and the unit has an output which can be used to switch other lights or electrical equipment.

The unit is adjustable to stay on for between 2½ to 5½ minutes after it ceases to detect infra-red radiation. The output can be used to control other electrical equipment consuming up to 400 watts, for example, other lights round a building, a burglar alarm or halogen security floodlights. These may be selectively switched when the building is left unoccupied or when the occupiers go to bed. The unit is Design Centre approved and measures 9x4½x 3¾ inches (approx).

In domestic situations the unit offers the convenience of an outdoor or indoor light to automatically welcome guests in a parking area or at a front entrance or to deter intruders. There are also safety and economy applications, for example, the lighting of landings and staircases where there are elderly people or where lights would otherwise be left on all night for security or to cater for intermittent traffic.

The security-courtesy light costs £86.00 including VAT, postage and packing and can be ordered from Semiconductor Supplies International Ltd, Dawson House, 128-130 Carshalton Road, Sutton, Surrey SM1 4RS, tel 01-643 1126.

Exhibitions, Conferences, Etc

It's all of three months since we last presented a round-up of forthcoming conferences, exhibitions and other meetings of interest to the electronic fraternity, and the pile of press releases once more looms large before me. Here, then, in something like chronological order, are the pick of the bunch.

Electronics for Peace are holding a series of regional conferences this summer in order to allow electronic and computer engineers to meet and discuss the wider social and military implications of their work. The first conference is in Sheffield on Saturday June 2nd (the day after this issue is scheduled to appear, but we know some people manage to get hold of their copy early), the second conference is in Bristol on Saturday June 9th and the final one is in London on Saturday June 16th. Details are available from EfP, 151 Courthouse Road, Maidenhead, Berkshire SL6 6HY, tel 0892-46354 or 0628-20225 (both numbers evenings only).

The Computer Fair is described as Europe's biggest personal and small business computer exhibition and takes place at Earl's Court in London from the 14th to the 17th June. The Exhibition is arranged in two distinct areas, one devoted to home computers and one to business systems, and the first day has been designated a business/trade only day. Opening hours are from 10.00 am to 6.00 pm on the 14th, 15th and 16th June and 10.00 am to 5.00 pm on the 17th, and further details can be obtained from the Exhibition Manager, The Computer Fair, Reed Exhibitions, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 4QQ, tel 01-643 8040.

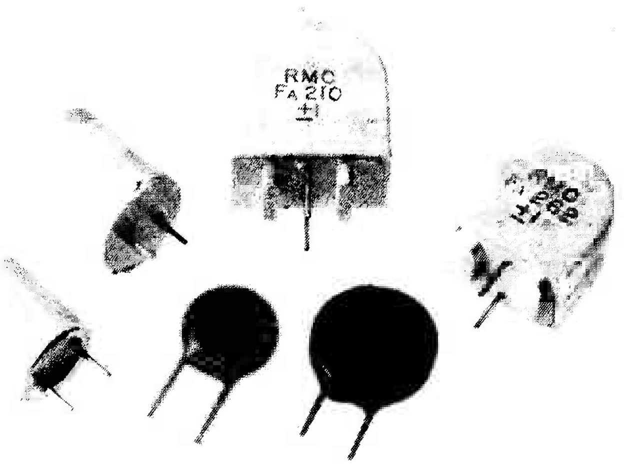
The Electronic Organ Constructors Society are holding a TMS 3617 workshop (whatever that is) in London on the 23rd June. Other meetings in London this year include a session on amplifiers and speakers on September the 8th and one on PCB manufacture and UV box construction on the 17th November. The EOCS is a non-profit making organisation which exists to promote the design and construction of organs and other electronic musical instruments by amateur enthusiasts. It holds five meetings a year in the London area and others in the provinces and also publishes a magazine five times a year. Details of both the meetings and the society generally are available from Percy Vickery, the Publicity Secretary, 5 Cringle Avenue, Southbourne, Bournemouth, Dorset BH6 4HX, tel 0202-423863.

The Leeds Electronics Show is in its 21st year and takes place at Leeds University from the 3rd to the 5th July. The show includes a full programme of seminars and the organisers claim that the exhibitors will range from large, established, market leaders in the industry to small up-and-coming companies. For details contact the Leeds Electronics Show, Evan Steadman Services Ltd, The Hubb, Emson Close, Saffron Walden, Essex CB10 1HL, tel 0799-26699.

The What Peripherals? exhibition will be held at the Barbican in London from the 13th to the 16th September and promises to offer visitors the opportunity to compare a wide range of peripherals for their systems. The full-colour magazine and stand guide which will be issued free to all those attending contains comprehensive details of all peripherals whether the manufacturer is exhibiting or not. Tickets cost £2.00 each for adults and £1.00 for under sixteens and can be purchased in advance from Computer Marketplace (Exhibitions) Ltd, 66 Wymering Road, London W9.

The International Symposium on Electrostatics takes place in Southampton from the 26th to the 28th September, and aims to provide an understanding of the fundamentals of this subject and to discuss the applications and hazards. The symposium is organised jointly by Southampton University and Oyez Scientific and Technical Services Ltd and is aimed at a wide range of specialists including those in the microelectronics, avionic and other industries. For details contact Miss Helen Raquet, Oyez Scientific and Technical Services Ltd, Third Floor, Bath House, 56 Holborn Viaduct, London EC1, tel 01-236 4080.

The World Computer Ergonomics Conference will be held at the Whitbread Conference Centre in London on the 4th and 5th of October and aims to bring managers, users, designers and programmers together to discuss input languages, interactive procedures, VDU health hazards, input devices and work-station ergonomics. The conference is sponsored by Ericsson Information Systems and will be touring to three of the American States and to Amsterdam, Dusseldorf and Helsinki as well as London. For details contact Karen Lee, Connexion, 72 Fielding Road, Chiswick, London W4, tel 01-995 8536.



Piezo Resonators

RBS have introduced into the UK the UN-Quartz range of piezoelectric ceramic resonators which, they claim, offer excellent stability for a wide variety of tuning applications at a fraction of the cost of quartz devices.

Using a circular piezoelectric element supported at its central nodal points and operating in the radial resonant node, the resonant frequency is inversely proportional to the diameter. To accommodate a range of resonant frequencies from 185kHz to 500kHz five package sizes are available from 0.430 inches to 0.740 inches. Frequency tolerances of ± 1kHz are standard and the resonator will not drift more than ± 0.2% from the 25°C frequency over the range −20 to +65°C. The resistance at resonant frequency is less than 10 Ohms.

The UN-Quartz resonators are said to be ideally suited for tuning high frequency, square wave oscillators in clock and baud rate generators for computers, calculators and digital instruments. In telecommunication dial tone synthesiser and digital pulse dialling they provide an inexpensive sine and square wave control and are cost-effective for frequency control in TV receivers, CRT display terminals and carrier-current systems for remote controls and alarms.

A comprehensive manual describing standard types, specifications and circuit applications is available from RBS Ltd, Unit 4, Airport Trading Estate, Biggin Hill, Westerham, Kent TN16 3BW, Tel Biggin Hill 71011.

Alarm Yourself

The Blade DIY electronic alarm kit comes as a basic kit which can be extended almost indefinitely by means of a wide range of add-on modules. The system can be extended to provide fire as well as theft alarm facilities and the manufacturers claim that it can be installed in your house in a single weekend.

The basic kit includes the control unit, an outside bell, an inside siren, a rechargeable battery, a personal attack button, a standard pressure mat, a stair-type pressure mat, a patio door switch, five magnetic door switches, 50m of four-core cable and 100 cable clips. Accessories which can be purchased to extend the system include window foil and connector blocks, a breaking-glass sound detector, an infrared intruder detector and an external strobe light. Further door switches, pressure mats, etc can also be added to the system and all the accessory packs come complete with instructions. The system uses a key rather than a combination lock for setting and uses the usual entry and exit delay arrangements. The protected area can be divided into two zones so that you can move freely around in one part of the house while unoccupied areas are protected, the circuit is so arranged that cutting any of the wires will sound the alarm, and the bell is timed to sound for 20-30 minutes once triggered before resetting, thus complying with the noise pollution laws. The four-core cable supplied is colour coded and the main wiring diagram in the instruction is similarly coloured so as to make installation as simple as possible.

The Blade alarm system basic kit costs £143.75 inclusive of VAT and the various accessories range in price from a matter of pence for anti-tamper switches up to £54.90 for the infrared intruder detector. Blade Electronic Security, 217 Warbreck Moor, Aintree, Liverpool L9 0HU, tel 051-523 8440.

● B&R Electrical Products of Harlow have launched a mail order component catalogue backed by a same-day despatch service and a telephone 'hotline' for technical advice. The catalogue is extensively illustrated, covers connectors, switches, relays, circuit breakers, meters, etc, and includes such hard-to-find items as DIL attenuators and rotary coded switches. Copies are available free-of-charge from B & R Electrical Products, Ltd, Temple Fields, Harlow, Essex CM20 2YD.

● Acorn Computers have won the Queen's Award for Technological Achievement for their BBC microcomputer. The Award pays special tribute to the advanced design of the machine and commends Acorn "for the development of a microcomputer system with many innovative features".

Courses

A lot of literature has landed on our news desk in the last month concerning technical courses, mostly computing, aimed at everyone from the well-heeled holiday-maker to the unemployed youngster seeking a career.

The London Computer and Electronics School opened recently in Hammersmith, West London, and offers six and twelve month courses to anyone aged 19 or over who is unemployed and has not been in full-time education in the past two years. The school is funded by the Manpower Services Commission, The Deparment of Trade and industry, the London Borough of Hammersmith and Fulham and the BOC group of companies, and will pay its students a wage of around £40 per week according to personal circumstances. The courses on offer are computer programming and computer operation, both of which last six months, and an electronics technician course which lasts twelve months. For details contact Tony Fielden, Director, London Computer and Electronics School, Glenthorne House, Hammersmith Grove, London W6, tel 01-741 9345.

M.A.P.S. Ltd are running three consecutive one week computing holidays for the handicapped, beginning on July 23rd. Four hundred applications were received for the twenty-five places on a one-week course run last year, so the number of places on each of the courses this year has been increased to sixty. The Holidays will be held at Valence School in Westerham, Kent, a boarding school which caters for 110 handicapped pupils during term time and is thus well equipped for the purpose, and the total cost will be £145, although there is a possibility of the Department of Industry providing a grant to offset part of this as they did last year. The organisers say they would also be interested to hear from anyone who has or knows of any software or hardware aimed particularly at the handicapped as they are compiling a catalogue of such material. They also run a series of other computer holiday courses aimed at business and professional users and including such diverse items as a course for doctors on using computers in general practice and one for architects, designers and so forth on computer graphics. Contact M.A.P.S. Ltd, 37 University Road, Highfield, Southampton SO2 1TL, tel 0703 558621.

The University of Salford are again running a series of one, two and three day computer courses, this time covering the Apple II, IBM PC, the BBC and the CBM microcomputers. The various courses cover a wide range, from introductory courses aimed at the beginner through to more specialised courses dealing with such matters as graphics and sound and the use of the various machines in measurement and control applications. The courses are at various dates from now until well into July so those interested should hurry up and contact the Conference Office, Maxwell Building, University of Salford, Salford M5 4WT, tel 061-736 5843 extension 449.

ICS are running four, four-day courses covering hands-on skills on microprocessors, taking full advantage of 16-bit micros, microprocessor troubleshooting techniques and VLSI design. The courses all cost £545.00 plus VAT with the exception of the microprocessor troubleshooting course which costs £595.00 plus VAT, and all take place in London in June and are repeated in either September or October. For full details contact ICS Publishing Co. (UK) Ltd., 3 Swan Court, Leatherhead, Surrey KT22 8AD, tel 0372-379211.

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AC128K	0.34
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AC141	0.26
AC141K	0.40
AC142	0.26
AC142K	0.48
AC151	0.45
AC152	0.45
AC176	0.28
AC176K	0.46
AC187	0.26
AC187K	0.40
AC188	0.28
AC188K	0.40
ACY40	0.80
AD142	1.10
AD143	1.10
AD149	0.96
AD161	0.42
AD162	0.42
AD161/AD162	0.96
AF106	0.48
AF114	2.10
AF115	2.10
AF116	2.10
AF117	2.10
AF118	0.85
AF121	0.82
AF124	0.48
AF125	0.48
AF126	0.48
AF127	0.48
AF139	0.68
AF178	0.68
AF239	0.68
AF279S	0.75
AL100	2.50
AL102	1.88
AL113	2.20
ASY80	1.75
AU110	1.40
AY102	4.32
BA102	0.34
BA110	0.87
BA121	0.40
BA129	0.38
BA148	0.16
BA154	0.08
BA155	0.10
BA156	0.08
BA157	0.28
BA164	0.14
BB104B	0.52
BB105B	0.30
BB105G	0.48
BB110B	0.42
BC107	0.10
A or B	0.12

Type	Price (£)
BC108	0.10
A,B or C	0.12
BC113	0.14
BC114	0.12
BC115	0.12
BC116	0.15
BC117	0.22
BC118	0.17
BC119	0.30
BC125	0.12
BC140	0.28
BC141	0.42
BC142	0.30
BC143	0.30
BC147	0.08
A or B	0.10
BC148	0.08
A or B	0.10
BC149	0.09
BC157	0.10
BC158	0.10
BC159	0.10
BC160	0.30
BC161	0.30
BC168B	0.12
BC169C	0.10
BC170	0.14
BC170B	0.12
BC171	0.10
BC171	0.10
A or B	0.08
BC172	0.08
A or B	0.12
BC177	0.20
BC178A	0.22
BC182	0.09
A,B or C	0.09
BC182L	0.09
A,B or C	0.09
BC183	0.09
A,B or C	0.10
BC183L	0.08
A,B or C	0.12
BC184L	0.10
A,B or C	0.10
BC207	0.15
BC208	0.16
BC212	0.09
A,B or C	0.10
BC212L	0.08
A,B or C	0.10
BC213	0.09
A or B	0.10
BC213L	0.10
A or B	0.10
BC237	0.11
BC238	0.12
BC239C	0.14
BC251	0.12
A,B or C	0.14
BC301	0.30

Type	Price (£)
BC302	0.32
BC303	0.32
BC307	0.10
BC308A	0.10
BC323	0.99
BC327	0.14
BC328	0.14
BC337	0.12
BC338	0.12
BC350	0.14
BC440	0.30
BC441	0.32
BC461	0.32
BC547	0.12
BC548	0.12
BC549	0.12
BC550	0.18
BC550C	0.18
BC557	0.12
BC558	0.12
BCX34	0.27
BCY70	0.15
BCY71	0.17
BCY72	0.18
BCZ10	1.68
BCZ11	1.45
BD124P	0.80
BC130Y	0.68
BD131	0.34
BD132	0.34
BD131/BD132	0.95
BD135	0.32
BD136	0.36
BD137	0.36
BD138	0.38
BD139	0.38
BD140	0.38
BD144	1.60
BD145	1.82
BD150A	0.51
BD159	0.65
BD160	1.85
BD165	0.45
BD175	0.60
BD182	1.00
BD183	1.10
BD184	1.20
BD201	0.72
BD202	0.87
BD204	0.80
BD222	0.80
BD225	0.86
BD232	0.45
BD233	0.60
BD234	0.62
BD235	0.63
BD236	0.63
BD237	0.65
BD238	0.56
BD241	0.60
BD243A	0.80

Type	Price (£)
BD244A	0.65
BD375	0.32
BD410	0.76
BD434	0.68
BD436	0.68
BD437	0.76
BD438	0.75
BD439	0.68
BD507	0.48
BD508	0.53
BD509	0.54
BD510	0.48
BD517	0.56
BD520	0.66
BD699	1.25
BD707	0.88
BDX18	2.35
BDX32	2.10
BF115	0.32
BF117	0.54
BF119	0.82
BF120	0.38
BF123	0.40
BF125	0.42
BF127	0.38
BF152	0.16
BF154	0.23
BF157	0.40
BF158	0.22
BF159	0.24
BF160	0.23
BF167	0.30
BF173	0.25
BF177	0.42
BF178	0.30
BF180	0.35
BF181	0.35
BF182	0.32
BF183	0.32
BF184	0.32
BF185	0.32
BF194	0.08
BF195	0.10
BF196	0.10
BF197	0.10
BF198	0.14
BF199	0.15
BF200	0.26
BF222	0.48
BF224	0.20
BF224J	0.16
BF240	0.20
BF241	0.20
BF244	0.26
BF244A	0.28
BF244C	0.24
BF245A	0.28
BF254	0.15
BF256	0.40
BF257	0.32

Type	Price (£)
BF258	0.30
BF259	0.32
BF262	0.30
BF263	0.30
BF270	0.30
BF271	0.26
BF273	0.18
BF274	0.32
BF323	0.92
BF336	0.26
BF337	0.26
BF338	0.26
BF355	0.42
BF363	0.82
BF367	0.24
BF371	0.27
BF422	0.38
BF450	0.38
BF457	0.33
BF458	0.36
BF459	0.44
BFR39	0.22
BFR40	0.22
BFR41	0.22
BFR51	0.30
BFR61	0.32
BFR62	0.28
BFR88	0.34
BFR90	1.72
BFT41	0.38
BFT43	0.38
BFW10	0.79
BFW44	0.76
BFX29	0.28
BFX30	0.30
BFX80	3.56
BFX84	0.24
BFX85	0.26
BFX86	0.26
BFX87	0.26
BFX89	0.65
BFY50	0.21
BFY51	0.21
BFY52	0.21
BFY57	0.40
BFY90	0.90
BFY90S	1.34
BR100	0.20
BR101	0.44
BR103	0.58
BRC4443	1.76
BRY39	0.38
BRY56	0.42
BRY61	0.86
BSS17	0.56
BSS27	0.92
BSX19	0.34
BSX20	0.34
BSX59	0.62
BSX76	0.29
BT100A/02	0.94

Type	Price (£)
BT101/300	1.15
BT101/500	1.25
BT102/300	1.35
BT102/500	1.65
BT106	1.50
BT108	1.30
BT109	1.18
BT116	1.25
BT119	3.62
BT120	3.60
BT121	3.02
BT138/600	1.30
BT151/560R	0.90
BT151/300R	1.15
BTY79/400R	2.80
BU100A	2.30
BU104	2.00
BU105	1.20
BU105/02	1.56
BU108	1.80
BU124	1.75
BU126	1.25
BU133	1.80
BU204	1.35
BU205	1.30
BU206	1.70
BU208	1.55
BU208A	1.63
BU208/02	2.05
BU326S	1.75
BU407	1.65
BU407D	1.80
BUX80	3.70
BUY20	1.75
BUY69A	2.60
BUY69B	1.98
BY101	0.48
BY118	1.10
BY122	0.68
BY126	0.12
BY127	0.10
BY133	0.16
BY135	0.25
BY164	0.44
BY179	0.86
BY182	0.87
BY184	0.40
BY187	0.72
BY189	4.75
BY198	0.44
BY199	0.47
BY206	0.24
BY207	0.24
BY210/400	0.25
BY210/600	0.26
BY210/800	0.30
BY223	1.20
BY227	0.26
BY229	0.30
BY238	0.68
BYX10	0.24

Type	Price (£)
BYX36/150	0.22
BYX36/600	0.28
BYX48/300	0.72
BYX49/300	0.47
BYX55/350	0.29
BYX55/600	0.33
BYX71/600	1.18
BYZ12	0.42
C106D	0.80
E1222	0.40
E5024	0.30
GET872	0.48
ITT44	0.04
ITT2002	0.11
ME0402	0.20
ME0404/2	0.24
MEU21	0.60
MJ400	1.25
MJ2955	0.90
MJ3000	1.98
MJE240	0.60
MJE340	0.54
MJE370	0.88
MJE520	0.48
MJE2955	0.99
MJE3055	0.70
MPSL01	0.28
OA47	0.10
OA90	0.08
OA91	0.06
OA95	0.18
OA200	0.06
OA202	0.15
OC25	2.10
OC26	1.70
OC28	1.50
OC29	2.47
OC35	1.75
OC36	1.75
OC42	0.72
OC42K	1.40
OC44	0.72
OC45	0.58
OC71	0.50
OC72	0.52
OC81	0.68
OC200	2.46
OC202	2.20
ORP12	0.85
R2008B	1.50
R2010B	1.52
SHG1.5	0.40
TAG1/100	1.40
TAG3/400	1.78
TIC44	0.40
TIC45	0.45
TIC46	0.48
TIC47	0.70
TIC106A	0.70
TIP30A	0.46
TIP31C	0.54

Type	Price (£)
TIP32	0.40
TIP32C	0.60
TIP33A	0.63
TIP34A	0.72
TIP41C	0.46
TIP42A	0.52
TIP47	0.60
TIP110	0.88
TIP2955	0.60
TIP3055	0.60
TIS43	0.32
TIS88	0.40
TIS90	0.25
TIS91	0.28
ZTX108	0.12
ZTX109	0.12
ZTX212	0.28
IN4001	0.05
IN4003	0.05
IN4004	0.06
IN4006	0.07
IN4007	0.07
IN4148	0.05
IN5400	0.12
IN5402	0.15
IN5405	0.16
IN5406	0.18
IN5408	0.20
IS920	0.08
2N697	0.55
2N706A	0.33
2N2904	0.28
2N2906	0.24
2N2926G	0.10
2N3053	0.22
2N3054	0.56
2N3055	0.45
2N3702	0.10
2N3704	0.10
2N3708	0.10
2N3772	1.90
2N3773	2.70
2N3904	0.16
2N3906	0.16
2N5294	0.48
2N6107	0.71
2N6126	0.68
2SB337	1.60
2SC1172Y	2.90
2SC1173Y	0.82
2SC1302	1.40
2SC1226	0.84
2SC1279	0.50
2SC1306	0.92
2SC1307	1.40
2SC1413A	2.70
2SC1444	1.45
2AC1449	0.63

Type	Price (£)
2SC1507	0.63
2SC1678	1.06
2SC1758	0.68
2SC1909	1.20
2SC1923	0.30
2SC1945	2.88
2SC1953	0.74
2SC1957	0.76
2SC1969	2.88
2SC2028	0.73
2SC2029	1.00
2SC2078	1.05
2SC2091	0.73
2SC2098	2.90
2SC2122A	3.20
2SC2166	1.20
2SC2314	0.80
2SC2335	1.50
2SC2749	2.70
2SC2752	0.60
2SD234	0.64
2SD348	3.30
2SD986	0.62
2SK134	3.80
2SK135	1.90
3N126	1.90
3N211	2.52
3SK45	0.76

ROTARY POTS

0.25W CARBON
LOG. 4K7 — 2M2
IN. 1K — 2M2
32p ea. 10 for £3
Any 100 for **£27.50**

VEROBOARD

2½ x 3¾	85p
2½ x 5	£1.00
2½x17	£3.25
3¾ x 17	£1.05
3¾ x 5	£1.15
3¾ x 17	£4.10
4¾ x 17¾	£4.95
Pkt of 100 pins	50p
Spot face cutter	£1.48
Pin insertion tool	£3.50
Vero Wiring Pen & Spool	£3.50
DIP board	£3.85
Vero Strip	£1.25

HV Disc Ceramic

1kV 1.5nF	18p
8kV 10, 47, 82, 100, 120, 150, 180, 200, 220pF	30p
270, 300pF	39p
10kV 1nF	67p

VALVES

Type	Price (£)
DY802	0.88
DY86/87	0.75
ECC81	0.95
ECC82	0.65
ECC83	0.75
ECC84	0.85
ECC85	0.90
ECC88	0.95
ECF80	0.95
ECH81	0.75
ECH84	0.75
ECL82	0.75
ECL86	0.98
EF80	0.65
EF86	1.60
EF183	0.75
EF184	0.75
EH90	0.94
EL34	2.50
EL84	0.69
EL509	5.50
EM87	2.55
EY86/87	0.67
EY500A	1.65
PCC84	0.50
PCC85	0.65
PCC89	0.74
PCC189	0.85
PCF80	0.75
PCF86	1.25
PCF200	1.95
PCF801	1.45
PCF802	0.85
PCF806	1.20
PCL82	0.90
PCL83	2.50
PCL84	0.90
PCL86	0.98
PCL805/85	1.35
PD500	3.75
PFL200	1.35
PL33	1.50
PL36	1.45
PL81	0.85
PL82	0.75
PL83	0.65
PL84	0.75
PL95	2.00
PL504	1.20
PL508	2.40
PL509/519	5.95
PY88	1.80
PY500A	2.40
U26	1.90
UCH81	0.90
UCL82	1.70
6J5GT	1.75
6SJ7	2.20
30FL12	1.60

ZENER DIODES

400mW Plastic 3V-75V **8p each 10/7**
1.3W Plastic 3V-200V **15p each 10/£1.40**
1.5W Flange 4.7-47V **£1.28 each**
2.5W Plastic 7.5-75V **87p each**
20W Stud 7.5-75V **£1.31 each**

INTEGRATED CIRCUITS (£) EACH

AN240P	3.42	SN76530P	1.40
AN214QQ	3.88	SN76533N	1.60
AN7150	2.90	SN76650N	1.05
CA3065	1.75	SN76660N	0.75
CA4031P	2.88	SN76666N	0.80
CA4102	3.30	STK015	6.50
CA4250	3.50	TA7108P	3.20
CA4400	2.98	TA7120P	3.20
CA4422	3.07	TA7129AP	3.65
LC7120	5.33	TA7130P	1.65
LC7130	5.26	TA7172	1.80
LC7137	5.16	TA7193	5.50
LM380N	0.80	TA7172P	1.80
LM1303N	2.52	TA7176	2.50
HA1151P	3.12	TA7202P	4.18
MC1307P	1.85	TA7204P	1.86
MC1310P	1.85	TA7205AP	1.50
MC1312P	2.25	TA7208P	3.27
MC1327P	2.25	TA7210P	6.50
MC1330P	0.83	TA7222P	1.88
MC1349P	1.85	TA7223P	3.68
MC1350P	1.20	TA7227P	5.60
MC1351P	2.50	TA7310A	1.80
MC1352P	1.50	TA7609P	4.28
MC1357P	2.88	TA7611AP	2.88
MC1358P	1.30	TAA263	2.46
MC1496P	1.15	TAA310A	2.68
ML231B	2.10	TAA550	0.50
ML232B	2.10	TAA570	1.99
ML237B	2.30	TAA611A12	3.50
NE555	0.25	TAA611B12	2.65
C-mos 555	0.88	TAA630S	3.90
NE556	0.60	TAA661B	1.70
SAA1024	5.35	TAA700	2.80
SAA1025	8.40	TAA840	3.38
SAS560A	2.50	TAD100	2.80
SAS560S	1.85	FM FILTER	1.20
SAS570S	1.85	TBA120A	1.00
SAS580	2.85	AS,S SA,SB	1.20
SAS590	2.82	Q,T,U,Q	1.32
SC9503P	1.10	TBA120B	1.30
SL432A	4.00	TBA231	1.45
SL901B	5.20	TBA281	2.65
SL917B	6.25	TBA395	1.20
SL1327Q	1.10	TBA480Q	1.50
SN76003N	2.44	TBA400	2.30
SN76013	1.90	TBA510	2.60
SN76023ND	2.90	TBA510Q	2.60
SN76033N	2.45	TBA520/Q	1.60
SN76110N	1.12	TBA530/Q	1.30
SN76115N	2.00	TBA540/Q	1.40
SN76131N	1.65	TBA550/Q	1.52
SN76226ND	1.80	TBA560C	1.70
SN76227N	1.10	TBA560CQ	1.40

TBA570	1.50
TBA641BX1	4.50
TBA673	2.40
TBA700	2.85
TBA750	2.60
TBA800	1.60
TBA810P	1.10
TBA810	1.20
TBA820	1.60
TBA890	3.80
TBA920/Q	3.00
TBA940/2A	3.05
TBA970	4.05
TBA990	1.88
TCA160C	3.90
TCA270S	4.00
TCA270SA	4.02
TCA800	3.10
TCA940	1.90
TDA440	3.80
TDA1002	1.90
TDA1003A	5.50
TDA1004A	2.90
TDA1006A	2.40
TDA1035S	4.50
TDA1044	4.30
TDA1170S	3.00
TDA1190	3.50
TDA1200	2.98
TDA1270Q	3.70
TDA1327A	1.66
TDA1352A/B	1.56
TDA1412	1.20
TDA2002	2.80
TDA2020	4.00
TDA2030	2.78
TDA2140	5.90
TDA2521	4.10
TDA2523	3.50
TDA2530	2.70
TDA2540	3.80
TDA2541	3.80
TDA2560	3.50
TDA2571A	3.50
TDA2561	3.20
TDA2590	3.20
TDA2591	2.98
TDA2593	2.98
TDA2610	3.20
TDA2611A	1.94
TDA2640	2.90
TDA2680	3.40
TDA2690	3.50
TDA3950A/B	2.80
UPC554C	1.32
UPC557H	0.90
UPC566H	2.95
UP575C2	3.20
UPC1018C	1.10
UPC1025H	2.90
UPC1032H	0.90
UPC1156H	4.20

UPC1158H	0.76
UPC1163H	0.98
UPC1181H	1.60
UPC185H2	3.75
UPC1212C	1.30
UPC1230H	3.90
UPC1350C	3.90
UPC1367C	3.40
UPC1378H	4.40
UPC2002H	2.80

BRIDGES

1½A 50V	0.27
100V	0.28
200V	0.32
400V	0.40
600V	0.50
800V	0.58
2A 100V	0.52
200V	0.55
400V	0.61
600V	0.67
800V	0.70
6A 100V	0.66
200V	0.68
400V	0.74
600V	0.80
800V	0.86
10A 50V	2.20
100V	2.24
200V	2.35
400V	2.50
600V	3.50
25A 50V	2.05
100V	2.25
200V	2.40
400V	3.20
600V	3.95

PANEL METERS

FSD
60 x 46 x 35mm
0-50µA
0-100µA
0-500µA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"

ALL — £5.00 EACH

RESISTORS - CARBON FILM 5%

¼W 1R0 to 10M (E12 Range)	**2p each. 15p/10. 75p/100**
½W 2R2 to 10M (E24 Range)	**2p each. 15p/10. 75p/100**
1W 10R to 2M2 (E12 Range)	**7p each. 65p/10. 6.00/100**
2W 10R to 2M2 (E6 Range)	**8p each. 70p/10. 6.00/100**

RESITOR KITS — each value individually packed

¼W pack 10 each value E12 — 10R to 1M 610 pieces	4.80
¼W pack 5 each value E12 — 10R to 1M 305 pieces	2.75
½W pack 10 each value E12 — 2R2 to 2M2 730 pieces	5.25
½W pack 5 each value E12 — 2R2 to 2M2 365 pieces	3.00
1W pack 5 each value E12 — 2R2 to 1M 353 pieces	15.00
2W pack 10 each value E6 — 10R to 2M2 317 pieces	18.00

RESISTORS WIREWOUND Generally 5%

2.5W - 0.22 to 270R - Available in preferred values	0.20
4W - 1R0 to 10K - Available in preferred values	0.21
7W - 0.476R to 22K - Available in preferred values	0.25
11W - 1R0 to 22K - Available in preferred values	0.29
17W - 1R0 to 22K - Available in preferred values	0.37

TERMINAL BLOCKS

2 amp 12 way	0.19
5 amp 12 way	0.20
10 amp 12 way	0.40
15 amp 12 way	0.46
32 amp. 12 way	0.90

JULY SPECIAL

Phillips Video Projection Screen 60"
£50 each p&p £8

AU110	10 for **£12** 100 for **£85**
BC308A	10 for **50p.** 100 for **£3**
BC170	10 for **50p** 100 for **£3**

SOLDERING SECTION

Antex 15W iron	5.00
Antex 18W iron	5.00
Antex 25W iron	5.20
Antex elements	2.00
Antex bits	0.95
Antex stands	1.90
Soldersucker	4.50
Spare nozzles for Soldersucker	0.45
Antex Soldering station complete with 1 iron — 30W or 40W	49.95
25W KIT — Iron with 13A plug and stand	£6.40
15W KIT — Iron with 13A plug and stand	£6.20

SERVICE AIDS

ALL SERVISOL PRODUCTS

Switch Cleaner	0.88
Circuit Freezer	0.96
Foam Cleanser	0.84
Aero Klene	0.78
Silicone Grease (Aerosol)	1.00
Antistantic Spray	0.82
Plastic Seal	0.88
Excel Polish	0.76
Fire Extinguisher 640g	2.80
Video Head Cleaner	0.88
Silicone Grease (IC) 75g	1.00
Solda Mop (Std)	0.72
Solda Mop (L/Gauge)	0.72

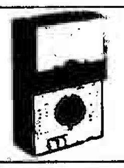
Additional P&P on above 30p

MULTIBLOCK

Multiblock 4-Way Extension Socket
PVC body with internal cable grip fitted with 13A fuse and neon indicator. Max total load 13A 250V. Length 10½; Width 2½.
Price **£3.90** each (P&P) 25p in addition to 35p normal charge).

PLUGS & SOCKETS

Metal Co-ax Plug	0.18	10/1.60
Plastic Co-ax Plug	0.14	10/1.20
Single Junction Socket	0.80	10/6.00
Plastic Phono	0.10	10/80p
FM Plugs	0.20	10/1.75
1PL259	0.38	10/3.50
Reducer	0.15	10/1.25
¼in Plastic-Mono Plug	0.15	10/1.20
¼in Metal Mono Plug	0.30	10/2.30
2.5mm Plug Metal	0.18	10/1.40
3.5mm Plug Metal	0.18	10/80p
2.5mm Chassis Socket	0.10	10/80p
3.5mm Chassis Socket	0.10	10/1.20
2 pin ¼in Mono Chassis Socket	0.14	10/1.75
4 pin ¼in Mono Chassis Socket	0.20	10/2.70
6 pin ¼in Mono Chassis Socket	0.30	10/1.25
4mm Banana Plug	0.15	10/1.25
4mm Banana Socket	0.15	10/80p
PP3 Battery Connectors	0.06	10/1.20
PP9 Battery Connectors	0.15	



MULTIMETER SPECIAL

Russian type U4324 — (20,000 O P V)
DC Volts 0.6, 1.2, 3, 12, 30, 60, 600, 1200.
AC Volts: 3, 6, 15, 60, 150, 300, 600, 900
DC Curr. M/A: 0.06, 0.6, 6, 60, 600, 3000
AC Curr M/A: 0.3, 3, 30, 300, 3000
DC Resistance 0.2, 5, 50, 500, 5000K.
level dB −10 to +12.

Supplied with rechargeable batteries.
Price £12.00 Incl of p/p & VAT.

1984 CATALOGUE

Send now for our latest catalogue — 109 pages — packed with complete range of components — fully illustrated, price 65p per copy includes 30p credit note special offers sheets, order form and pre-paid envelope

FUSEHOLDERS

20mm Panel Mounting	0.28
20mm Chassis Mounting	0.06
1¼" Panel Mounting	0.35
1¼" Chassis Mounting	0.12
Carline 1¼" holder	0.10

CHART RECORDERS

Brand new 3 channel pen recorders complete with charts spares kit. Full spec upon request — Once only bargain £40 + £10 p&p plus 15% VAT

NI CAD

Universal Ni-Cad charger, charges PP3, AA, C, D
Price £5.00

TOGGLE SWITCH MIN

SPST — 2 TAG — 66p
SPDT — 3 TAG — 68p
DPDT — 6 TAG — 72p
DPDT — 6 TAG — 86p
(C-off)

ROTARY SWITCHES

1p 12w — 40p
2p 6w — 40p
3p 4w — 40p
4p 3w — 40p

BUZZERS

SOLID STATE
6v and 12v — **80p each**

POWER SUPPLY

Integral 13A plug — 1 metre lead with 3.5m jack plug — 12v 250mA
PRICE £3.00 (p&p 50p)

TRANSFORMERS

	1+	10+	100+	1000+
4.5-0-4.5v 400m/A	50p	45p	35p	30p
6-0-6v 100m/A	58p	52p	43p	40p
6-0-6v 500m/A	65p	60p	48p	45p

Carriage: 48p per transformer, £1.60 per 10; £4.50 per 100, £30 per 1,000

FUSES Prices per 10

1¼" Quick Blow. 100, 150, 250mA **£1.30.** 1, 1.25, 1.5, 2, 2.5, 3, 10, 15A **55p. 1¼" Time Delay.** 100mA **£3.50.** 150mA **£2.25** 250, 300, 500, 600, 750, 850mA **£1.84.** 1, 1.25, 1.5, 1.6, 2A **£1.84.** 2.5A, 3.15, 3, 5A **£2.82. 20mm Quick Blow.** 100, 125, 160, 200, 250, 315, 400, 500, 630, 800mA, 1, 1.25, 1.6, 2, 2.5, 3.15, 4, 5, 6.3A **40p. 20mm Time Delay.** 100, 125, 160, 200mA **£1.80.** 250, 315, 400, 500, 630, 800mA **£1.00.** 1, 1.25, 1.6, 2, 2.5, 3.15, 4, 5, 6.3A **85p. 1" Mains.** 2, 3, 5, 7, 10, 13A **85p.**

Manufacturers please note — we can offer very competitive production quantities of 20 mm Quick Blow & Time Delay range — apply for quotation.

EUROPEAN ADAPTORS

These very high quality British made two pin European adaptors are ideal for driving Radios, cassette recorders, TV games, calculators etc. The adaptors fit in the UK shaver socket

REF	DC Voltage	Current	1+	10+	100+
EOB	4.5V	200m/a	50p	45p	32p
EM3	6V	200m/a	£1.00	60p	55p
EO9	6V	400m/a	£1.50	£1.25	85p

Postage & Packing: 45p per adaptor or £1.60 per 10, £4.50 per 100

(1,000 off qty price on application)

IC SOCKETS Dil to Dil

8 pin	0.08	0.70/10
14 pin	0.10	0.95/10
16 pin	0.11	1.00/10
18 pin	0.14	1.60/10
22 pin	0.21	1.95/10
24 pin	0.25	2.25/10
28 pin	0.30	2.75/10
40 pin	0.34	3.10/10

D CONNECTORS

	9 way	15 way	25 way
MALE			
Solder lugs	80p	105p	160p
Angle pins	150p	210p	250p
FEMALE			
Solder lugs	105p	160p	200p
Angle pins	165p	215p	290p
COVERS	85p	80p	80p

VOLTAGE REGULATORS

78L05 - 30p
78L12 - 30p
78L15 - 30p
7805 - 65p
7812 - 58p
7815 - 58p
LM317K - 3.50
LM317T - 90p

LEDS

3mm
Red - 10p 10/85p
Green - 13p 10/1.00
Yellow - 13p 10/1.00
5mm
Red - 10p 10/85p
Green - 13p 10/1.00
Yellow - 13p 10/1.00

MARCO TRADING (Dept ET7)
The Maltings
High Street
Wem, Shropshire SY4 5EN
Tel: 0939 32763

ORDERING: All components are brand new and to full specification. Please add 45p postage/packing (unless otherwise specified) to all orders then add 15% VAT to the total. Either send cheque/cash/postal order or send/telephone your Access or Visa number. Official orders from schools, universities, colleges etc most welcome. (Do not forget to send for our 1984 catalogue — only 65p per copy.
All orders despatched by return of mail.
NEW RETAIL 1000 squ ft shop now open Mon-Fri 9.00-5.00 Sat 9-12.00

TI-66 Programmable Calculator

Texas Instruments have announced a new, full specification programmable calculator, the TI-66, which comes in a horizontal computer-like case and provides the college student, engineer and science professional with more than 170 scientific functions, large memory area and user-friendly programming features.

The calculator has arithmetic, logarithmic, trigonometric, statistical, and polar to rectangular conversion features. It can accommodate a maximum of 512 program steps or 64 data memories with each memory convertible to 8 program steps. With 9 levels of parenthesis and 6 levels of subroutines it can handle almost any problem. When entering or reviewing a program the TI-66 displays readable alphanumeric abbreviations of the instructions. It uses the same set of instructions as the TI-58C/59 family of calculators, and the constant memory feature retains data and program information even when the calculator is turned off. It also connects to TI's PC-200 thermal printer, giving it printing and listing capabilities.

The TI-66 should already be available in the shops and its recommended retail price is £44.99 including VAT.

Low-Voltage Audio Amplifier ICs

Sprague Electric has launched a dual, low-voltage, audio amplifier IC for use as a stereo headphone driver in portable radios, tape players and other battery-operated equipment. The ULN-3783M comes in an 8-pin plastic mini-DIP case and requires few external components, significantly reducing system size, weight and production cost.

Rated for operation up to 12V, it has a voltage gain of 42dB, low noise and excellent channel separation. Operating in class AB, it features a very low quiescent current and will operate with a supply voltage as low as 2.4V at reduced volume without any significant increase in distortion. Other features include an ability to operate over the temperature range +20 C to +85 C, and built-in protection against AC short circuits. The package has a copper alloy leadframe which maximises heat dissipation without the need for an external heat sink.

Also new from Sprague is the ULN-3784B 4-watt audio power amplifier, a 14-pin dual-in-line device designed for consumer, automotive and communications applications. It operates from a single supply voltage between 9 and 32VDC, and when oerating from a 24V supply will deliver 4 watts of low-distortion audio into an 8 ohm load. Output power with a 28V supply is typically 4.8 watts into a 16 ohm load. The plastic package has tabs for attaching an inexpensive heat sink to increase power dissipation, and can be used with a standard integrated circuit socket or printed circuit layout.

The ULN-3784B is a direct replacement for the LM380N and the LM384N and, in addition to providing a significantly improved performance, offers a wider margin of protection against supply transients. Performance characteristics include a high input impedance, a fixed internal gain of 34dB, and an ability to operate over the temperature range −20°C to +85 C. Other features include built-in protection against thermal overloads and AC short-circuits, and internal bandwidth limiting which provides a significant degree of immunity to radio frequency interference.

Sprague Electronic (UK) Ltd, Salbrook Road, Salfords, Surrey RH1 5DZ, tel 02934-5666.

● Applications are invited for the 1984 Karl Heinrich Gyr and Heinrich Landis Commemorative Prize, awarded annually for practical contributions to the advancement of electrical or electronic science or engineering. Last year's £500 prize was awarded to the team who developed an instrument to automatically characterise optical fibres. The closing date for entries is 2nd July, and applications forms can be obtained from The Secretary, The Institution of Electrical Engineers, Savoy Place, London WC2R 0BL, tel 01-240 1871.

● At long, long last it seems that things are stirring in the land of the Cortex. Even as I write, a Users Group is slowly raising its not-particularly-ugly head above the platitude and broken-promise strewn ground, eyes alert, hands ready to grab your cash in exchange for regular issues of a user magazine, a helpline service and a disc software base. For up-to-the-minute details of the beast's movements and information on where you can contact it, see ETI next month.

● Semiconductor Supplies International have issued a new 30-page stock list covering their range of semiconductors, resistors and capacitors. They offer a computer-based service to mail order customers and can be contacted at Dawson House, 128-130 Carshalton Road, Sutton, Surrey SM1 4RS, tel 01-643 1126.

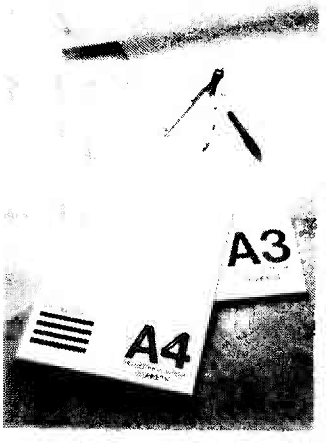
● Cambridge connectors have produced a catalogue detailing their range of flat-cable IDS headers and sockets, all of which are designed to meet the requirements of British Standards, DIN standards and MIL Specifications. Contact Cambridge Connectors Ltd, Denny End Industrial Estate, Waterbeach, Cambridge CB5 9P8, tel 0223-860 041.

PCB Grid Film

Universal Grids are a range of PCB layout films which have a pale, blue grid printed on them. PCB designers can thus tape directly onto the film without using graph paper or a grid sheet as backing, and because the grid is blue it will not show up when the artwork is photographed.

The grid sheets are made from a highly stable, polyester matt film and are available with either metric or imperial rulings and in sizes from A1 to A4. The manufacturers claim that a significant improvement in accuracy can be achieved by working directly onto a grid-printed film, and suggest that the sheets will also find wide application in other areas of draughting and design.

A pack of eight A4 Universal Grid sheets costs £5.17, a pack of five A3 sheets costs £6.21, A2 sheets cost £2.04 each and A1 sheets cost £4.00 each. Further



details and a list of stockists are available from Universal (Electronics) Grids Ltd, P.O. Box 3, Liskeard, Cornwall, tel 0579-20878.

ETI

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7427	60p
7428	60p
7430	60p
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74110	90p
74111	55p
74116	220p
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74121	90p
74122	100p
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74154	250p
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74LS138	120p
74LS139	120p
74LS145	150p
74LS147	220p
74LS148	220p
74LS151	100p
74LS153	100p
74LS154	300p
74LS156	125p
74LS157	100p
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74LS170	220p
74LS173A	120p
74LS174	120p
74LS175	120p
74LS181	250p
74LS183	270p
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74LS259	200p
74LS260	90p
74LS261	120p
74LS266	100p
74LS273	240p
74LS275	175p
74LS279	120p
74LS280	240p
74LS283	120p
74LS290	110p
74LS292	900p
74LS293	125p
74LS295	140p
74LS297	900p
74LS298	150p
74LS299	250p
74LS321	300p
74LS323	250p
74LS324/624	350p
74LS348	250p
74LS352	150p
74LS353	150p
74LS356	220p
74LS363	180p
74LS364	180p
74LS365A	100p
74LS366A	100p
74LS367A	100p
74LS368A	55p
74LS373	POA
74LS374	POA
74LS375	100p
74LS377	180p
74LS378	150p
74LS379	140p
74LS390	140p
74LS393	200p
74LS395A	140p
74LS399	210p
74LS445	180p
74LS465	220p
74LS466	150p
74LS467	220p
74LS490	170p
74LS540	200p
74LS541	200p
74LS608	700p
74LS610	1900p
74LS612	1900p
74LS624	150p
74LS626	350p
74LS628	350p
74LS629	300p
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74LS640-1	300p
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74S74	120p
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4018	75p
4019	60p
4020	90p
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4519	75p
4520	75p
4521	125p
4522	90p
4526	90p
4527	90p
4528	75p
4529	90p
4531	75p
4532	80p
4534	400p
4536	220p
4538	90p
4539	90p
4541	90p
4543	100p
4553	220p
4555	60p
4556	70p
4557	250p
4560	120p
4566	200p
4568	300p
4569	200p
4572	50p
4583	75p
4584	48p
4585	65p
4599	290p
4724	150p
14411	900p
14412	850p
14416	300p
14419	300p
14490	550p
14495	450p
14500	700p
14599	350p
22100	350p
22101	700p
22102	700p
40014	48p
40085	90p
40097	75p
40098	75p
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LINEAR ICs

AD7581	£15	LM391	180p	TA7130	180p
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AY-3-1350	350p	LM710	50p	TBA231	120p
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AY-3-8912	500p	LM725C	300p	TBA810	100p
CA3019A	100p	LM733	75p	TBA820	80p
CA3028A	150p	LM741	20p	TBA950	225p
CA3046	70p	LM747	70p	TC9109	500p
CA3059	350p	LM748	40p	TCA210	350p
CA3060	350p	LM1011	480p	TCA220	350p
CA3080E	80p	LM1014	150p	TCA940	175p
CA3086	80p	LM1801	300p	TCA965	120p
CA3089E	250p	LM1830	250p	TDA1004A	£5
CA3090AQ	3.75	LM1871	300p	TDA1008	320p
CA3130E	90p	LM1872	300p	TDA1010	250p
CA3130T	110	LM1886	500p	TDA1022	500p
CA3140E	60p	LM1889	350p	TDA1024	120p
CA3140T	110	LM2917	250p	TDA1170	300p
CA3160E	100p	LM3302	75p	TDA2002	325p
CA3161E	150p	LM3900	50p	TDA2003	325p
CA3162E	450p	LM3909	120p	TDA2004	300p
CA3189E	300p	LM3911	160p	TDA2006	350p
CA3240E	120	LM3914	350p	TDA2020	320p
CA3280G	225	LM3915	350p	TD20300	250p
D7002	450p	LM3916	350p	TDA7000	350p
DAC1408-8	200p	LM13600	110p	TL061CP	50p
DAC0808	200p	M51513L	230p	TL062	75p
DG308	300p	M51516L	500p	TL064	110p
HA1366	190p	MB3712	200p	TL071	45p
HA1388	260p	MB3730	400p	TL072	60p
ICL7106	700p	MC1310P	150p	TL074	110p
ICL7511	96p	MC1413	130p	TL081	45p
ICL7650	400p	MC1458	40p	TL082	55p
ICL7660	250p	MC1493	100p	TL083	75p
ICL8038	300p	MC1495L	350p	TL084	100p
ICM7216B	£24	MC1496	70p	TL094	200p
ICM7217	900p	MC3340P	200p	TL170	50p
ICM7555	100p	MC3401	50p	TL430C	120p
ICM7556	140p	MC3403	65p	UA2240	120p
LC7120	300p	MF10CN	360p	UAA170	200p
LC7130	325p	MK50240	900p	ULN2003A	130p
LC7137	350p	MK50398	790p	ULN2004A	130p
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LF351	60p	ML922	400p	ULN2802	250p
LF353	100p	MM57160	620p	ULN2803	250p
LF355	100p	MM6221A	300p	ULN2804	250p
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LM307	45p	NE565	150	XR2206	400p
LM308CN	75p	NE566	150p	XR2211	575p
LM310	120p	NE567	140p	XR2240	120p
LM311	70p	NE570	400p	ZN414	80p
LM318	150p	NE571	400p	ZN419C	190p
LM319	160p	NE592	75p	ZN423E	130p
LM319N	160p	NE5532P	200p	ZN424E	130p
LM324	30p	NE5533P	160p	ZN425E	350p
LM334Z	90p	NE5534P	120p	ZN426E	300p
LM335Z	140p	NE5534AP	200	ZN427E	600p
LM339	40p	OP-07EP	600p	ZN428E	450p
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8V	7808	60p	7908	65p
12V	7812	50p	7912	55p
15V	7815	50p	7915	55p
18V	7818	60p	7918	65p
24V	7824	60p	7924	65p
5V 100mA	78L05	30p	79L05	45p
6V 100mA	78L06	30p		
8V 100mA	78L08	30p		
12V 100mA	78L12	30p	79L12	50p
15V 100mA	78L15	30p	79L15	50p

OTHER REGULATORS

Fixed Rgulators		
LM309K	1A 5V	140p
LM323K	3A 5V	450p
78H05KC	5A 5V	600p
78H12	5A 12V	750p
78P05	10A 5V	900p
Variable Regulators		
LM305AH		250p
LM317T	TO-220	150p
LM317K	TO3	250p
LM337T		225p
LM350T	10A+VAR	400p
LM396K	10A+VAR	1500p
LM723N		50p
78HGKC	5A+VAR	700
78GUIC	1A+VAR	225p
79HGGKC	5A−VAR	775p
79GUIC	1A−VAR	250p
Switching Regulators		
ICL7660		250p
SG3524		300p
TL494		300p
TL497		300p
78S40		250p

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MCS2400	190p	TIL113	70p
MOC3020	150p	TIL116	70p
IL074	180p		
6N137	400p		

LEDS

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TIL209 Red	10p	MAN72	140p
TIL211 Gr	12p	MAN74	140p
TIL212 Yel	15p	MAN4640	200p
		MAN8910	250p
0.2"		NSB5881	570p
TIL220 Red	10p	TIL311	600p
TIL222 Gr	12p	TIL321/3	130p
TIL228 Yel	15p	TIL330	140p
Rectangular		TIL729	140p
LEDs(R,G,Y)	30p	TIL730	140p
		7750/60	200p
		TIL730	140p

DISPLAYS

DL704	140p
DL707Red	140p

DIL SWITCHES

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16 pin	45p
18 pin	50p
20 pin	66p
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24 pin	75p
28 pin	100p
40 pin	130p

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BY127	12p
BYX36300	20p
OA47	10p
OA90/91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/2	12p
1N5403/4	14p
1N5404/5	14p
1N5404/7	19p
IS920	9p

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1A 400V	25p
1A 600V	30p
2A 50V	30p
2A 100V	35p
2A 400V	45p
3A 200V	60p
3A 600V	72p
4A 100V	95p
4A 400V	100p
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6A 100V	100p
6A 400V	120p
10A 400V	200p
25A 400V	400p

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72168	£22
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40 pin	30p

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8039	550p
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8748	£36
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68705P3S	£26
6852	250p
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8228	250p
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8253C-5	£18
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8256	£36
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8259C-5	750p
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2114-4L	400p
2147	450p
4027-3	300p
4116-15	200p
4116-20	175p
4118-3	500p
4164-15	500p
4164-20	450p
4416-20	600p
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74S570	650p

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2532 30	700p
2564	700p
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DS8830	140p
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DS8832	150p
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DS8836	150p
DS8838	225p
DS8880	170p
LF13201	450p
MC1488	100p
MC1489	100p
MC3446	250p
MC3459	450p
MC3470	650p
MC3480	850p
MC3486	500p
MC3487	300p
MC4024	325p
MC4044	325p
MC14411	700p
MC14412	750p
ML922	400p
ULN2001	130p
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ULN2004A	130p
ULN2068	290p
ULN2802	250p
ULN2803	250p
ULN2804	200p
75107	120p
75108	120p
75109	120p
75110	160p
75112	160p
75113	120p
75114	160p
75115	160p
75121	140p
75122	140p
75150P	120p
75154	140p
75159	220p
75161	350p
75162	400p
7536	150p
75451	72p
75452	72p
75453	72p
75454	72p
75480	150p
75491	65p
75492	65p
8T26	120p
8T28	120p
8T95	90p
8T96	90p
8T97	90p
8T98	90p
81LS95	220p
81LS96	220p
81LS97	220p
81LS98	220p
88LS120	400p
9602	220p
9636A	160p
9637AP	160p
9638	160p
ZN425E8	350p
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2.4576(S)	275p
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2.662	250p
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3.5795	120p
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4.608	250p
4.9152	250p
5.000	175p
6.00	150p
6.144	175p
7.00	150p
7.168	175p
8.00	175p
8.867	175p
10.00	175p
10.50	250p
10.70	200p
11.00	300p
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BC327	16p	BU208	200p	TIP125	75p	2N3904	18p		
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BD189	60p	MPSA12	50p	ZTX752	70p	2N5875	250p		
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BD242	60p	MPSA56	30p	2N918	45p	2N6107	65p		
BD379	60p	MPSA70	50p	2N930	30p	2N6247	190p		
BD380	60p	MPSA93	40p	2N1131/2	50p	2N6254	130p		
BD677	45p	MPSU06	63p	2N1613	36p	2N6290	65p		
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BF256B	50p	MPSU45	90p	2N2102	70p	2SC1307	150p		
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VERSATILE EPROM EMULATOR

If imitation is the sincerest form of flattery, your EPROMs are going to have a lot to blush about. Design by Mike Bedford.

Microprocessor systems may be divided into two main categories. The first group, which will be familiar to all home computer enthusiasts, is usually referred to as a personal computer and is comparatively highly priced. Such systems contain a large amount of memory, mostly RAM and a wide variety of I/O connected to devices such as keyboards, VDUs etc, making them very versatile pieces of equipment which may be programmed to carry out an almost infinite variety of different tasks. The second group may be described as minimal microprocessor systems and are used for control applications. Even domestic appliances now include such systems as their cost compares favourably with that of dedicated digital electronics. Such a system is designed to do one specific task and for this reason has less memory than systems in the first group, most of this memory being ROM or EPROM, and the I/O is not designed to interface with normal computer peripherals.

This brings us to the question of how software is developed for such dedicated control systems. To put it simply, this may be carried out on the system itself or on a separate development system. If the control computer itself is to be used it will have to be given some facilities additional to those required to carry out its final task. This is obviously out of the question in the commercial world where the extra cost would be prohibitive. In the amateur world, however, this approach has generally been used, the board having a monitor EPROM and interface to a keypad and LED display.

If software could be developed on a separate computer the availability of editors, assemblers, compilers and hardware such as displays and mass storage devices would simplify the process very much. However, unless special hardware is available, the development cycle will then consist of:— modify software — program EPROM — test on target system — modify software etc. etc. The fact that this process involves programming EPROMs slows it down very much.

This article describes the construction of a piece of hardware which allows software to be developed on a separate computer without having to program EPROMs until the program is perfected. An EPROM emulator is basically a dual port memory card, ie, a RAM board which may be accessed from either computer. The method of operation is to produce software on the development system and download the object code to the emulator, after which the control computer may access the card as if it were its own memory. To ease interfacing to the target system the emulator is fitted with a length of ribbon cable and a DIL header which may be plugged directly into an EPROM socket.

System Philosophy

The most convenient way to add an EPROM emulator to a home computer is to interface it directly onto the bus so that it may be accessed as memory. However, this is also the most system dependent way of adding the hardware, which means that it will only be usable with one type of computer or, at best, only with computers using one family of processors.

This emulator has been designed so that it may be interfaced in quite a number of different ways and the user may pick the method which is most suited to his particular computer.

a) The board has been artworked to the Microtan standard so that users of this computer may plug it directly into the mother board and access it directly as system memory.

b) Since the TANBUS signals are fairly standard among 6502, 6800 and 6809 systems, owners of other computers using these processors may interface the emulator card onto the bus so long as they sort out the physical aspects of this (ie, making sure the edge connectors match).

c) For those users with computers utilising different processors (including the large number of Z80 systems) or those with a memory map, which is already full, the emulator may be interfaced via a parallel port. Although this is a very versatile method there are certain disadvantages: a small amount of downloading/uploading software is required on the computer, and 23 bits of parallel I/O are needed for the interface.

d) The most versatile method of all is also the most complicated, and for this reason will be dealt with in a separate article. This is to add some local intelligence in the form of a simple processor board with an RS232 interface to the emulator. The system would then be able to communicate with any computer having a standard RS232 serial interface using standard system routines on that computer. In fact, the universal EPROM programmer card described in the August and September '83 and January '84 issues of ETI may also be added to the system, giving a three card intelligent EPROM programmer/emulator which may be interfaced to virtually any computer and which would provide very comprehensive firmware development facilities.

The card described in this article is even more versatile than the foregoing paragraph would suggest. So far we have only considered the card as an EPROM emulator. The board is, of course, essentially an 8k RAM card and thus may be used as a memory extension without any reference to emulation. In these days of 16k and 48k computers an extra 8k may not seem a very big leap forward, but the basic Microtan has only 1k of RAM and even if the TANEX card is being used this board would double the amount of available RAM. In addition the emulator contains low power CMOS memory and battery back-up facilities, enabling data to be retained on power down. Even in a system with a full memory map it may be used as external non-volatile memory, accessing it via a PIA.

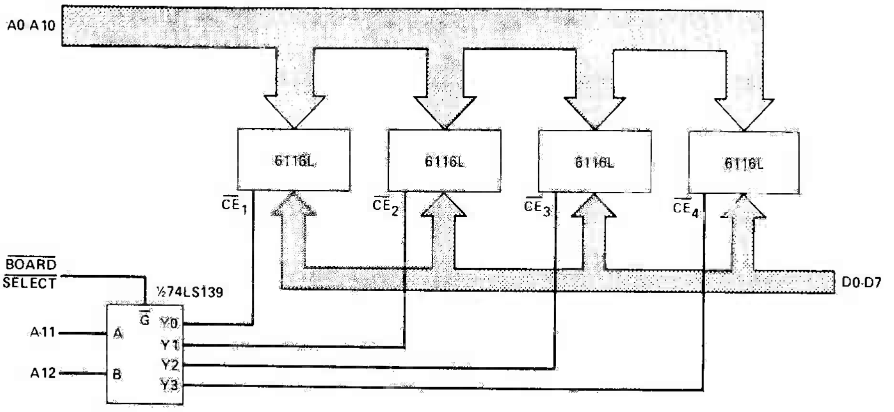


Fig. 1 The RAM interface arrangements, showing how A11 and A12 are used to select between memory chips by means of a 2-to-4 line decoder.

Design Process

This article not only describes the construction of a piece of equipment which readers may assemble for their home computers, it also describes the various options which have been used in the design and how the circuit as it now appears was arrived at.

Choice Of Ram: We have already noted that an EPROM emulator is essentially a random access memory (RAM) card. The most fundamental design consideration therefore is what type of RAM ICs to use. Since it was felt that the memory on the card whould be non-volatile, being backed up by a battery when the computer is switched off, the choice is limited to CMOS static RAMS, all other devices having too high a current consumption to be powered from a battery for very long.

The next question is the total size of the memory to be used and how this total should be made up in terms of individual chips. The choice is essentially between 2K byte devices and 8K byte devices. The 8K devices have only recently been introduced and as a result are still very expensive. For this reason alone, rather then any technical consideration, these memories were rejected in favour of 2K RAMs. So how many devices should be used on the emulator? Four can easily fit onto an 8" x 4½" card without making it double sided. At least 8 chips could be put on a double sided card, but it was thought that on grounds of economy the board should be made single sided if at all possible. Four ICs will in fact give 8K bytes of memory in total which means that all EPROMs up to and including the 2764 (or 3564) may be emulated. At the moment most amateur computer equipment uses 2716s, 2732s or occasionally 2764s, so this seems quite an adequate solution. If, at a later date, a need arises to emulate larger EPROMs, two such boards could be used together with a small amount of additional logic.

The final question, then, is exactly which 2K byte CMOS static RAMs to use. Not all CMOS static RAMs have a low enough standby current for battery backed-up applications, and the choice eventually narrowed to the 6116L or the 5516. The 5516 has a number of advantages over the 6116L, having a standby current of 1.0μA (depending on temperature) compared to 4.0μA typically for the 6116L, and two CE inputs, one specifically intended for a power-down signal, hence simplifying battery backed-up operation. Further, standby mode is only guaranteed on the 6116L if all the inputs are held to within 0.2V of 0V or VCC (except for CE which must be high) which means that 21 pull-up or pull-down resistors are required.

In spite of these considerations, the 6116L was eventually chosen on the grounds of its lower cost. Assuming a 100 mAh capacity battery is used, a data retention time of quite a few thousand hours will still be achieved. The circuit will be slightly more complicated but it was felt that a cost reduction in the region of £10 was of prime importance. It was also realised that, since 6116Ls have a standard JEDEC pin out, designing the circuit around these devices would mean that users not wanting battery back-up can choose a number of other, less expensive, 2K x 8 RAMs.

Intefacing The Ram: In order to address 8K bytes of memory, 13 address bits (A0-A12) are required (8196 (8K) = 2^{13}). Of these 13 bits it is evident that 11 will connect directly to the 6116L devices whilst the remaining two will be required to select which of the four RAM chips to address. This implies an arrangement like that shown in Fig. 1, where the ½ 74LS139 is a 2 to 4-line decoder, a device which inputs a 2 bit binary value and gives a logic zero at one of the outputs depending on the input value. The eight data bits obviously connect directly to all the RAM chips.

If this were a standard 8K memory card for an 8 bit microprocessor system, the board select signal would take a logic low value for one combination of the remaining address bits (A13-A15) hence locating the board in one of the 8, 8K blocks available within the 64K addressing space. This would ideally require a 3 to 8 line decoder, but since there is already a 74LS139 in the circuit only half of which is used, it seems more appropriate to use the other half and then use A15 or an inverted A15 to select it.

Since this is not a simple 8K RAM card but an EPROM emulator, there is an alternative board select condition, namely, when the EPROM socket is being read. To generate the final board select signal therefore, the two active low signals are ORed. This is shown in Fig. 2. It should be noted that, in the final version, the link arrangement associated with A15 has been slightly changed to avoid the possibility of 2 TTL loads being

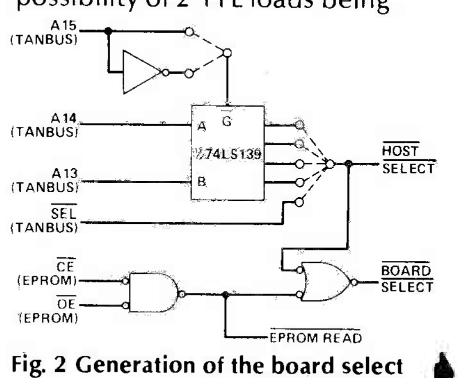


Fig. 2 Generation of the board select and host select signals.

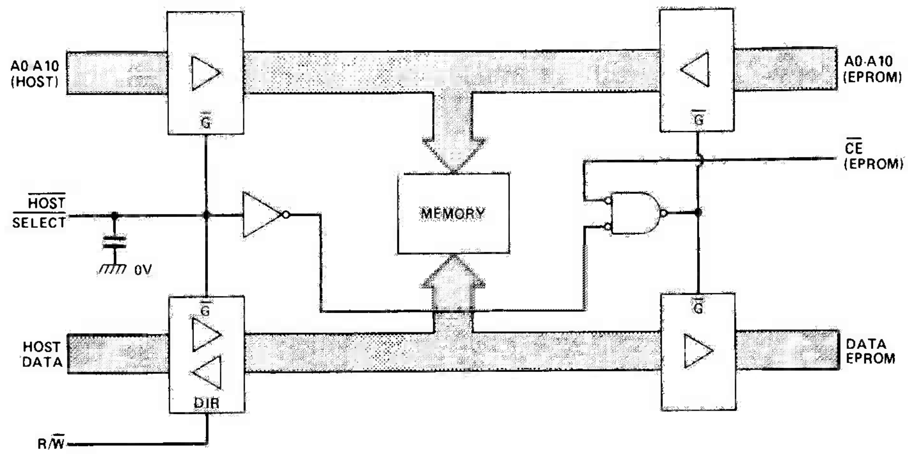


Fig. 3 The use of buffers to prevent the host and target systems being simultaneously connected to the RAM chips.

applied to this signal. Note also that an external board enable signal from the edge connector is link selectable. This was added to reduce by 2 the number of PIA lines required when interfacing the card in his way.

So far we have discussed how the 8 data bits and 11 of the address bits connect to the 6116Ls without considering whether these are the EPROM address and data busses or the corresponding host computer signals. Both sets of signals must be connected to the RAMs, but if this is done directly it would short the bus of the host computer to the bus of the target system, a condition which would prevent either system functioning.

The answer is to use buffers, only one of which may be enabled at any one time. It was decided that the buffers to the target system should normally be enabled but whenever the development computer required access to the memory it would take priority, enabling its buffers and disabling those to the target system. Address buses are always uni-directional, and as such a 74LS244 buffer may be used. Data buses can be either uni-directional or bi-directional depending on whether there is write access to the memory. The data bus to the host must be bi-directional so a 74LS245 is used, whereas the data bus to the EPROM socket only requires read access and a 74LS244 is sufficient.

During initial testing it was discovered that the target system port occasionally suffered from read errors. This was caused by false CE signals generated in the host during the first half of the processor cycle in which addresses are not valid. Since the duration of such signals is very short, the addition of a capacitor effectively overcomes this problem. Figure 3 illustrates this aspect of the circuit.

One final point on the interfacing of the RAMs to the address and data buses. You might expect A0 on the host and target systems to be connected to A0 on the RAMs, A1 to A1, etc. This is not the case in this circuit. From an electronic point of view there is no reason why it should not have been interfaced this way, and if it were not for the fact that the author also produced the PCB artwork this is the way the circuit would have been designed.

It was designed in the manner presented so as to simplify the artwork and keep the number of wire links down to a minimum. This might seem a strange decision to make but as far as the outside world is concerned, the address pin labelling on the RAM chips is quite arbitrary. It makes no difference what order they are connected in — each address bit combination still addresses a unique location within the IC. A similar argument may be applied to the data pins on the ICs. It should be noted that this method should not be used when interfacing EPROMs as these will have been programmed assuming the correct signal order and hence compatibility must be maintained.

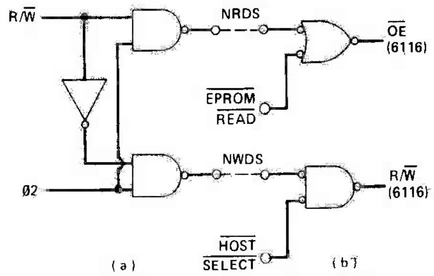


Fig. 4 a & b Generation of the OE and R/W signals.

RAM Control Signals: We have already dealt with A0-A10, D0-D7 and CE on the 6116Ls; this leaves the OE and R/W still to be connected. These signals are equivalent to the Intel NRDS and NWDS respectively and Fig. 4a shows the standard method of generating them from 6502 signals. Since the EPROM port of this card has no write access to the RAM, the generated NWDS does not require ORing with a similar signal associated with the EPROM port. However, when the RAM is enabled by a read from the EPROM port but a R/W is generated by a write to some other memory on the host system, the signal must be gated with HOST SELECT in order to prevent a false write. The OE, on the other hand, does require ORing with a corresponding signal on the target system.

The additional two gates required are shown in Fig. 4b which extends Fig. 4a. It should be noted that OE and R/W can both be active when a write to the card is being carried out from the host system and the target system is attempting a read. This is not a problem since the data sheet for the 6116L makes it clear that, under these circumstances, the write takes priority over the read. This is perfectly acceptable since the host is to have priority over the target port.

Supply And Power-Down Circuitry: To ensure that there is data retention when the main computer supply is switched off a battery supply is required. Since the 6116L only requires 2.0V in its standby mode,

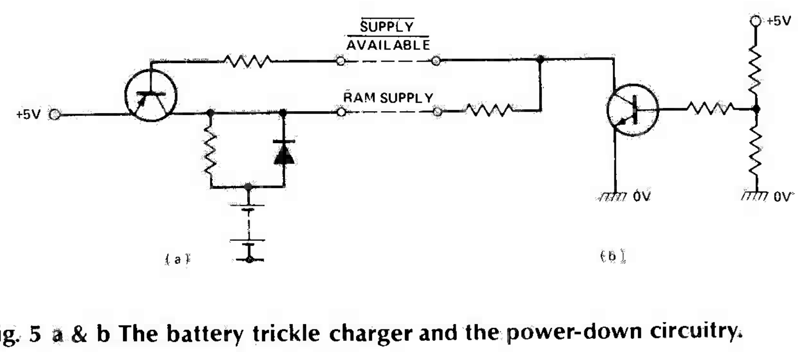
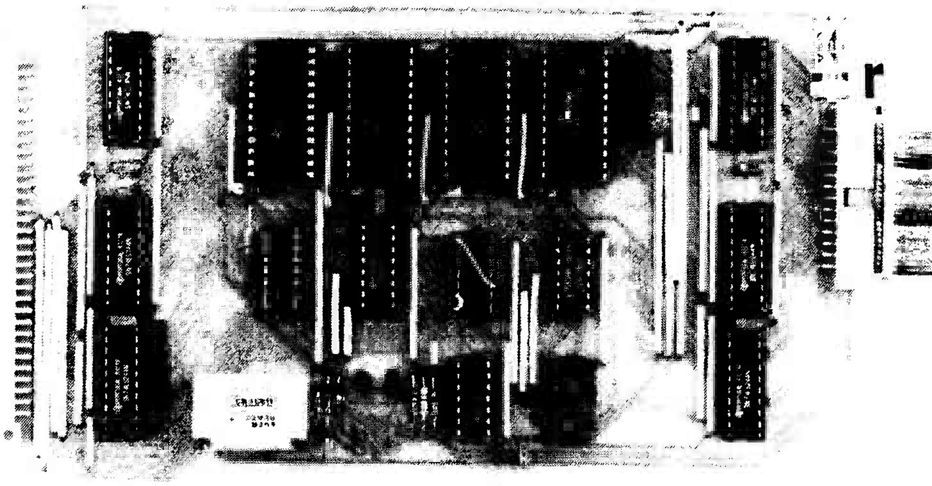


Fig. 5 a & b The battery trickle charger and the power-down circuitry.



the readily available PCB mounting 3.6V 100mAh battery is a perfect choice. Figure 5a shows a circuit in which the battery is trickle charged via the current limiting resistor when the main supply is present, supplies current to the RAMs via the diode when the main supply is not present, and is prevented from discharging through the power supply under these conditions by the transistor which will be turned off. The resistor value is selected to give a charging current of 1.0mA (the current stated for this battery in the data sheet). From Ohm's Law, this will be V/I where I is this charging current and V is the potential difference between the battery and the main supply (5V-3.6V) or in other words 1.5k ohms. Although there will be a potential drop of typically 0.7V across the diode, there will still be 3.6V-0.7V=2.9V available to the RAMs, which is within the specification for these devices.

It now remains to decide how to generate the power available signal. For the purpuses of supply isolation the requirements are not too stringent — all that is required is for it to go sufficiently high to turn on the transistor when the supply voltage is higher than the battery voltage. There is another use for this signal however, to write protect the memory on power down. Since the major part of any computer system is made up of TTL devices and these are only guaranteed to function correctly at supply voltages of 4.5V and above, it is quite feasible that random signals on the bus will cause un-intentional writes to takes place on power-down, hence corrupting the data in the RAM.

Considerable time was spent to find some way of accurately detecting a voltage level of about 4.75V to generate the supply available signal, but any such method would involve the constructor in some quite precise setting up which would obviously be undesirable. The method eventually used does not require any setting up, and although it does not succeed in accurately detecting 4.75V experiment shows that it works. The level detector is simply a potential divider and transistor so arranged that, when the supply voltage is greater than about 4.2V, a potential of greater than 0.7V is present at the transistor base which turns it on and hence gives a logic low signal. This arrangement is shown in Fig. 5b. If an attempt is made to detect something much closer to 4.75V, the resistor tolerances might cause the transistor not to turn fully on at 5.0V.

The need for write protection of the RAMs has already been mentioned. This is done by gating the four chip enable ($\overline{CE}$) signals in Fig. 1 with the supply available signal in such a way that they can't go low when the power isn't present. Obviously, the gates used need to be active even when the main supply is not present, so they must consume little power and work on a low supply voltage. This demands a CMOS device. Figure 6 shows this gating arrangement which is used to modify the circuit given in Fig. 2.

If the circuit portions illustrated in Figs 1-6 are connected together the result will be the complete circuit diagram shown in Fig 7. There will be a few changes from the circuits already given due to the following:—

1) A few extra gates have been added as buffers to ensure that no more than 1 TTL load is presented to any bussed signal.
2) To minimise the number of IC packages required, two gates have sometimes been used to replace a single gate of a different type. For example, an AND gate followed by an inverter has been used as a NAND gate in two places.
3) Gates have sometimes been drawn in negative logic notation to clarify their function. In the final circuit diagram, however, these have been translated to their more conventional forms.
4) The 6116L RAMs are only in their low power standby mode when all their inputs are within 0.2V of either 0V or VCC. The resistors in the SIL packages, ie RP1, RP2 and RP3, have been added to ensure this.
5) In accordance with normal digital practice, a number of decoupling and reservoir capacitors have been connected across the supplies.
6) Since a number of less expensive but higher power RAMs are pin compatible with the 6116L devices, and since not all users would require all four RAMs to be non-volatile, links have been added to allow the user to select either the main supply or the battery supply to each of the RAMs.

Next month: Construction and use

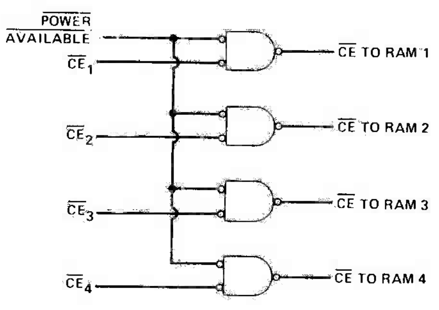


Fig. 6 A modification to the circuit shown in Fig. 2 which provides write protection for the RAMs on power-down.

HOW IT WORKS

Since a lengthy description of the design process has already been given, this section really serves only to give an overall picture of the circuit, outlining which components are associated with each particular task.

The memory is made up of four 2K x 8 RAMs, these being IC8, IC9, IC10 and IC11. The RAMs are connected to internal data and address busses which are isolated from the host and target system busses by various tri-state buffers. IC5 buffers the host data bus, IC12 ad IC14 the host address bvus, IC6 the target data bus and IC13 and IC15 the target address bus. The circuitry comprising IC1c and IC2d controls the buffer enabling and ensures that both sets cannot be enabled at the same time and that the host takes priority. IC3 and most of the remainder of IC1 and IC2 are associated with generating the RAM CE, OE and R/W signals by a combination of control signals from both ports. The RAM CE is split into four separate signals for the four RAMs by IC5b, and IC7 ensures that these signals can't be active under power-down conditions. This circuitry requires a signal indicating that the appropriate portion of the host memory map has been addressed, and this signal is generated by IC5a, IC1d, LK1 and LK2. The remainder of the circuit is associated with the battery supply and power-down circuitry.

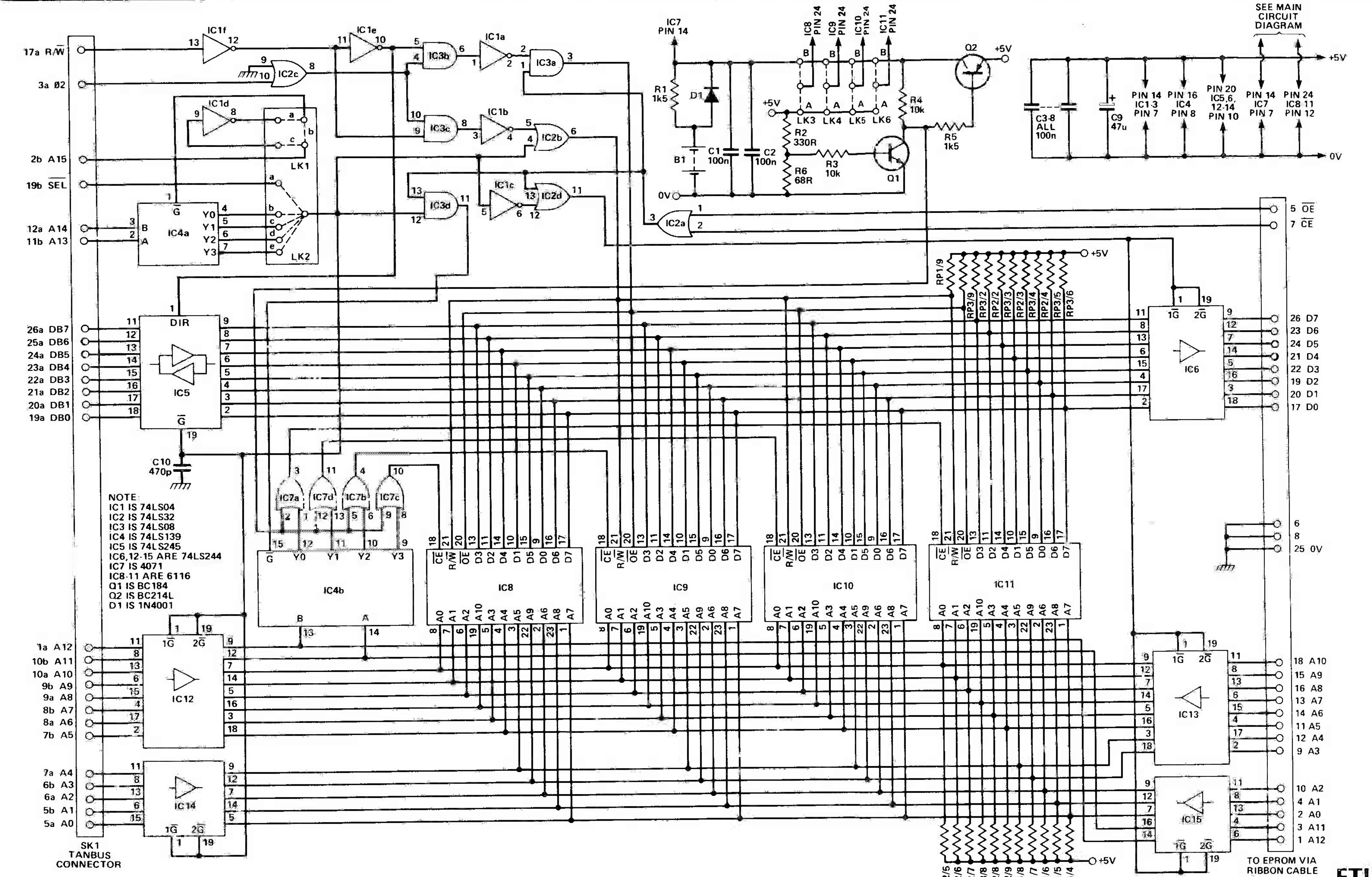


Fig. 7 The circuit diagram of the EPROM Emulator.

COMMUNICATIONS SATELLITES (PART 1)

Just by picking up the 'phone and dialling a number, you could put yourself in the space age. In this short series of articles, Roger Bond will be looking at the real world of satellite communications.

Any space enthusiast will tell you about Telstar and any school boy will tell you of the killer breed of satellites pranging each other on the big screen. In between these two extremes is the reality of modern satellite communications.

In 1962, Telstar was the first, in circular orbit around the earth and at a height of about 250 miles. So it was visible for only about half an hour from any given earth station, and Goonhilly's first aerial weighing 1100 tons had to be quite a smooth operator in order to track this fast-moving busybody.

In June 1965 Early Bird (INTELSAT 1) went into geostationary orbit over the Atlantic. INTELSAT stands for INternational TELecommunications SATellite and a geostationary orbit is an orbit stationary with respect to a point on the earth, ie. the satellite is moving with the earth's rotation and so staying in the same position with respect to the earth's surface.

Two other satellites took up station over the Pacific and Indian Oceans in 1967 and 1969 respectively and earthlings were fully covered by eyes in the sky. These three satellites formed the INTELSAT I network working to Andover (USA), Raisting (Germany), Goonhilly (UK) and Pleumeur Bodou (France). These satellites provided 240 circuits but could work to only one ground station at a time. INTELSAT II removed this limitation. The signal strength from these satellites was so low that receiving equipment had to be cooled in liquid helium (4.2 K, −268.8°C) to suppress background noise. Receiving signals from these satellites was like trying to pick up heat from a one killowatt electric heater stationed as far away as the moon.

In 1968 Aerial 1 at Goonhilly was joined by a second and in 1972 by a third aerial. Aerials are located in the south of England because the further south the antenna is, the less ground-generated interference it will 'see'; the further north the aerial, the closer to the horizon the satellite gets, until it vanishes from sight!

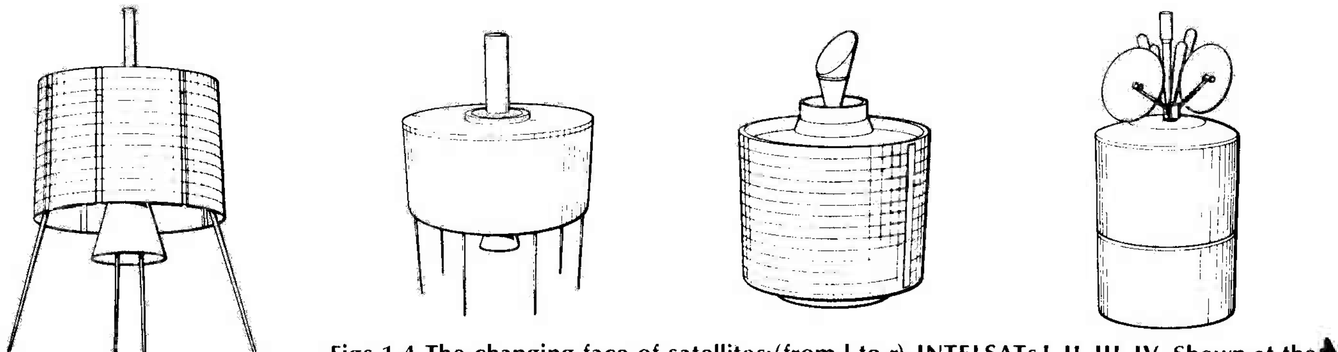
INTELSAT III was launched in 1968 and could provide 1500 circuits or 4 television channels or a combination of the two. Compare this with INTELSAT II which had to suppress its 240 circuits in order to transmit television. The design life was also increased from three years to five years. Today's satellites are designed for a life of seven years and an estimate of seven out of eight successful launches. A commercial satellite cost about £10 million to build and about £13 million to launch in 1977 so the insurance premiums are quite high. By comparison, aerial three at Goonhilly cost £2 million. Today a satellite costs about £50 million to build and launch.

In 1977 INTELSAT IV was launched with a life of seven years but in this short space of time the demand had increased so much and technology had advanced so rapidly that the IVA was launched in 1978 followed by today's INTELSAT V in 1980. The main difference between the IV and IVA apart from an increase of circuit capacity (4000 to 6000), was assignment by demand, SPADE, on the IVA — but more about that later.

Modern Satellites

To understand the trend and thinking towards modern satellite communications we need to start with INTELSAT IV. Figures 1 to 4 show the profiles of INTELSATS I to IV. Intelsat IV like all modern satellites is positioned 36,000 km above the earth and produces a 0.5 sec delay in a two way conversation. That is the time it takes for radio waves travelling at the speed of light to 'bounce' off the satellite. These signals are transmitted upwards at a frequency of 6 GHz and down at 4 GHz, so inside the satellite is a transponder which is a receiver, a frequency changer and a transmitter.

In fact there are twelve transponders each with a



Figs 1-4 The changing face of satellites: (from l to r) INTELSATs I, II, III, IV. Shown at the top of the page is Telstar (photo by courtesy British Telecom).

bandwidth of 36 MHz and a guard band of 4 MHz between transponders. Therefore the total satellite bandwidth is about 500 MHz. There are two types of aerials:—
a) The global beam, which is a horn type and radiates a beam of 17° width;
b) The spot beam, which is a parabaloid dish radiates a much narrower beam, only 4.5° in width, which covers a smaller area on the earth. The effective power is 35 dBw (that is, to the receiver on earth, the signal is 35 dB up on what would be radiated by a dipole aerial radiating 1 watt of RF power); by comparison, the effective power of the global beam is 23 dBw.

The spot beams, with their focussing, are used for high-density traffic, from one point and another, eg USA to UK. The global beams, being unfocussed, carry signals of interest to many countries; so one small user-country can communicate with another by extracting at the earth station the carrier that is of particular interest to it and rejecting all the other carriers; this facility is used mainly for television.

Compared to INTELSAT III, INTELSAT IV has a smaller bandwidth for the same channel capacity and this is achieved by reducing the frequency deviation of the FM (Frequency Modulated) carriers. The guard band is 10% to 20% of the occupied bandwidth for IV compared to 60% to 90% for III. The FM carriers can cope with 24 channels up to 960 channels depending on the carrier chosen. These channels are 4 kHz audio channels which may be used to carry data or speech.

INTELSAT IV Earth Segment

Engineers use the jargon 'space segment' for the earth station. Usually restrictions on the launch rocket payload limit the size of aerials that the satellite can carry and the power available to feed those aerials. Hence the burden of picking up weak signals from satellites and radiating strong signals back becomes the responsibility of the earth segment

To keep the earth station costs down, the number of different sizes of carrier frequency is restricted to nine. The carrier to noise ratio is about 10 dB so expensive threshold demodulators, also used in INTELSAT III, are still needed.

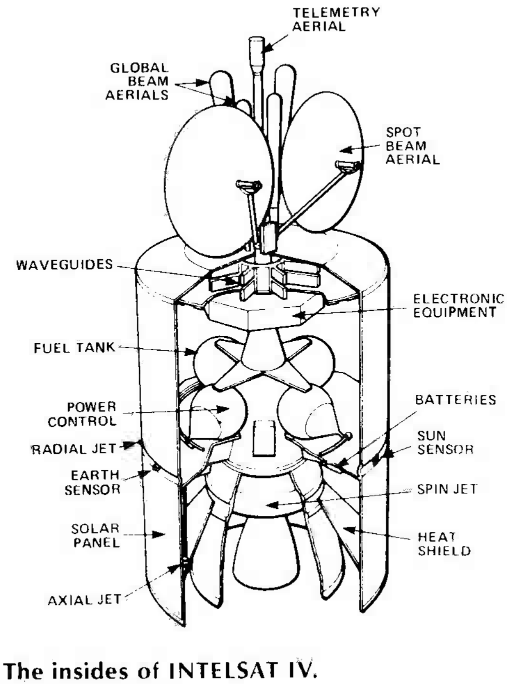


Fig. 5 The insides of INTELSAT IV.

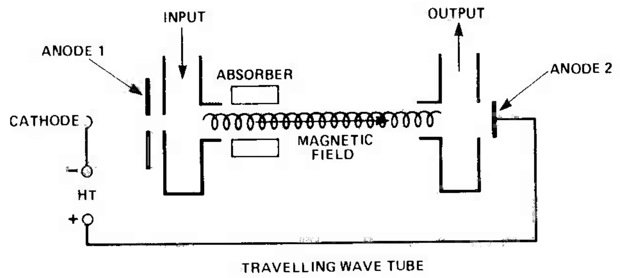


Fig. 6 A travelling wave tube.

One kind of threshold demodulator is the frequency modulated feedback type, in which a fraction of the output signal from the demodulator is fed back to a voltage controlled oscillator which is controlled by a phase comparator. This helps to reduce the deviation of the centre frequency to zero, and the accurate centring of the signal gives an improvement of the carrier-to-noise ratio.

We shall look at the transmit and receive directions of the earth segment separately but they do have certain aspects in common. For instance, they both use travelling wave amplifiers.

One kind of travelling wave tube (TWT) is the helix type (Fig. 6), in which a spiral coil of wire is used to propagate the signal. The pitch of the spiral turns determines the speed of signal propagation. A magnetic field parallel to the axis of the tube prevents spreading of the electron beam. Reflection at the output could cause oscillations and an absorber is used to prevent this.

The other thing that they have in common is that they both use an IF of 70MHz, although transmit and receive frequencies are different, these being 6GHz and 4GHz respectively.

Transmit Direction

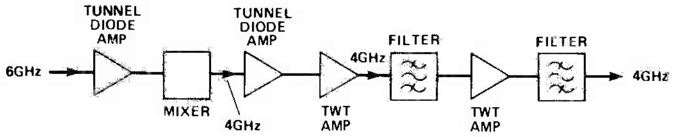
The intermediate frequency is 70 MHz which is converted to 6 GHz. There are two stages of power amplification using travelling wave tubes. The first TWT gives 39 dB gain over its 500 MHz bandwidth and the second TWT gives about 30dB gain. For a single carrier the power of the transponder can be concentrated; for several carriers the power must be distributed. If multiple carriers are used with, say, an output of 1kW each, the minimum gain will be 30dB and, because of the manner in which TWTs operate, this will be at the top of the spectrum. The maximum permissible variation is 10dB over the 500MHz satellite band.

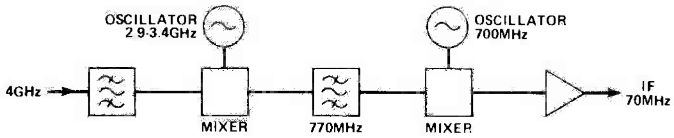
Supergroups, which are blocks of twelve channels each 4 kHz wide, are reassembled at the earth station depending on their destinations. The supergroups occupy the bandwidth 60 kHz to 108 kHz. Groups on landlines occupy the bandwidth 60-108kHz=48kHz and it is possible to fit another group in the spectrum space below 60kHz, starting at 12kHz ie 60-12=48kHz.

A 60kHz pilot is inserted at the earth station and failure of this pilot will cause changeover to standby equipment at the earth station. The sub-baseband 4 to 12 kHz is used in 4 kHz lots for engineering services. Each 4 kHz has a speech channel in the range 300-2600 Hz and the rest of the 4 kHz slot is used by five telegraph channels.

The portion below 4 kHz is used for energy disposal. A symmetrical triangular waveform is applied to the modulator during light traffic periods to spread the energy across the spectrum and prevent peaks of high energy.

Low capacity equipment will have less standby than





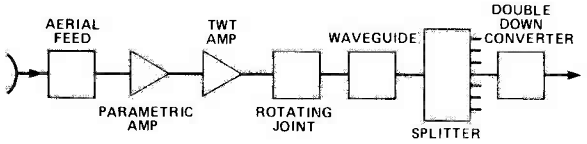


Fig. 7 (top) Signal path through a satellite.

Fig 8. (middle) A double down converter.

Fig. 9 (bottom) Full receive path of an earth station.

high capacity equipment. For instance, for 24-channel telephony, there is one lot of standby equipment for every five in use. For high capacity carriers, say 900 channels between the UK and USA, the RF equipment that is usually duplicated is demodulators, baseband equipment ie equipment which assembles groups of channels, and double down converters which are explained in the next section.

Receive Path

Figure 8 shows the receive path of earth station equipment illustrating double down conversion. The first IF is at 770 MHz and the second at 70 MHz. But before it gets to this stage it passes through three stages of parametric amplifiers, cooled to a temperature of 16 K. These amplify a weak signal of typically −120 dBW by 30 dB. The signal then passes through a travelling wave amplifier which supplies another 40 dB amplification over the whole 500 MHz bandwidth. We can now develop the picture in Fig. 8 to that in Fig. 9.

There is a choice of power amplifiers. Travelling wave tubes are more flexible but the multi-cavity klystron is more efficient. The TWT needs to work about 10 dB below full power to avoid intermodulation distortion. On the other hand the klystron needs time for tuning up and there can be long breaks if a frequency change is required.

Threshold extension demodulators lower the threshold of the impulsive noise. This threshold is the point at which the signal-to-noise ratio becomes unacceptable and too much information is lost. The semiconductors used have specially doped junctions with reach-through effects which enables low power signals to be recovered.

With the present state of art of transistor technology, a total noise figure of 10,000pW has been chosen as a design limit for a satellite link. Any signal greater than this can be detected, any signal below this figure is lost. All the time designers are developing new methods of reducing noise in equipment enabling the detection of weaker signals.

Most of the noise comes from the aerial itself and the first stage of amplification and if we take G as the gain of the aerial and T as the temperature in degrees absolute then G/T gives a rough rule of thumb relating aerial gain to temperature in order to detect a signal in the presence of noise. We can see that increasing the value of G gives an improved figure hence the large diameter aerials at earth stations. We can also improve this figure of merit by reducing T which is why the equipment is cooled reducing thermal agitation and hence reducing the noise contribution from thermal noise.

Earlier we mentioned the need to limit the number of different carriers to nine. However by 1975 these had increased to twenty and the early frequency splitters used circulators but now stripline couplers giving two outlets each are available. A circulator is a waveguide with a ferrite rod at the axis of the waveguide and if an external magnetic field is applied to rotate the wave then a wave perpendicular to port one will exit at port three, a wave perpendicular to port 2 will exit at port 4 and so on.

A stripline is a metal conductor embedded in dielectric. It's all part of the move away from the bulkiness of waveguide 'plumbing' and towards the compactness of semiconductor-like devices and integrated circuits if possible. Because of the large power outputs already available, the manufacturers of microwave devices have been slow to take advantage of developments in integrated circuits.

SPADE

Time is big money on a satellite link so what better way to use it than to assign speech slots only when demanded? This of course makes it expensive for the earth station which needs to have computer controlled equipment. SPADE stands for Single channel per carrier, Pulse code modulation, multiple Access, Demand assignment Equipment.

The 12 transponders of Intelsat IV each had a bandwidth of 36MHz and carriers (when modulated) with bandwidths of 2.5MHz, 5MHz, 7.5MHz, 10MHz, 15MHz, 20MHz, 25MHz and 35MHz. These could carry speech channels from 24 up to 960. For instance, if a carrier with a 35MHz bandwidth is chosen, the transponder's 36MHz is taken up. Alternately for fewer channels a combination of the smaller bandwidths can be chosen. This can be wasteful if a country wants say 35 channels. The carrier giving 2.5MHz bandwidth and carrying 24 channels is not sufficient so a carrier with a 5MHz bandwidth with a 60 channel capacity is allocated. But with only 35 channels used, the rest is wasted. In any case these channels are active for only a few hours each day because of for instance time differences between the two countries involved.

In addition, only one half of a circuit is working at any given time since usually one party speaks while the other listens. Taking all this into account there is only 40% activity during a conversation and a channel unit on the SPADE system transmits a carrier only when speech is present (ie, the power is turned off when not needed). This must not be confused with TASI (time assigned speed interpolation) which is used mainly on submarine cables (in TASI, the channel is re-allocated to another talker when the user ceases speaking). A transponder can support the power requirement of 400 channels but with 40% activity this can be doubled to 800 channels since the channel unit conserves satellite power. SPADE was used to a more limited extent on Intelsat IV, but fully implemented on Intelsat IV A, whose profile is shown in Fig. 10 and in 1974 twenty earth stations started SPADE operations.

One 36MHz transponder is divided into 800 channels each 45KHz wide, ie. a 4KHz audio channel when frequency modulated, occupies 45KHz. Eight hundred channels equals 400 circuits since two channels are required for two-way conversation.

The king-pin of SPADE is the demand assignment

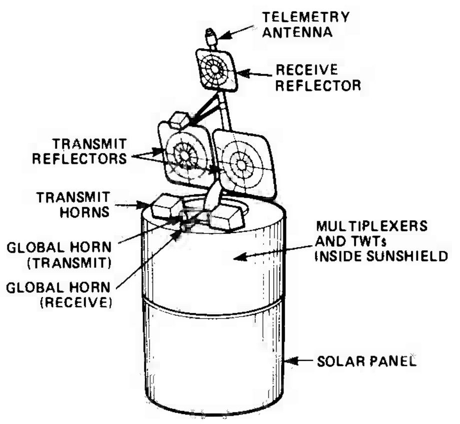


Fig. 10 INTELSAT IVA.

signalling and switching unit (DASS) which controls the setting up of calls with up to 49 terminals at other earth stations. Communication between earth stations is over common signalling channels (CSC). These are shared by all stations on a time basis as follows.

As signalling information is extracted at the terrestrial interface unit (TIU) Fig. 11, converted to digital form and transmitted over the 128kbit/s CSC link. One earth station must act as control and transmit a reference burst with its own data burst and the burst of all other stations synchronised to this on a TDMA (time division multiplex assignment) basis ie. in a given time frame, every station transmits a little information in its given time window. In the receive path, the TIU converts digital signalling back to analogue since the terrestrial networks use analogue signalling mainly.

When a request is made for a call, the DASS unit selects a pair of frequencies from its bank and informs the distant station via the CSC of the chosen frequencies. Then all DASS units immediately update their channel records.

When the call is finished the DASS unit releases the circuit and returns the carriers to its bank. DASS units can be programmed to record the duration of calls for charging purposes and any failures for engineering purposes. It is quite remarkable, the amount of work that computers could handle as long ago as ten years!

The 4kHz analogue channels are converted to digital form and transmitted at 64 Kbit/s. This can easily handle data at 1200 bit/s, 2400 bit/s and 4800 bit/s which are the normal data rates over a 4kHz audio channel when used for data transmission.

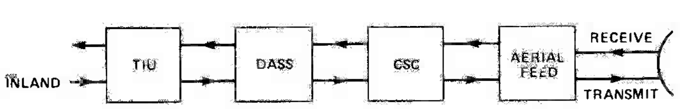


Fig. 11 A SPADE terminal.

Calling All Shipping

Around 1974, when SPADE stated operations, the need was felt for a satellite service to ships, mainly because the MF and HF radio service was starting to get congested. Moveover, radio is subject to fading for hours, even days.

Transmission started in the L band at 1.5 GHz from satellite to ship and at 1.6GHz from ship to satellite. A bandwidth of 7.5MHz was allocated and in the Atlantic region 80 channels would be required by 1990. At 50 kHz bandwidth per channel, 4MHz out of the allocated 7.5MHz would be used and 7000 ships were expected to use this service.

In 1978 the USA launched MARISAT (MARItime SATellite) and Europe MAROTS (MARitime Orbial Test Satellite). MARISAT operated at 6/4GHz (C band) between satellite and coast station and MAROTS at 14/11GHz. These were experimental satellites. MARISAT changed to INMARSAT in 1982 and this stands for INternational MARitime SATellites. MAROTS is now MARECS, MARitime European Communications Satellite. All very confusing!

Initially satellites will be power limited rather than bandwidth limited but future satellites will have high speed data at 9.6Kbit/s for facsimile (transmission of still pictures like weather maps, newspapers etc), ship operating information, navigation, rescue and fleet messages.

Operation is by means of SCPC (Single Channel Per Carrier) simlar to SPADE. Two methods of modulation are available, narrowband FM or phase-shift keying. The former gives a better carrier-to-noise-ratio.

So messages are passed in two stages, from coast station to satellite and then from satellite to ship at a different frequency. Because of the call-charging limitations of countries, shore to ship calls are semi-automatic but fully automatic for ship to shore.

We've seen earlier how it was the responsibility of the earth segment to provide signals of sufficient strength for transmission as well as detect weak signals in the receive path. However a ship's aerial is limited by space so it is up to the satellite to provide sufficient power. A gain/noise temperature (G/T) of 4dB/K at the ship's aerial is typical.

The other thing that is typical of a ship is a roll of up to 30° and pitching up to 10° so the aerial must be stabilised with a gyroscope to provide an aerial pointing of ±1°.

To find the satellite, step tracking is used. The aerial is moved slightly, then the voltage fed back from the demodulator is used to decide whether the received signal from the satellite has increased or decreased. If the signal has decreased, the aerial is turned in the opposite direction but if the signal has increased, the aerial is turned another small step in the same direction. The aerial locates the satellite accurately by acting in azimuth and elevation in turn.

The UK is the third largest shareholder in INMARSAT and there is a pair of satellites over each of the Atlantic, Pacific and Indian Oceans. One satellite of each pair is in service and the other is a spare. Actually, "Satellite" is not quite accurate, INMARSAT does not have its own satellites but leases transponders off Intelsat.

Because of power limitations, only 40 of the 286 carriers can be transmitted simultaneously. In future INMARSAT may launch its own satellites capable of transmitting 125 carriers simultaneously and the possibility of aeronautical communication is being explored.

Aerial 5 at Goonhilly serves the maritime community with a 14m diametre aerial and 3KW transmitter. It transmits in the C band, (6/4 GHz) to a satellite in the Atlantic Ocean Region.

Since there is more than one coast earth station (CES) in each ocean region there is a need for a network co-ordination centre for each region. These are at Southbury (USA) for the Atlantic Region, Iberaki (Japan) for the Pacific Ocean and Yamaguchi (Japan) for the Indian Ocean. INMARSAT headquarters are in London.

Continued next month.

ETI

THE WARLOCK BURGLAR ALARM

"Save a joule — Lose a jewel — What a fool; Spend a joule — Save a jewel — That's cool!" Phil Walker, of whose poetry, John Betjeman is reputed to have said "It's enough to make a banana blush", can at least design a good burglar alarm.

This project has been designed to give considerable flexibility while keeping the cost down. It can be used with either two-wire or four-wire systems and will give anti-tamper protection to the wiring if required. The unit also provides suitable connections for use with a self-protecting audible alarm which we hope to publish soon.

The unit as described caters for up to four pairs of alarm loop circuits containing normally closed switches or can simultaneously deal with normally open switches if necessary. Each pair of alarm loops consists of one loop at ground potential and one loop at about +12V. Breaking either loop or shorting one to the other will trigger the alarm. One pair of loops is designed to be used as the anti-tamper circuit and can be left operative while the rest of the system is disabled. Another loop pair is fitted with a circuit which allows restricted exit and entry and a time delay (from 8 to 90 secs) so that an authorised person can leave and re-enter the premises without setting off the main alarm.

It should be possible to use this project with most types of active and passive alarm sensors although some of the active ones will need external power.

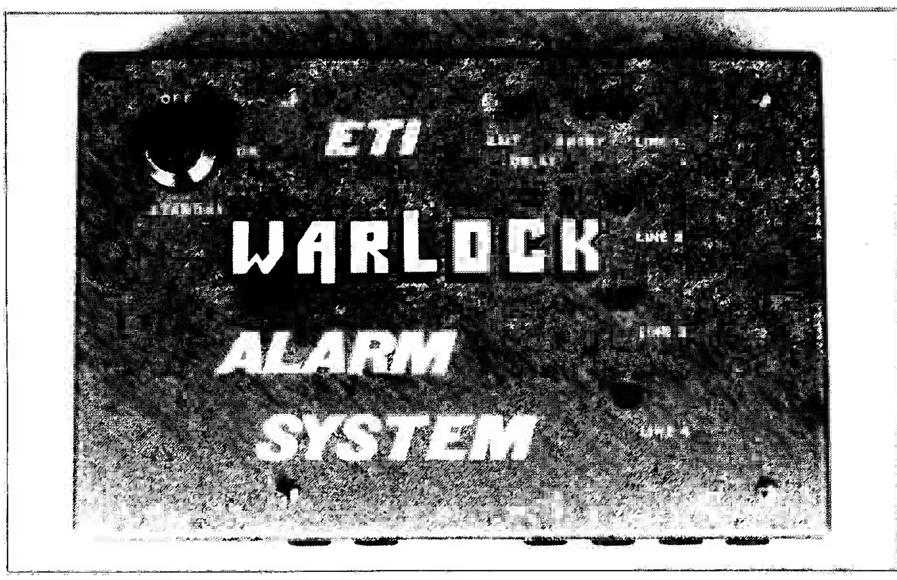
The Circuit

This project is designed to monitor up to eight alarm loop circuits. These loops are connected in pairs with one circuit at ground potential and the other at supply potential. Two pairs are simple loop sensors which respond immediately if either loop is disconnected or one is shorted to the other. The third pair is connected to the exit/entry delay system and allows a timed exit period and timed entry period before setting off the alarm. The last pair are very similar to the simple loop sensors with the exception that they can remain active when the rest of the circuit is inhibited.

The loop sensing circuitry for all the loop pairs is identical and very simple in operation. The same current flows through both loops of a pair and is determined by a single resistor. If either loop is broken then the current will divert into one of the input transistors which will then cause an alarm condition to be flagged. Shorting the two loops together causes a similar condition at the output as it robs the sensor circuit of its power supply.

The alarm latch and condition indicating circuitry is also virtually identical for each loop pair. It has been designed so that while the pair is inhibited by its own switch the LED is off. When a loop pair is enabled but the alarm module is disabled by the key the LED will be on and steady while the loops are in a safe condition and will flash if the loops are in an unsafe condition. At this stage no alarm will be sounded and the cause should be rectified before enabling the alarm. Once the unit has been enabled if an alarm signal arrives at one of the three non-delay loop pairs the latch will be set and an alarm condition will be sent to the output circuit to activate the audible warning device(s). Also the LED for that pair will flash. Note that the state of the loops will have no further effect on the alarm latch.

The operation of the delay loop pair is a little different. The alarm condition from the loop sensor circuit sets a latch which in turn starts a counter which counts 8192 pul-



HOW IT WORKS

This project can be considered in five parts. These are:—

a) the input loop sensors
b) entry and exit delay circuit
c) alarm latch and condition indicators
d) alarm trigger, local sounder and remote relay switch
e) power supply

The first section consists of four identical circuits each of which provides two loops. One loop operates at 0V potential while the other operates at close to the supply rail. The current flowing through each loop is determined by R1 in the first circuit and similarly in the others. If both loops are complete, this current will flow through the external via D1 and D2 and both Q1 and Q2 will be in the off state. Thus the collector of Q2 will be in the high state.

If the upper loop is broken, the current through R1 will now flow through D9 and the base of Q1. Q1 will now conduct and allow current to flow down R5 into the base of Q2. This transistor will now conduct and pull its collector low to signal an alarm condition.

If, on the other hand, the lower loop is broken, the current through R1 will now flow via D10 into the base of Q2 and thus turn it on giving the same alarm condition.

Finally, if the two loops are shorted together by some agency the supply voltage will be dropped across R13 while the collector of Q2 will again go low to signal an alarm.

This should provide a good measure of protection against most tampering with the wiring.

The second section of the project is the entry and exit delay. This is fairy complex as it performs several functions. The input from the line sensor circuit first enters IC1a where it is gated with the reset signal from IC2a and a time-out signal from IC3.

If the reset signal is active (output of IC2a high) then no further action occurs. Also the outputs of IC1a and c are forced low causing IC1b output to go high. This causes IC3 to be reset. The high output from IC2a also resets and holds IC4a and b.

If, however, the reset signal is inactive, the alarm input going low causes the output of IC1a to go high. This forces the latch formed by IC1b and c to change state with IC1b output going low. This removes the high on the reset line to IC3 which will start to count the pulses coming from the oscillator IC2b. IC3 is a 14-stage divider which increments with each input pulse. The output from the 6th stage controls the audio frequency oscillator IC2c which generates a bleep sound from the piezo-electric sounder, X1. The output from the 14th stage clocks IC4a and b when it goes high and simultaneously resets IC3 via the sections of IC1. When IC4a is clocked its Q output goes high and its $\bar{Q}$ output will go low. If during the counting period of IC3 the alarm input has gone high gain, then the output of IC5a at the time of clocking IC4b will be low otherwise it will be high. The current state if IC5a is clocked into IC4b at the end of the counting period and if this is low no alarm is given. If it is high then the alarm is sounded.

After the first such sequence in which the alarm is not activated, if the alarm input signal goes active again, a similar sequence is followed with the exception that the output of IC5a is held high by the $\bar{Q}$ output of IC4a being low. At the end of the count period the alarm will be sounded whatever the state of the sensor signal.

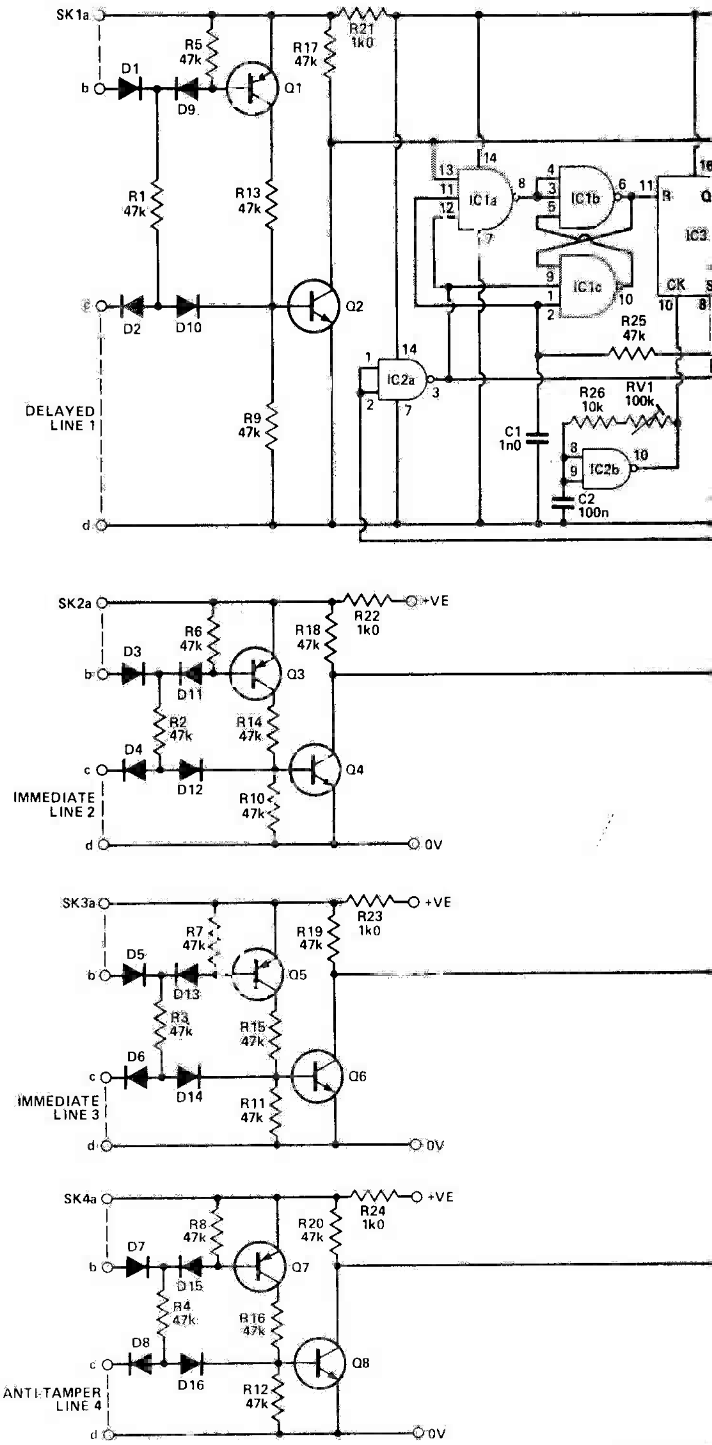
The circuitry around IC5b, c and d are present to cause either LED5 or LED6 to flash at the bleep rate to indicate that exit or entry time delay is active.

ALARM LATCH, ETC

The circuit around IC6 forms a status indicator for the alarm sensor signal. In the first timing period, the latch formed by IC6a and b is disabled by the low on IC4a Q output. If an alarm condition is detected by the loop sensor circuit then the output of IC6a will go high but will not latch. This will allow a low frequency flash signal from IC2d to drive IC6d and hence LED1. In the second timing period the latch will be enabled and if an alarm condition occurs, it will stay with the flash signal enabled.

The alarm signal from this part of the circuit is taken from the $\bar{Q}$ output of IC4b and goes low to signal an alarm condition. The circuit around SW1 and D17 allows the whole channel to be disabled if needed. This causes the LED1 to be turned off whereas a normal low on the reset line via R25 will cause the rest of the circuit to be reset and LED1 will be on if the alarm sensor is not active and flashing if it is.

The circuits for the other latch and condition indicators are virtually identical with the exception that the input to the NAND latch goes directly to the reset line via its resistor; in these channels the alarm signal is taken from the NAND latch as an immediate result is required. The reset circuit for channel 4 is slightly modified such that it can remain active when the other channels are turned off.



ALARM TRIGGER ETC

The outputs from all the latches are collected into a NAND gate IC10a so that any one which goes low will cause the output to go high. This is then gated with the reset signal such that both must be high before the alarm is sounded. The output of this gate, IC10b, is normally high and keeps Q9 conducting. If it goes low, RLA1 is de-energised and the main alarm sounds. This mode of operation ensures that cutting off the power supply will sound the alarm.

Also, if either IC10b output goes low or channel 4 (IC9b) alarm output goes low, Q10 is switched on and the buzzer X2 sounds. This is to allow tamper-

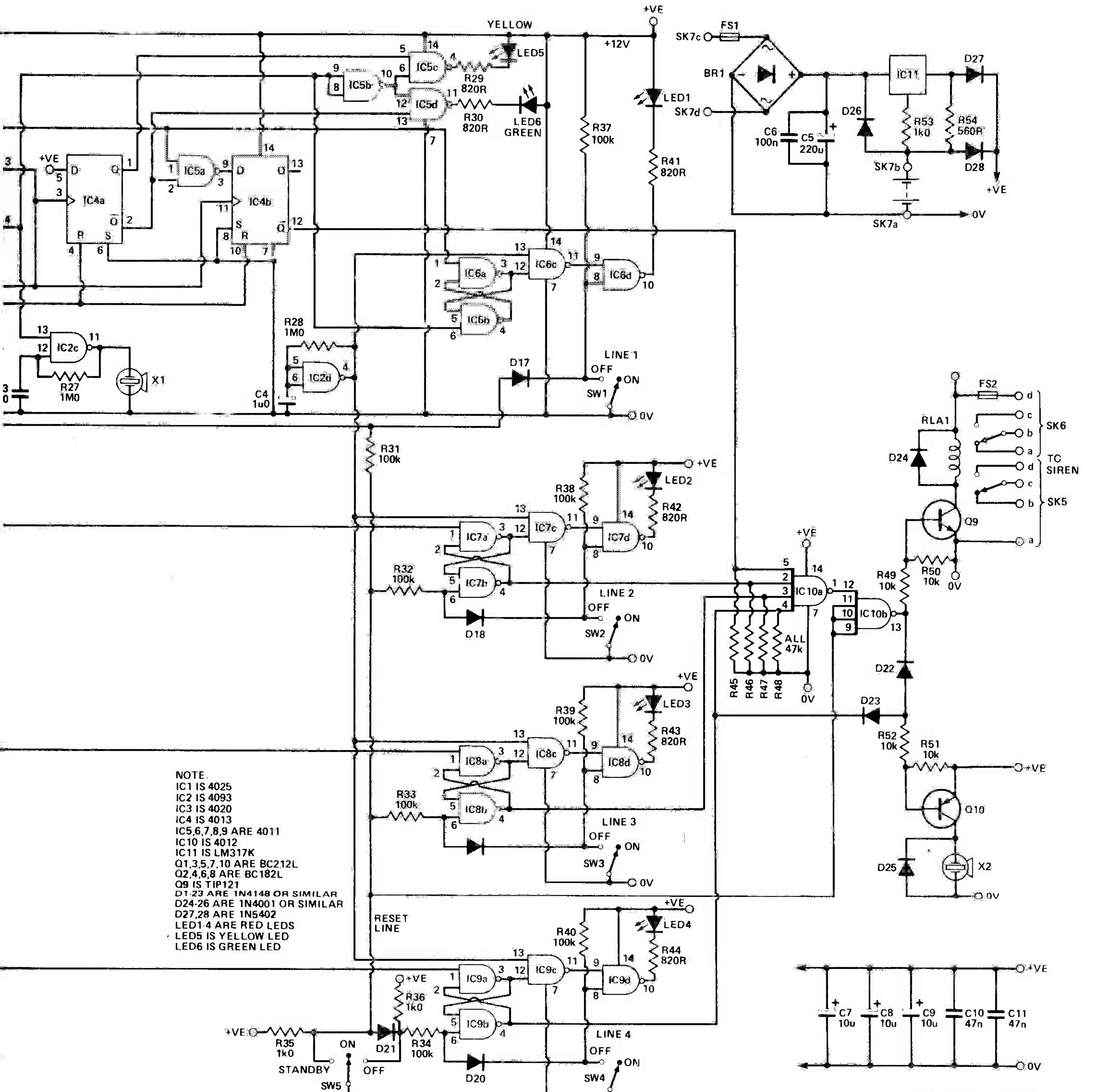


Fig. 1 Circuit diagram

ing to be detected without setting off the main alarm.

POWER SUPPLY

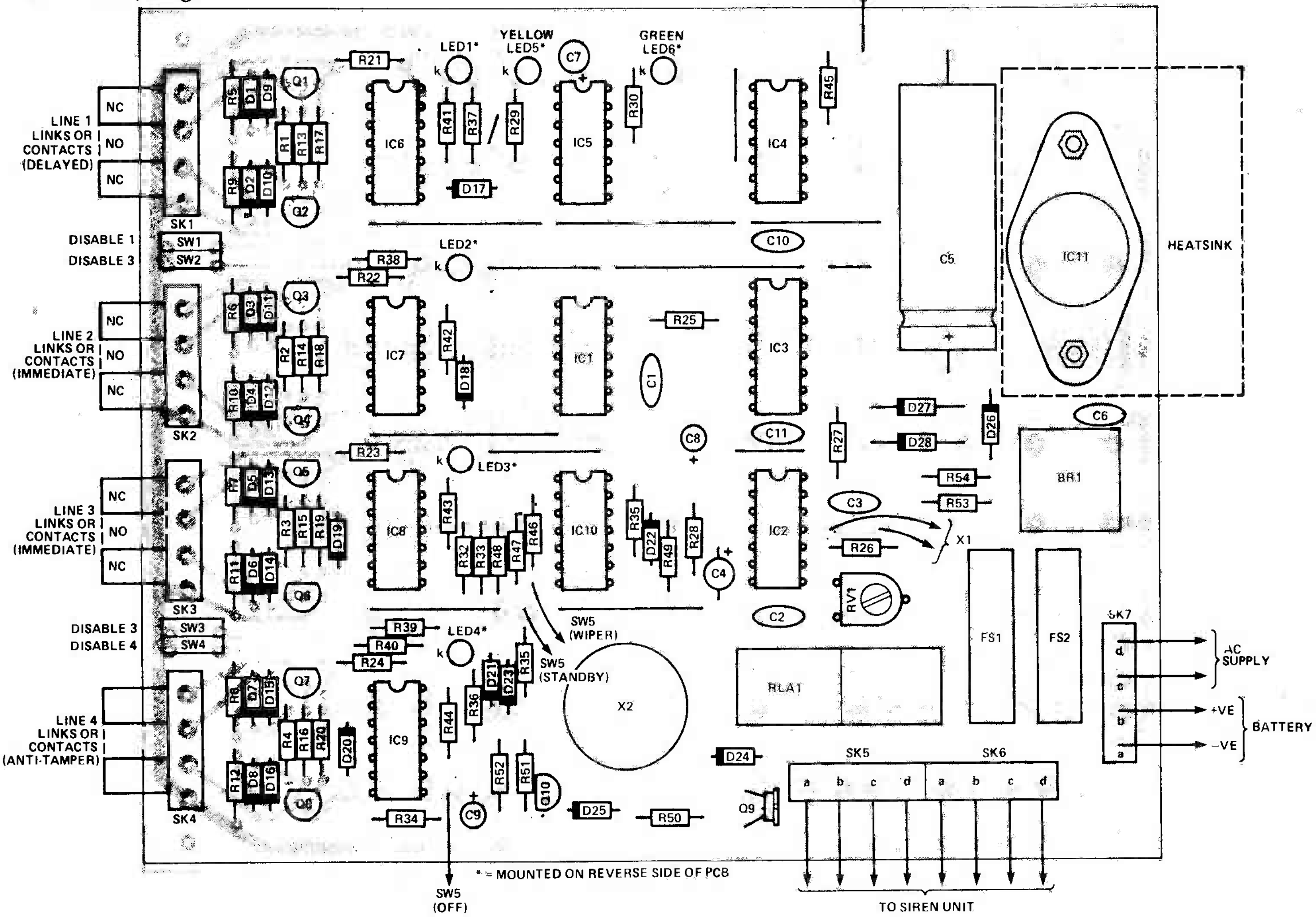
This part of the circuit uses a standard bridge rectifier and capacitor arrangement but the regulator system is a little unusual. The circuit uses an LM317 regulator with its reference terminal connected to a 12V battery. This means that the output voltage will be about 1.2 volts above the battery voltage. While AC power is applied the battery is charged via R46 and the main circuit is supplied via D27 at about 12.5V. If the power fails the circuitry will be powered from the battery via D28 ensuring that the alarm circuit is always powered.

ses from an oscillator, whose frequency (and hence the delay time) is controlled by the variable resistor RV1.

When the count is complete, the state of the loop sensor is tested. If it is still in the alarm condition the output from the circuit activates the output stage immediately. If, however, the loop sensor circuit is non-active — ie the door is shut — the alarm is not given and the circuit goes into its second stage.

During the first stage (normally while you are leaving the property) the green LED will flash while the timer is operating and the red LED will flash while the door is open. If, once the first stage of operation is complete, the loop sensor circuit becomes active again, the counter circuit will start again but this time the alarm will sound at the end of the time period whatever the state of the loop sensor unless the alarm is disabled with the proper key. During this stage the orange LED and the red LED will flash. During both timing stages a bleep will

Fig. 2 Overlay diagram



PARTS LIST

RESISTORS (¼W 5% carbon film)

R1-20,25,45-48	47K
R21-24,35,36,53	1K0
R26,49-52	10K
R27,28	1M0
R29,30,41-44	820R
R31-34, 37-40	100K
R54	560R
RV1	100K

CAPACITORS (100 volt PCB mounting polyester unless stated)

C1,3	1n0
C2,6,11,12,13	100n
C4	1µ0
C5	2200µF 25V electrolytic
C7,8,9	10µF Tant. bead or min. A1. 25V

SEMICONDUCTORS

IC1	4025
IC2	4093
IC3	4020
IC4	4013
IC5,6,7,8,9	4011
IC10	4012
IC11	LM317K
Q1,3,5,7,10	BC212L
Q2,4,6,8	BC182L
Q9	TIP121
D1-23 inc.	1N4148 or similar
D24,25,26	1N4002
D27,28	1N5402
BR1	200V 2A potted bridge rectifier
LED1,2,3,4	0.2 inch red LED
LED5	0.2 inch yellow LED
LED6	0.2 inch green LED

MISCELLANEOUS

SW1,2 SW3,4	2-way DIL switch
SW5	3-position keyswitch
X1	PB2720 piezo sounder
X2	12V PCB mounting buzzer
RLA1	12V relay 2 pole changeover 5A (Maplin YX98G or similar)
SK1,2,3,4,5,6,7	4 way PCB mount screw terminals
FS1	2A 20 mm fuse + PCB holder
FS2	1A 20 mm fuse + PCB holder
B1	12V 280 mA-hr Ni-Cd battery (or 2x 6V)
T1	12V 20VA transformer in box with suitable fuse

PCB; large die-cast box; small microswitch with NO contact (ie contact closes when switch operated); heatsink for IC11 (see Fig. 3); TO3 mounting kit and thermal grease; spring clips for batteries; solder tag; wire, solder, etc.

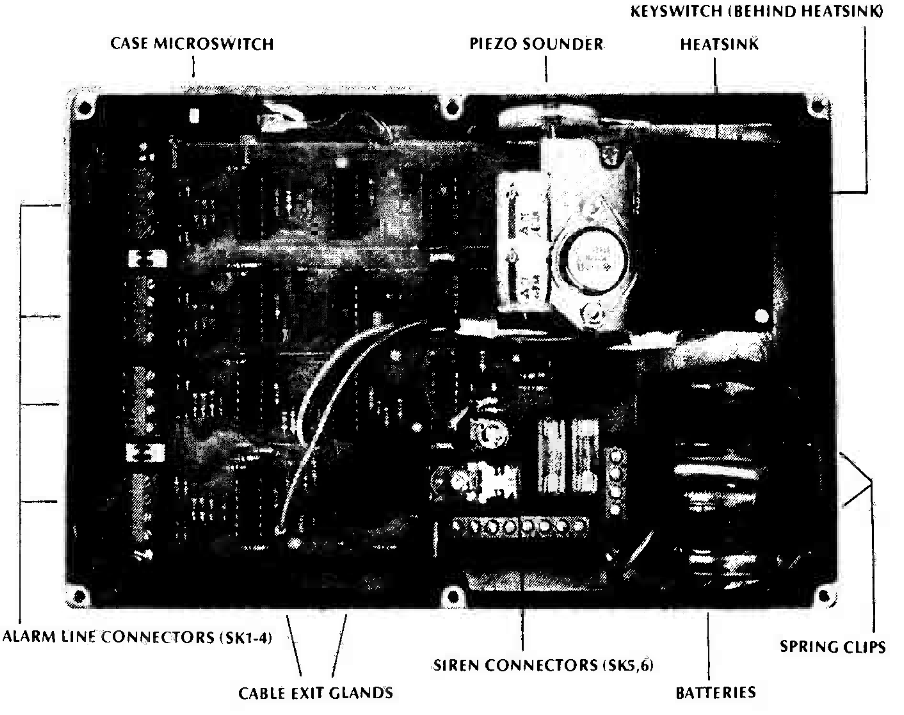
sound so that you are aware that something will happen soon if you take no action.

The reset circuitry is arranged around a three-way keyswitch. In one position all the unit is switched off. This is to allow you to do maintenance or add extra sensors. In the second position most of the unit is disabled with the exception of the loop pair used for the anti-tamper circuits. This is the normal "off" position which allows full access to the premises but sounds an internal alarm if the wiring or alarm unit is molested; for this facility we have assumed that there will be someone nearby who can investigate. In the last position the unit is fully active and ready to go. Any alarm conditions will be dealt with as appropriate.

All the alarm outputs from the sensor and latch circuits are gathered into a gate circuit which also uses the state of the reset line as an inhibit. The output from this drives a power relay via a transistor such that the relay is de-energised when an alarm occurs. This prevents someone just cutting the wires to stop the alarm. The output from the gate circuit also drives an internal buzzer which also serves as the alarm for the anti-tamper loops.

Power for the whole unit is normally supplied from a 12V AC external supply which is rectified and smoothed. This is then roughly regulated by a monolithic regulator IC which also charges the internal battery. If the external AC supply is cut off then the internal battery will supply the circuit for at least a couple of hours. This should be long enough to cover a mains failure but a larger battery may be needed in some cases.

If a three-position keyswitch is not available or extra security is reqired then two two-position switches could be used. One of these would control the main unit while the other would control the anti-tamper circuit. By connecting the latter to the main reset line instead of directly to ground both keys would be needed to totally disable the unit.



Internal layout of the prototype.

Construction

The majority of the components for this project are fitted on to the PCB. This should reduce the scope for errors but, as usual, care must be taken to insert all the diodes, transistors, ICs and polarised capacitors correctly. There are quite a few links on the board and all of these must be inserted correctly. It would probably be best to insert IC holders into the PCB first followed by resistors, diodes, capacitors and terminal blocks. The links could be inserted immediately after the IC sockets. The last things to fit are the large components such as fuseholders, relay, buzzer, the LM317 and heatsink and C5. When fitting the regulator IC note that it should be insulated from the heatsink.

The LEDs should not be fitted yet as they could be positioned on the foil side of the PCB to poke through the box when assembled. At this stage it would be prudent to test the circuit. Use a 12V supply into the battery terminals and check that each part of the circuit from the loop sensors onward is operational. It will help to wire the keyswitch at least temporarily.

When the board is working correctly the LEDs can be fitted in place and permanent wiring installed to the keyswitch and piezo sounder. All other wiring is done via the screw connectors for the eight loop-sensor circuits, the relay contacts and power supply. The PCB is designed to fit into a large die-cast box with its Ni-Cd battery but not the transformer. This should be housed in its own box or could possibly be a suitably rated bell transformer. The box used for the unit should have a micro-switch fitted into it such that the removal of the lid will activate it. This switch and a pair of wires in the power cable should form one of the anti-tamper loops. The other is available for general use.

We shall be dealing with the use of the alarm unit, including the wiring up to the siren unit, in the near future, when we describe the siren unit itself. **ETI**

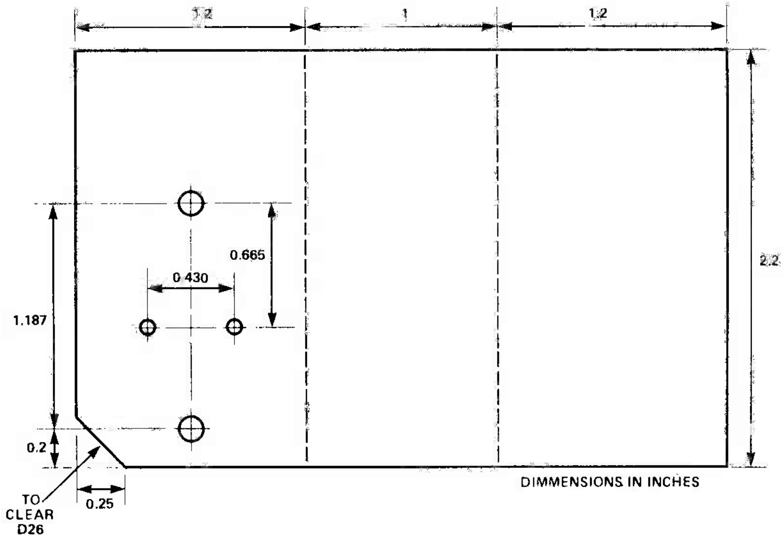
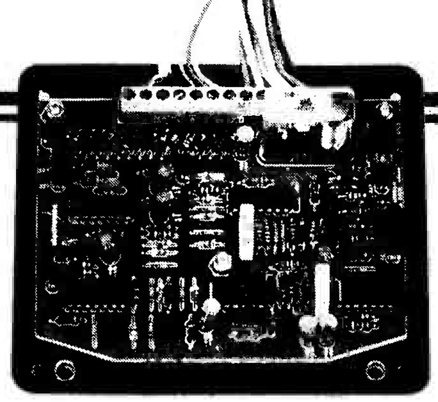


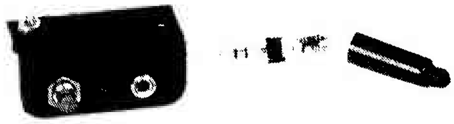
Fig. 3 A suitable heatsink for IC11

BUYLINES

We suggest you make do with whatever buzzer you can find for X2, all the better if it actually fits the PCB! With the keyswitch, if you can't find a single three-way device, two two-way ones can be used as already described. Nothing else should cause any problems.



ELECTRONIZE CAR ALARM



The repertoire of alarming noises generated by Ian Pitt's car has just been increased by one — courtesy of Electronize Design.

The Electronize car alarm consists of a simple control panel which mounts below the dashboard and a bulkhead-mounting box containing the main circuitry which can be hidden away in the engine compartment. The existing courtesy light door switches are used to detect anyone entering the vehicle and the horn and the headlights are used to attract attention. The only other additions are a switch to detect when the bonnet is opened and a similar arrangement for the boot if one is not already fitted.

The circuit is armed by pressing a button on the dashboard control panel, after which a delay circuit allows thirty seconds for leaving the vehicle and closing all the doors. Opening any of the doors after that triggers the circuit into entry delay mode, allowing ten seconds to get inside the car and switch off the alarm. Opening the bonnet or the boot will trigger the alarm immediately, as will attempting to remove a radio or any other accessories attached to the sensing loop. Turning the ignition on will also trigger the alarm immediately and, provided the car has a conventional or standard CD electronic ignition system, will prevent the engine firing. If a contactless CD system is fitted the engine will start, but the alarm will still be triggered. A safety interlock prevents the circuit being armed when the engine is running, thus removing the possibility of a driver accidentally knocking the alarm switch while the vehicle is in motion and thus causing the engine to cut out.

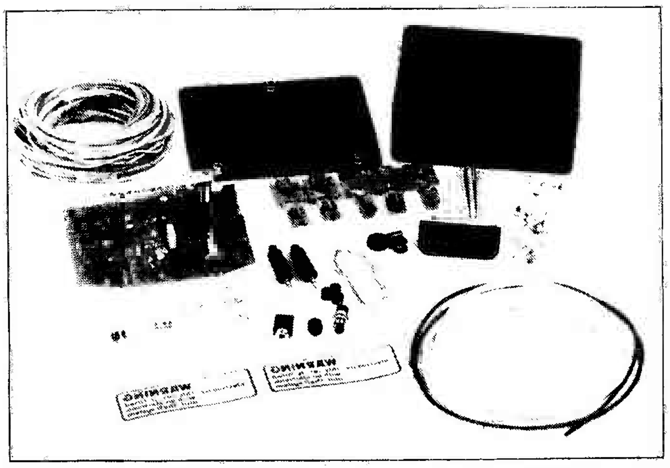
A key is used to turn the alarm off, making it impossible for an intruder to disarm the system during the ten second delay after a door has been opened. The key consists of a miniature stereo jack plug containing two 1% tolerance resistors. Two further resistors are contained in the alarm circuitry, and only if the two pairs match will the alarm switch off. The 1% resistors are supplied with the kit and Electronize claim that they are chosen from a range of 45 values, giving a total of 2025 possible combinations for a pair.

The alarm circuit employs a low power quad op-amp and four CMOS ICs to give a very low drain current. A thyristor is used to inhibit the ignition circuit and a multipole relay switches the horn and headlights. This allows the switching to be entirely independent of the supply rails, enabling the horn switching circuit to be connected directly across the horn push regardless of whether the horn is switched on the positive or earth side. The relay is driven by an oscillator so that the horn and the headlights pulse on and off when the alarm is triggered. A further feature of the circuit is that, once armed, the main unit will continue to operate even if the leads between it and the control panel are cut.

Construction

The kit arrives packed in a number of small, polythene bags each with a packing slip carrying the packer's initials, and includes just about everything you could need including the solder. No errors or shortages were found in the kit as supplied and everything was easy to find and identify.

The first stage in the construction is the assembly of the PCB. The instructions include an overlay diagram and a full component listing and each item is identified by its colour code or physical appearance as appropriate. The PCB has all the component positions marked on it in white in a very helpful fashion — the thyristor, for example, which could easily be mounted either way around, is accompanied by a note on the PCB which shows on which side the type number should appear. The instructions are also very clear and include a section on general soldering principles, although I am not sure that a circuit of this complexity would be attractive to a beginner. The only error I could find anywhere in the notes was a reference to the earth lead which should be attached to the PCB but which is not shown on the overlay diagram. However, since there is only one hole it could possibly go into and since it is shown on the installation wiring diagram further on in the instructions, this didn't pose much of a problem.



The complete kit as it arrived, except that the PCB is shown here already assembled.

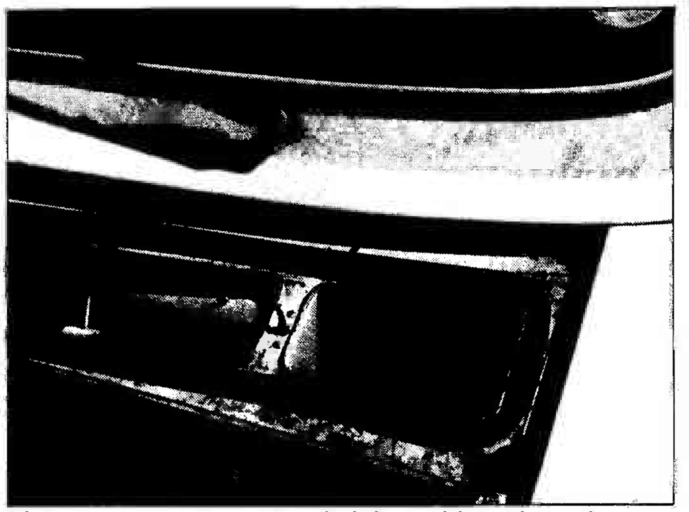
A couple of perspective drawings show how the little control panel should be wired and the accompanying instructions are again fairly comprehensive. The jack plug is quite simple to assemble because it only contains two resistors, but a drawing is used to make it clear which resistance goes where since it is important that the two exactly match the pair in the main alarm box. Two jack plugs and two sets of resistances are provided so that a spare key can be assembled.

At this stage, with the control panel, the jack key and the main unit all complete, I decided to set the system up on the bench and try it out before installing it in my car. With a couple of 12 V lamps to simulate the presence of the horn and headlights, it was a simple task to check the unit through almost all aspects of its operation and establish that it was working quite correctly. I also took the opportunity to try it out at various supply voltages and found that it would work satisfactorily over a far wider voltage range than it is likely to encounter in normal use.

Electronize give reasonably detailed instructions for installing the alarm but obviously cannot take account of all the many makes and models of car the system might be fitted to. A little bit of care and thought is thus required here, and the installation is likely to take rather longer than the initial assembly. It took me a full morning to get everything installed and connected up and a few odd hours later on to test the system, tidy up the wiring and put everything back as it should be. The amount of time the process takes could vary enormously according to the make of car and your familiarity with its wiring.

The main box was readily attached to a blank section of the bulkhead using the self-tapping screws provided. The small control panel proved just as easy to fit underneath the dashboard and again is attached using self-tapping screws. The bonnet switch, however, was not so easy to fit. Electronize intend that it be installed from above into a cross-member or other horizontal surface onto which the bonnet closes, but I found that the switch would not then compress sufficiently to allow the bonnet to be closed. Accordingly, I attached the switch to the underside of a panel, spaced it away with washers and secured it with pop-rivets, allowing just sufficient of the plunger to protrude to ensure efficient switching. The difficulty encountered in fitting this item is going to vary enormously from car to car, but I see that plunger-type door switches with various stem lengths are available quite cheaply from car accessory shops, so if the example provided really does prove impossible to fit it should not be difficult to find a more suitable replacement. You may also need to purchase such a switch if you wish to extend protection to the boot but do not have an automatically switched boot light already fitted.

The tiny alarm control panel is almost lost beneath the dashboard — you can just see it directly below the speedometer.

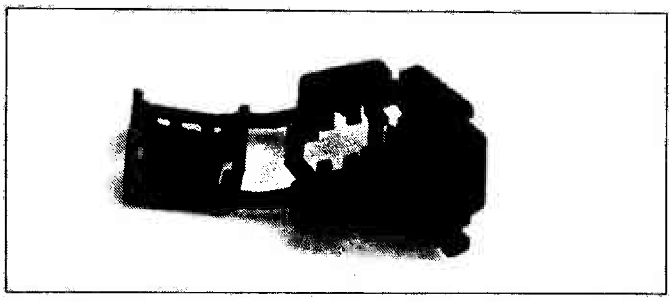


The plunger-type bonnet switch in position. The main alarm box is lurking in the shadows of the vent recess.

When the main box, the control panel and the bonnet switch are in place, the final task is to connect them all up. I had no trouble finding an existing cable access hole through the bulkhead into the engine compartment, and soon had the main box and the control panel connected together using the four-core cable supplied. The remaining cables from the main box I bundled together and secured with cable ties (not provided), branching each one out as necessary so as to keep the wiring fairly neat. Sleeved ¼" connectors are provided with the kit so I started with the leads using them and connected up the bonnet switch and the ignition lead via the negative side of the ignition coil. A tag and self-tapping screw are provided for the earth lead which I attached to the bulkhead fairly close to the main alarm box. The positive lead is simply taken back to the fuse box and attached using another of the ¼" connectors. An accessory lead input is provided on the alarm, allowing a wire to be threaded through a number of devices such as radio/cassettes, fog lamps, etc, before finally being attached to earth and so arranged that breaking the lead will immediately trigger the alarm. How this is attached will depend upon the accessories to be protected, but a ¼" connector is included in the kit for this purpose.

The remaining wires all have to be tapped into existing cables to make connection with the horn, headlights and the courtesy light door switches. I found it necessary to remove the dashboard and the parcel shelf from my car in order to locate all of the wiring I needed access to, and a circuit diagram of the car's electrical system with wiring colours marked on it proved very useful here.

The actual connections are made using 'tap-in' connectors. For the benefit of those unfamiliar with these handy devices, they consist of a plastic case which is grooved to carry one cable straight through and one cable end, and have a small, serrated metal blade which is pushed through the case when the wires are in place and which cuts the insulation on the two wires so as to make the connection. I have used them before on several occasions, but I found the type supplied by Electronize very fiddly to use. In the most extreme case, I found it difficult to line up the heavy-gauge horn feed wire present in my car alongside the much thinner horn leads provided with the alarm, hold the plastic case closed over the two, fold the blade flap into place and then squeeze the whole together with a pair of pliers, all



One of the 'tap-in' connectors supplied by Electronize. Similar connectors of much simpler construction are widely available.

whilst working in a cramped and uncomfortable position under the dashboard. After some minutes of repeatedly failing to line everything up I gave in and purchased a small pack of 'tap-in' connectors of much simpler construction from a high-street car accessory shop. These, as I had expected, were much easier to use and I had no further difficulty in making the connection to the horn circuit.

With the installation complete I tentatively applied power to the system, having first removed one connection from each of the car's horns. A full test procedure is given in the instructions and I followed this through without encountering a single problem. The alarm worked perfectly in all respects, the headlights flashing vigorously to indicate the alarm state and the LED on the control panel correctly indicating the dormant, armed and active states by being off, on or flashing as appropriate. When I had thoroughly checked the system, I reconnected the horns and once more armed and triggered the alarm. A few strident blasts synchronised with the flashing headlights confirmed that here, too, all was working correctly, and I'm sure the neighbours are grateful for my testing the system in this way rather than leaving the horns connected throughout the test sequence.

I must confess to having ben slightly intimidated by the alarm at first, almost afraid to leave the car with the alarm switched on in case it suddenly went berserk and started flashing its headlights and sounding its horn for no apparent reason. Happily that has not happened, and I am steadily gaining confidence in the system's ability to protect the car without generating false alarms. Window stickers warning that an alarm system is fitted are provided with the kit and this visible deterrent inspires a further degree of confidence. I am not quite sure why anyone should want to steal my rust-streaked, twelve-year-old saloon, but I received a timely warning a few weeks before the alarm was installed when a vehicle of a similar age and condition belonging to a friend was 'borrowed' for a joy ride and severely damaged. It's nice to think that they would now have considerable difficulty trying to do the same thing with my car. They might even choose to attack another car instead, one without an alarm system. Your's, perhaps?

The Electronize Electronic Car Alarm costs £19.95 in kit form or £29.95 built and ready for installation. Both prices include VAT but exclude postage and packing for which £1.00 extra should be added. Electronize Design, Tame Valley Industrial Estate, Magnus Road, Wilnecote, Tamworth B77 5BY, tel 0827-281 000.

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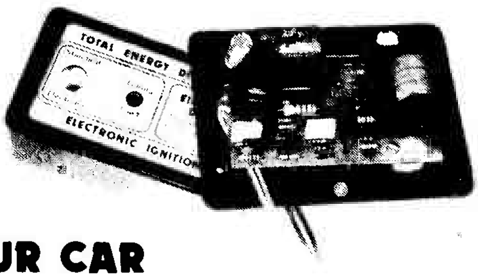

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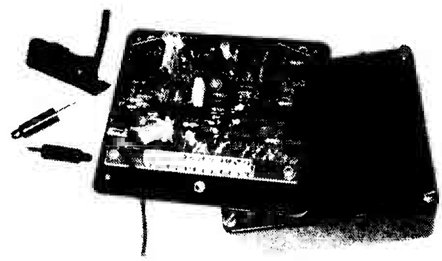

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★ **30 SECOND EXIT DELAY** The system is armed by pressing a small button on a dashboard mou... control panel. This starts a 30 second de... the owner can open and close d... al...

★ ...**Y** ...en a door is opened a 10 second ... lay op... e owner to disarm the system with the ... Latching circuits are used and once triggered the ... can only be cancelled by the key plug.

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AUDIO DESIGN

In this second part of the practical realisation of audio theory, John Linsley Hood describes the design of a very high quality audio amplifier, using MOSFETs.

In the previous article, describing the accompanying preamplifier, the basic design requirements of this power amplifier were outlined. These were: that it should offer an audio quality which was as good as the best commercial unit on the market, if only because there isn't any point in aiming lower than this; that is should have an input sensitivity and impedance which were both sufficiently high that signals from auxiliary sources could be routed directly to it, without manipulation by the preamplifier; and that it should be direct-coupled to the LS units.

Several other things followed on from this basic general specification: for example, if it is intended to be possible to route signals from auxiliary inputs directly to the power amplifier, to avoid any possible degradation in quality by preceding stages, then the power amplifier needs to have gain and balance controls on its input, rather than situated in the preamp. Another feature which is implied in this design spec is that the output stage should be based on the use of power MOSFETS, because they can offer a sound quality which is at least as good as that of bipolar transistors operated in class-A without the enormous penalty of the thermal dissipation of such designs.

I have a great liking for valves, myself, because they can be pretty to look at, they don't mind getting hot (in class-A use), and, with a good design, they are pretty well burst-proof. However, they need output transformers, and these are invariably so destructive of the potential performance of the circuit, especially in transient response, that I feel, sadly, that valve amplifiers are about in the same league as an oil tanker with sails and masts, a romantic idea overtaken by events.

Some other things which I hadn't dwelt upon, but which are necessary to consider if one is after the ultimate quality league, are stabilised power supplies, direct coupling, and the maximum practicable symmetry of the drive circuitry.

Stabilised PSU?

Looking at these in turn, the advantage of a stabilised PSU is that it will give a somewhat more solid bass response (mid range and treble response are more influenced by the circuit design of the amp and its feedback loop characteristics), and that the power output is identical under steady-state and transient conditions. In some ways this is an advantage, in that it will make power output specs less dependent on measuring conditions, and can help deliver more power into lower impedance loads. In some ways, though, it is less beneficial, because the simple power supply with output capacitor can, for a brief time, which is all that is needed on some transients, provide a higher peak power. (I looked at these pros and cons in an earlier article in ETI Jan. 1983). Many of these advantages can be gained, at lesser expense, by feeding the relatively low current, class-A, gain stage of the audio amp from its own PSU, separate from the power supply which feeds the output devices. However, there is yet another possibility in a stabilised PSU system which has finally swung my preference that way, and that is that it can be made to perform a LS protection system.

With any direct coupled amp, in which the output stage midpoint is taken directly to the LS units, there is a danger that an output device failure will damage the LS drivers, so a fuse, or a relay to disconnect the LS line, is a necessary precaution. Unfortunately, fuses and relay contacts tend to impair the electrical integrity of the circuit, which is made more apparent by the relatively high currents which are flowing in these paths. Gold-plated relay contacts do not impair the performance too much, provided that the thickness of the plate layer is adequate to survive the duty, but it would be better still to do without them.

Therefore, in this circuit I have chosen to provide the LS protection function by monitoring the DC offset at the LS terminals, and using any excess voltage deteced at this point to electronically disconnect both of the output stage power supply lines, with a suitable warning that this has happened.

Drive Symmetry

A further design aspect in the power amp which I have not yet discussed is that of drive symmetry. Ideally, any power amp should be capable of operating with equal facility in either polarity direction. This becomes of importance where large voltage swings are likely, which is in the final

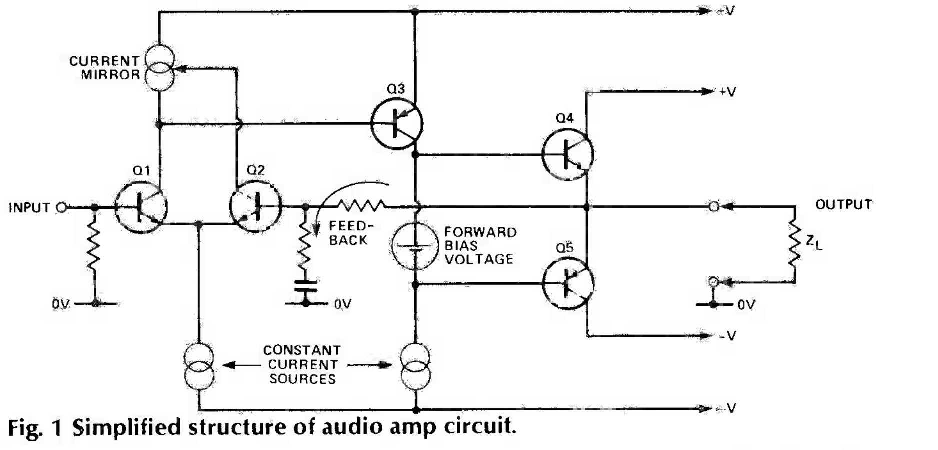


Fig. 1 Simplified structure of audio amp circuit.

class-A driver stage of the power amp, and in the output transistor pairs, Q3 and Q4 and 5, respectively, in my schematic circuit of Fig. 1, which is, itself a simplified version of my Fig. 5, in the fifth part of my Audio Design series (ETI, Jan 1984).

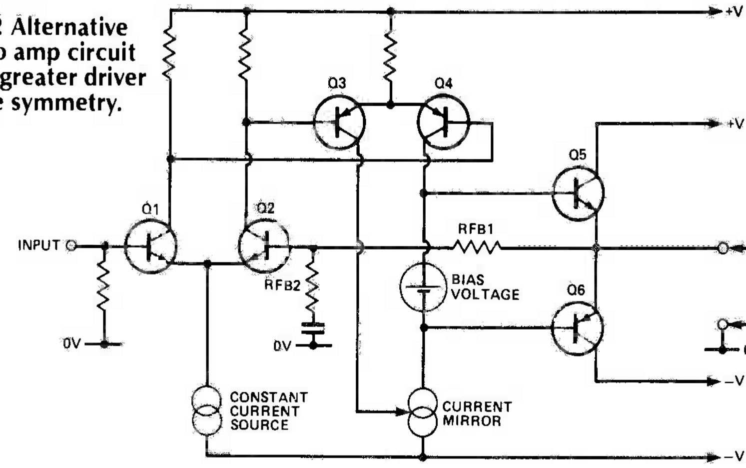
It isn't too difficult to make the output stages themselves quite symmetrical — within the limitations imposed by the transistors, which, in the case of the devices chosen, don't take effect until we get up to very high frequencies — but this is not true of the driver stage, Q3, and its constant-current source load. This is the point at which a conflict of requirements becomes apparent. If the biassing of the output stage is to remain constant, the load for Q3 must have constant current source characteristics, but it also must behave as an effective dynamic load for the amplifier stage Q3.

If the load on Q3 were purely resistive, there would be no great difficulty in satisfying this requirement, but there is, inevitably, some capacitance at this point, due to the output stage loading, and it then becomes essential that the current flow through the constant current source shall be able to charge this capacitance, as the voltage at Q3 collector falls, at a rate which is greater than the fastest negative-going rate of change called for by the incoming audio signal.

An apparently neat answer to this problem is given by the kind of circuit shown in Fig. 2, in which the input long-tailed pair drives a further symmetrical push-pull stage of amplification, Q3 and Q4, and the current mirror driven by Q3 provides a dynamic load for Q4. This was first introduced by National Semiconductors in the mid-1970's, in their LH0001 op-amp design, and adopted by Hitachi as the recommended driver stage for MOSFET power amplifiers using their devices.

However, there are snags. The first of these is that the current mirror load isn't any kind of constant current source, which leads to further consequential problems in maintaining output stage bias stability. The second is, surprisingly, that on close examination and comparison of the two systems, that of Fig. 1 is both more linear and also has a superior reactive load transient response — other things being equal — to that of Fig. 2. This is possibly the reason why such an obviously elegant solution

Fig. 2 Alternative audio amp circuit with greater driver stage symmetry.



to this problem has not found much favour in the minds of the IC designers, whose products overwhelmingly favour the Fig. 1 scheme, which is the layout I have ultimately returned to, with the implicit requirement that Q3 current must be adequate.

MOSFETisation

There are, however, some further improvements which can be made to this circuit, and of these, the major one is the replacement of the small signal transistors by low power versions of the power MOSFETs, which are now available. These are both faster and more linear than the equivalent bipolar junction transistors, and, in principle, all of the bipolar transistors shown in the original circuit (Fig. 5, ETI, Jan 1984, p45) could be so replaced, with suitable adjustments to the ciruitry, as shown in Fig. 3.

The current mirrors and constant current sources perform functions that do not benefit from 'MOSFETisation', and the higher mutual conductance of the input bipolar devices is definitely useful in maintaining a high circuit gain. However, N-channel MOSFETs are faster than P-channel equivalents, because electrons travel faster than holes, so to make it possible to use an N-channel device for Q3, the input stage must be recast to use PNP transistors for Q1 and Q2, rather than NPN types. Another possible improvement would be to use small-power MOSFETs to make Q4 and Q5 into compound output pairs.

In this form, the circuit gives an excellent performance. However, I am all in favour of simplicity, and with the small-power MOSFET final class-A stage, a sufficiently high stage gain is available for the output MOSFETs to be used as simple source-followers. Moreover, careful tailoring of the output and driver circuitry allows the removal of the output inductors normally essential in this style of circuitry. The final circuit layout is shown in Fig. 4.

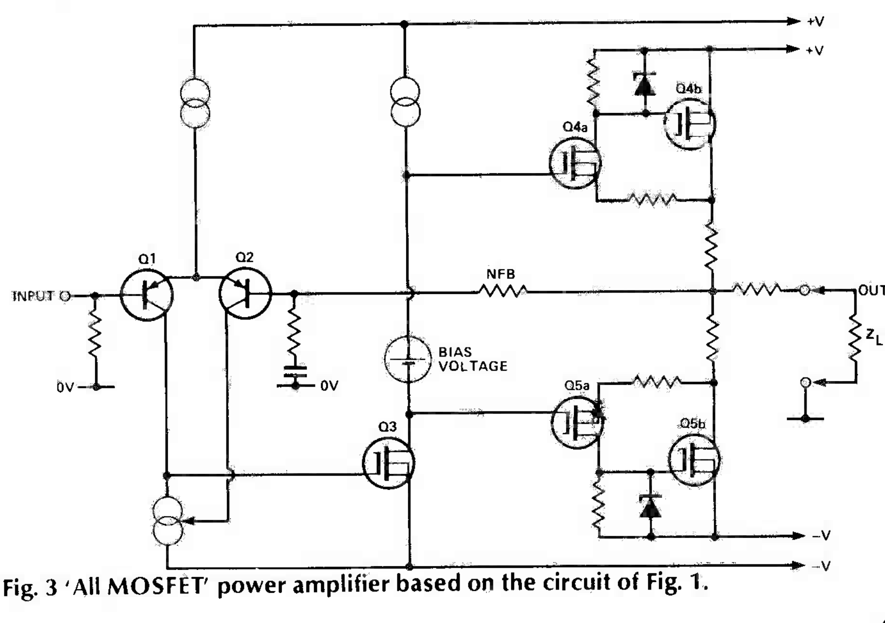
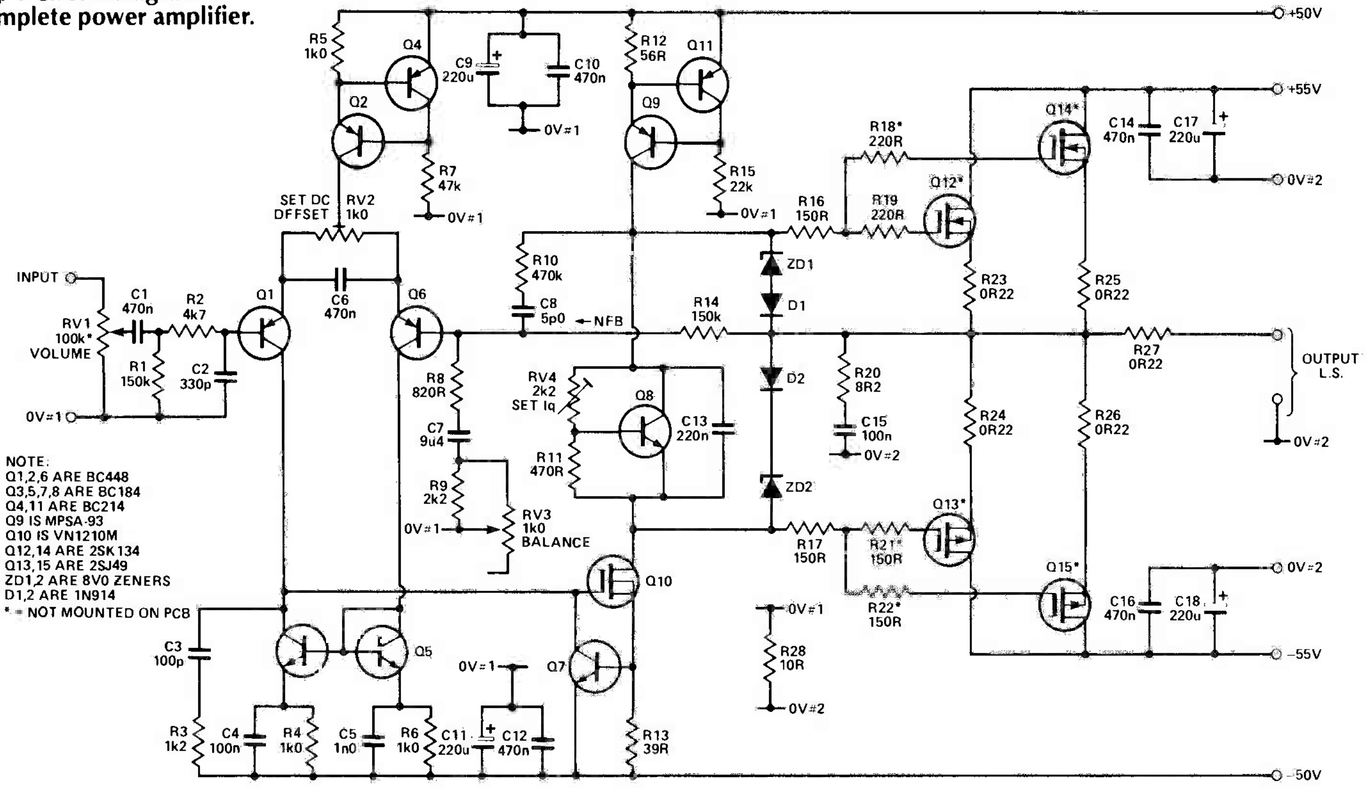


Fig. 3 'All MOSFET' power amplifier based on the circuit of Fig. 1.

Fig. 4 Circuit diagram of complete power amplifier.



Conflicting Requirements

In every audio power amplifier circuit design there is a conflict between the requirements of low harmonic distortion, smooth transient response, and reactive load stability. This arises because low harmonic distortion demands both that the basic structure of the circuit, and its component elements, shall be such that it has high intrinisic linearity, and that the negative feedback loop will provide an effective measure of linearity enhancement. However, a smooth transient response, and good reactive load stability both require that there is a good phase margin in the feedback loop at the point at which the amplifier gain has reached unity. This comparison is shown in Fig. 5.

The loop gain characteristics shown in curve (a), in which the gain is maintained at a high level to as high a frequency as possible, and then rolled off rapidly so that it is less than unity at the 180° phase shift point (if it is unity at this frequency the amplifier will oscillate uncontrollably), will give better THD (because the amount of feedback applied at higher frequencies is greater) than the type of characteristic shown in curve (b). On the other hand, the kind of amplifier response shown in 5(b) will have much better reactive load stability on 'awkward' loudspeaker loads, and will generally be more predictable, and 'smooth' sounding, in spite of rather worse THD.

Obviously this is one of the occasions where one wants to have the cake and eat it, and if one is a commercial manufacturer, one is more or less forced to adopt the 'low THD' choice, because this will be measured and quoted in the test reports, with the — to my mind — very important reactive load transient response taking pot luck; after all, this isn't a quotable parameter.

Since I am in the happy(?) position that I design amplifiers for my own use and pleasure, and not for sale, I am more concerned with how they will sound than how they will measure. Nevertheless, I am an engineer, and I have a normal engineers pride in doing things competently — which means, in practice, that I cannot call the job done until I have at least equalled, if not improved upon, the best performance I have so far come upon, in my own or in commercial designs. (Yes, I do look at, and test, whatever commercial units come my way, and I study their circuits to see if I can learn anything from these, in the way of clever engineering or crafty pieces of circuitry. Sadly, my feeling is often that elaborate and expensive paths have been adopted to achieve a result which could have been done as well or better with more simple and economical means.) For the record, the performance of this circuit, in respect of the THD levels obtained, *without sacrifice to transient response*, is the best I have achieved so far. I do not, at this moment, want to try to better it!

The THD figures are quoted in Table 1, and the way in which the THD varies with power and frequency, at max. output, is shown in Fig. 6a and 6b. I show the THD vs. power output at 10kHz, because, on the prototypes, the THD at 1kHz is, at all power levels below clipping, below the residual circuit and measurement apparatus background noise level. Such distortion products which can be extracted from this noise floor can be shown to originate in the signal source, and are around the 0.002% level (−94dB).

Circuit Analysis

As mentioned earlier, the design decision in the concept of this amplifier was that its input impedance and sensitivity should be such that it could be driven directly from the sort of input signal, in magnitude and impedance, which could be expected from typical auxiliary units — tuners, cassette recorders and the like. In practical terms this implies an input sensitivity of about 150mV and an input impedance greater than 100k.

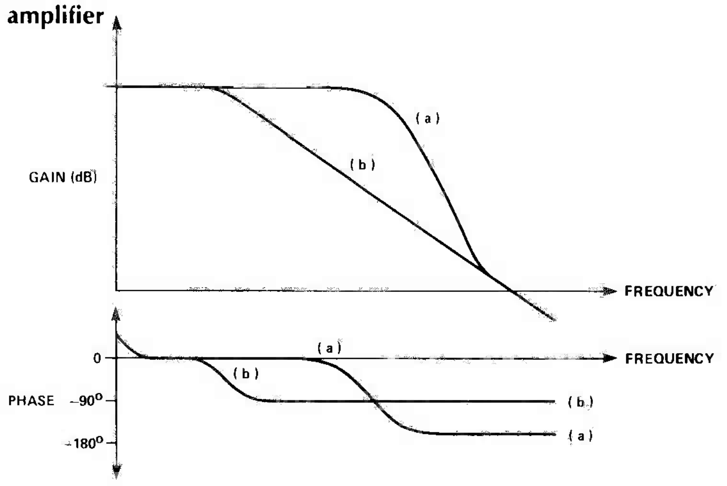


Fig. 5 Feedback amplifier gain and phase characteristics.

HARMONIC	DISTORTION (%)
2nd	0.021
3rd	0.003
4th	0.0015
5th	0.0007

Table 1 Harmonic analysis at 10 kHz (80W/8 ohms).

This determines the input impedance requirements of the input transistor stage, which can be met, adequately, by an input long-taled pair of reasonably high gain transistors operating at a collector current of 250uA. At this collector current, the typical current gain of the devices chosen is 250, giving a base current of 1uA, and a Z_{in} of about 330k.

To ensure that the input stage has a good DC balance, so that the output offset voltage of the amplifier is close to zero, the base circuit DC resistances for the input long-tailed pair (Q1 and Q6) are made similar, at 150k, and a 1k0 DC-offset adjust pot, RV2, (1k0 cermet) is connected in between the two emitters. This is adjusted so that the output voltage of the power amp is within about 50mV of 0V.

The input signal to the power amp is derived from the 100k gain control, RV1, via C1 and R2 — which acts with the 330pF input capacitor to lessen the sensitivity of the circuit to impulse noise or radio breakthrough. The current feed for the input stage is derived from the +50V line by the constant-current source, Q2 and Q4, through which the current flow is set to 500uA by the resistor R5 (1k0), and the collector load for the input stage is provided by the current load for the input stage is provided by the current mirror configuration of Q3 and Q5. By using high current gain transistors in this position (their operating collector voltages are very low) the current flow through Q3 is forced (by the action of the overall DC negative feedback loop in the amplifier) into a very close equivalence to that through Q5.

The action of the bypass capacitor across the emitter resistor of Q3 is to increase the output impedance and effective dynamic gain of this current mirror — an option which is available to us because we are driving a very high impedance following stage: the small-power MOSFET, Q10, whose gate circuit is effectively an open-circuit, apart from some 75pF of gate-source capacitance. The phase-correcting network, C3 and R3, together with the small emitter resistor bypass capacitor C5, adjust the HF phase-angle of the feedback in the 1MHz region, which is where the amplifier would otherwise approach a critical stability threshold. It will be appreciated that, with circuits operating in these frequencies, the layout of the components and interconnecting wiring has a great influence on the gain/phase characteristics of the system, which are optimised only for the PCB layouts employed. So, if you use a different layout, C3, C5 and R4 may need to be different!

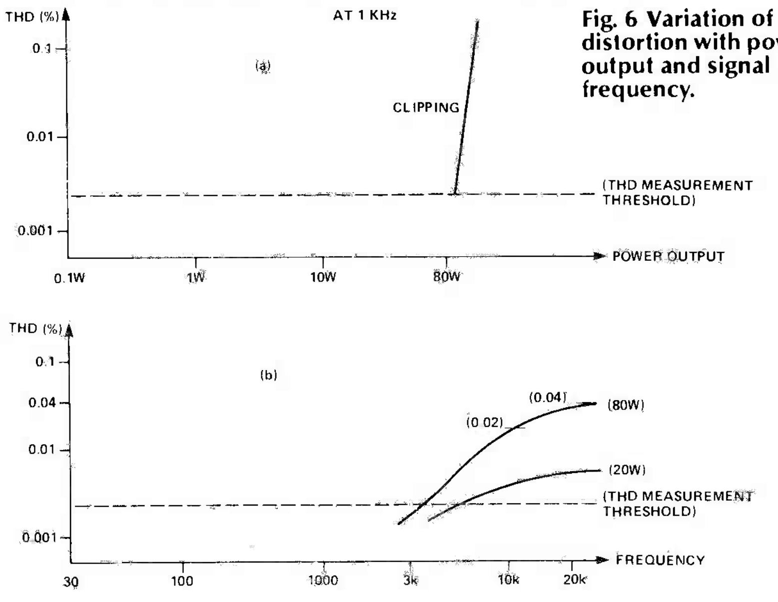


Fig. 6 Variation of harmonic distortion with power output and signal frequency.

Driver Stage

The second, class-A amplifier stage, using the MOSFET Q10, is quite straightforward in operation. The operating current is held at 10mA by the constant current source Q9 and Q11. If the current exceeds this value, the voltage drop across the 56R resistor R12 exceeds the 0.56V turn-on voltage for Q11, and it steals more of the base current fed to Q9 through R15. If the output current from Q9 falls, the converse occurs, and Q9 is turned on more fully. This constant current source protects the operation of this stage from an inadvertent output short-circuit, during a positive-going voltage excursion. A similar protective function is performed, in respect of an output short-circuit during a negative-going voltage excursion, by Q7 and R13. If the current through Q10 and R13 exceeds 14mA, Q7 will turn on and clamp the gate voltage of Q10. The actual class-A standing current through Q9 and Q10 is set at 10mA, as the largest practicable current flow compatible with the 625mW dissipation of Q9 (Q10 can dissipate 1W). Note that the collector/drain tracks on the PCB are broadened to assist in heat removal from these devices.

The choice of the class-A stage DC operating voltage (±50V) is determined only by the need to provide an adequate voltage swing to the output stage MOSFET gates.

For an output power of 80 watts into an 8 ohm load, an RMS voltage swing of 25.3V RMS is needed. This is equivalent to peak-to-peak voltage swing of 71.55V. However, it must be remembered that, at the peak output currents demanded (4.47 amps), the MOSFETs will require a 6V source-to-gate voltage. Also the circuit of Q9 and Q10 will only swing to within 2V of the positive or negative supply rails. Finally, at 4.47A, the voltage drops through R23, R24 and R27 will amount to 1.78V on each half cycle. Adding these together, we get 71.55 + 2 + 2 + 1.78 + 2x6V = 89.33, so ± 50V will be quite adequate.

The necessary forward bias for the output MOSFETs is generated by the 'amplified diode' circuit of Q8, which is bypassed by a small, non-polar, capacitor in the interests of HF symmetry, as is the zero DC offset adjust pot RV2.

Although the circuit will operate satisfactorily with a single pair of output MOSFETs, more power from the same HT supply voltage, an improved THD performance, and better low signal level, pure class-A, performance can be obtained, at a relatively modest extra cost, by doubling-up the output MOSFETs. These can be paralleled quite easily, provide that they have separate source and gate resistors. Since it is preferable for the gate resistors to be mounted close to the MOSFET gate pin connections, these are not included on the PCB.

Earthing

In order to avoid unwanted earth-loop effects, between the low-current input signal earth lines, and the high-current output earth lines, the '0V' lines at the inputs and outputs of the amplifier boards are separated, but joined on the PCB by a low-power 10 ohm resistor, R28. Each supply rail is decoupled, on the board, to its appropriate '0V' line by a 220uF/470nF electrolytic/non-polar combination.

Output transistor input overvoltage protection is given by the ZD1/D1 and ZD2/D2 networks connected between the outputs of the driver stage and the output of the amplifier, which limits the maximum forward gate drive voltage to 8.5V. The output 'buffer' resistor R27 serves two functions. These are to assist in rejecting externally generated signal voltages on the LS line, due for example to dynamic delayed echo effects within the LS units, from the amplifier internal NFB line, and also in allowing the amplifier, unusually in the case of a power MOSFET unit, to operate without an output LS line inductor.

The reactive load transient performance of this circuit is extremely good, in spite of the low level of HF THD. This is in part due to the 'tuning' of the amplifier phase characteristics in the 100KHz — 300KHz region by the R10/C8 network. By altering R10 one can tune the output to give a virtually impeccable square wave response (i.e., identical with or without added load capacitance) over the range 8R//100u to 8R//2.2uF — for R10 values from 220k to 600k. The mid-range value I have chosen is about optimum for 1uF//8R, though the actual differences in performance on either side of this value are very small.

Channel Balance Adjustment

I have chosen in this design to adjust the relative gain of the two channels by alteration of part of the low-signal level NFB resistor arm using R9 and RV3. With a two gang 1k0 pot., one half of which is connected in each channel in a reciprocal fashion, a ±6dB gain adjustment of each channel with reference to the other, is provided. A two gang pot. is essential to prevent inter-channel breathrough.

However, I am aware that this is a point of some controversy among users, some of whom very much prefer that each channel should be capable of reduction to zero output. For those who prefer this style of operation, I would recommend that a twin-spindle, concentric, input volume control is employed, RV3 be deleted, and R9 replaced by a 390R resistor.

Construction

A suitable PCB layout is shown in Fig. 7. As mentioned above, the layout employed will affect the performance at HF, and the consequent phase shifts within the feedback loop. Therefore, I strongly urge that the suggested layout is retained.

General Considerations

It has been demonstrated to me, in relation to an earlier design of mine, that the component types employed can have a significant effect on audible quality. In particular, the capacitor employed in the NFB loop (C7) is a very sensitive component, where a consider-

PARTS LIST

RESISTORS (metal film, 0.3W, unless stated)

R1	150k
R2	4k7
R3	1k2
R4,5,6	1k0
R7	47k
R8	820R
R9	2k2
R10	470k
R11	470R
R12	56R
R13	39R
R14	150k
R15	22k
R16-21	220R
R22	8R2 2.5W WW
R23-26	OR22 2.5W WW
R27	OR22 2.5W WW
RV1*	100k log stereo pot.
RV2	1k0 lin cermet preset, open horizontal
RV3*	1k0 lin stereo pot.
RV4	2k2 lin cermet preset, open horizontal

CAPACITORS (radial lead, stacked film polyester unless stated)

C1,6	470n
C2	330p polystyrene foil
C3	100p polystyrene foil
C4	100n
C5	1n0 polystyrene foil
C7a,b	9μ4 (2x4μ7 parallel) or 10μ (single) polycarbonate
C8a,b	5p0 (2x10p series) polystyrene foil
C9,11	220μ electrolytic
C10,12	470n
C13	220n
C14,16	470n
C15	100n
C17,18	220μ

SEMICONDUCTORS

Q1,2,6	BC448
Q3,5,7,8	BC184
Q4,11	BC214
Q9	MPSA-93
Q10	VN1210M
Q12, 14	2SK134
Q13,15	2SJ49
ZD1,2	8V0 Zener diodes
D1,2	1N914

MISCELLANEOUS

PCB, heatsinks to suit (see next month's article), connecting wire, etc.

* Note: items marked with an asterisk are common to both channels, so only one is required; two of all other components will be required for stereo.

able improvement in sound quality — not readily measured instrumentally — can be gained by the use of non-polar rather than, for example, a polar (tantalum bead or aluminium electrolytic) type. Polypropylene capacitors are probably the best choice, but these are bulky and difficult to obtain in large values, so I have designed this unit around the second best choice in this position, polycarbonate, and C7 is built up from two 4u7 polycarbonate capacitors connected in parallel. (10u polycarbonate capacitors are fairly rare, but if you can obtain them, one of these can be used instead.)

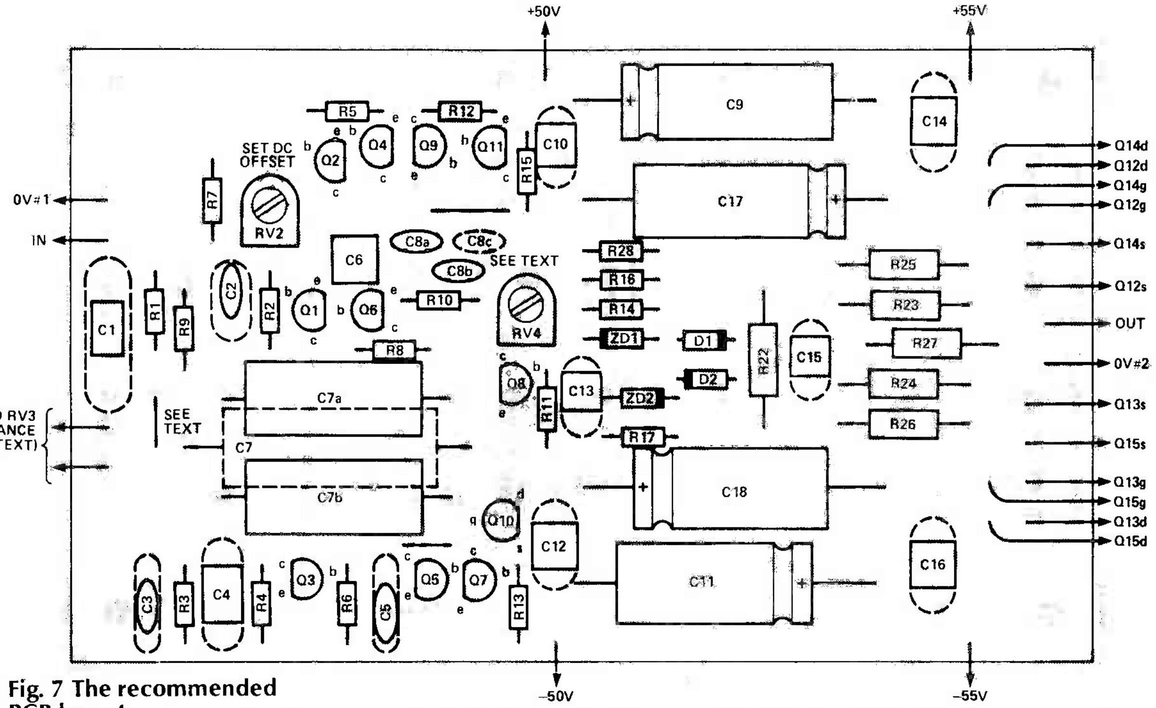


Fig. 7 The recommended PCB layout.

With the values chosen for R8 and R9, this gives a low frequency −3dB gain point of 14Hz, which is adequately low. The resistor types should be metal film 0.3 watt, or wirewound, as appropriate, and C8 is two 10pF polystyrene foil capacitors connected in series.

The other larger value capacitors, apart from the supply line decoupling electrolytics, are radial lead, stacked film, polyester types.

I will describe the setting up of the amplifier, the general component layout of the prototype, and the power supply and DC offset protection circuitry in the next article. **ETI**

HOUSEWATCH 2000 BURGLAR ALARM

Coloroll Ltd, a company more usually associated with wallpaper, has decided to enter the DIY burglar alarm market. So what's it got to do with ETI? Jack Shaw finds himself crawling beneath the floorboards to find out.

Fit a burglar alarm to my flat in the name of investigative journalism? Could this be a way of exchanging worrying about someone breaking into my flat for worrying about whether or not the alarm is going to trigger spuriously?

However, perhaps worse than this was the thought that I might be expected to give the system a practical test. How could I do that — break into my own flat? Ask the local, friendly burglar to give the system the once-over? Or wait until someone tries it out in earnest?

Luckily the people at ETI are very reasonable — they didn't expect me to do any of this, just install the device in question and say what I thought about it.

High-Tech

Some readers might be asking themselves, "Why is ETI interested in this sort of alarm anyway?". The answer to this question is that it is the first (at least, so far as we are aware) DIY alarm to use a combination of LSI technology and modern computer-like styling. It could be the shape of alarms to come — at least, the manufacturers think it will be.

The LSI technology is in the shape of a ULA (uncommitted logic array) developed specially for professionally installed security systems by Munford and White PLC, one of the UK's leading designers and manufacturers of electronic security equipment. (Although the alarm bears the name 'Coloroll', and is being marketed by this company, it is in fact manufactured by Munford and White.)

The use of LSI makes it possible for the main control unit to be quite small — 9" by 5½" by 1¼" deep, which, coincidentally, is almost exactly the same size as a Sinclair Spectrum. Like the Spectrum, the Housewatch 2000 has a separate mains supply (which is, in fact, a plug-mounted transformer, the rectifier, etc, being mounted inside the control unit). However, the unit does contain all the connectors for the alarm circuits, (housed under a removable panel protected by an anti-tamper switch), a numeric touch-panel, used to enter the code number to enable and disable the system (rather than fumbling around with a key), and a sounder.

Siren Song

The other main unit supplied in the kit is the siren unit, which is also positively dinky, being little larger than the control unit (although manufactured from metal as opposed to what looks like high-impact polystyrene for the control unit). The siren contains a smallish PCB with a bit of its own circuitry and the back-up NiCad battery, which supplies the whole system in the event of mains

power being removed for whatever reason. The circuitry sets off the alarm unit in the event of the wires to it being cut.

The siren transducer is a small (about 5") speaker with a clear plastic cone — and, despite a small size, believe me, the noise it is capable of making is ear-splitting.

The remaining com' nents supplied are the PSU (as already mentioned), ' e flush-mounting door switches (with operating magr ets), one surface-mounting door switch with magnet, a pressure mat, a personal attack button, a large amount of interconnecting wire (15 metres of four-core cable for the control unit to siren link and 50 metres of twin-core for the wiring of the sensors to the control unit), screws, rawlplugs and cable clips, and an instruction manual. Coloroll claim that they supply all you need to install a complete alarm system, and, with a couple of reservations, I found this to be the case.

Getting Hooked

The first thing that the manual recommends you to do is to hook up the PSU, control unit and siren on a table-top, to familiarise yourself with the system. Although the manual doesn't say so, this also gives you the opportunity to discover if any of these units are faulty before you've got them well-installed. In my case, all was OK.

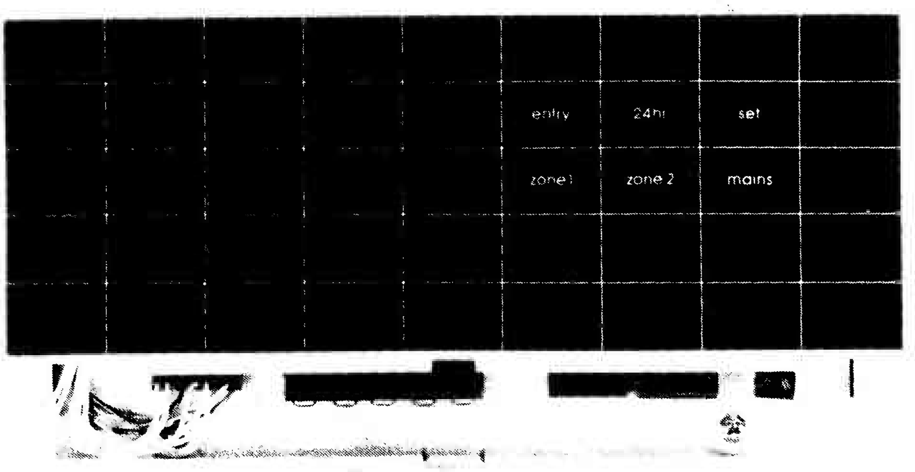
At this stage, you can set the code; this is a four-digit number (but with no repeated digits and no zero) which you use for setting and disabling the alarm (by my reckoning, this gives a total of 3024 possible codes). You set the code by plugging wires with bare ends into sockets — see photo if this explanation sounds a bit garbled! In my mind, this method must raise the question of long-term reliability. If a contact becomes 'dicky', you can't disable (or for that matter, enable) the alarm, and you will probably end up setting off the alarm via the control-unit anti-tamper switch before you can identify and remake the contact. I think that screw connectors would have been preferable for this job, and there certainly seems to be room for this to be done on future generations of the alarm.

Planning Ahead

The next stage is to plan the system carefully, so as to achieve maximum security with minimum effort. The alarm allows for a number of circuits to be used. There are two designated areas, zone 1 and zone 2, and these are where most of the door switches would normally be wired. The difference between the two circuits is that when the alarm is set in the 'part' mode, only contacts in zone 1 (plus other ciruits described later) are monitored — so zone 2 can be the sleeping area, enabling you to set the alarm in 'part' mode and still go to the loo at night without waking the neighbourhood!

The other zone available is that for the exit/entry area; contacts here don't set off the alarm immediately, but give you time to disable the alarm. There are also two other circuits — the anti-tamper circuit, which you can use to implement a four-wire system (ie running four wires rather than just two to all the contacts, making it far harder to bridge the circuits), and the personal attack circuit, which will set off the siren whether or not the alarm is disabled.

I found that the planning of the zones given in the manual was not necessarily the logical way for me to lay out my own system. This is probably because I live in a flat rather than a house. I used the circuits as follows: zone 1 is for the back door and to defend the door to the cellar where the PSU and much of the wiring are; zone 2 is used for all the interior door contacts; and the exit/entry circuit was used for the flat front door (although I



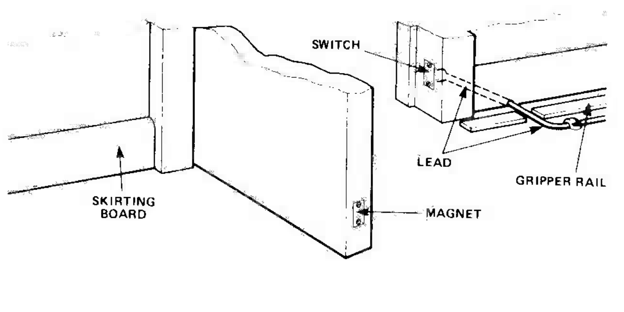
All is revealed (well, not quite, there's a label to say that any attempt to open the case invalidates the guarantee, so I hid the editor's jemmy). The connectors along the bottom are (l to r) code setting, alarm circuits, (lid microswitch), siren unit, and external PSU.

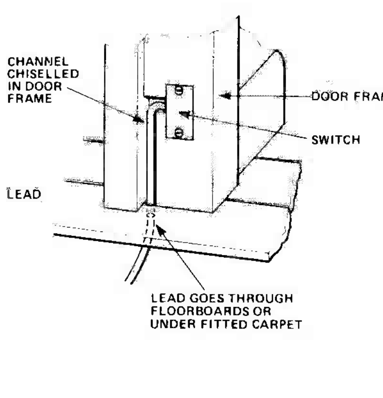
intend to add the pressure mat to this circuit once I have decided on the most suitable position near the front windows). So I would suggest using the lay-out in the manual as a good guide, but not necessarily the only way it is possible to design the system.

However, the main problem I had was in deciding where to put the external siren, and how to get the cable to it. As I live in a ground-floor flat, and I didn't think my upstairs neighbours would relish my drilling holes in their floorboards and wall, the height at which I could mount the siren was a bit limited, although you do need a fair-sized ladder to get to it none-the-less. However, I found when attempting to drill the wall to take the cable, that the wall was somewhat thicker than I had anticipated: the drill bit, bought specially for the job, and some 15" long just wasn't long enough to go through the 1900s-built solid wall, and I (almost literally) had to dig around to find a thinner section of wall, eventually finding a spot above the front bay windows. Actually, the otherwise very thorough manual is rather lacking in advice on loacating and wiring to the external siren.

Because access to the under-floor area is fairly easy, I decided to run most of the wiring here. For this reason, I decided that it was unnecessary to adopt a four-wire system. However, it was contemplated to the extent that I checked to see if there was any means of identifying one of the leads in the two-core wire supplied for the door switches. Unfortunately, there isn't — which would mean quite a lot of fiddling if you did try to implement the four-wire system. Wouldn't it be better to have supplied wire with a ridge down one side, as with some loudspeaker cables? I can't see that such identification would be of any use to an unwelcome tamperer, because it doesn't reveal how the wires have been used.

The recommended method of taking the wire from door switches, mounted in the bottom of the door was, at least for my ham-fisted self, impractical. What I resorted to was taking the cable down the front of the frame below the switch (see drawings) and thence under the carpet or straight down under the floorboards. The cable was set in a chiselled channel, which I then covered over with a suitable filler.





Above: the way the manual recommends doing it; and, left, the way I ended up doing it.

Another practical point is that unless the switch and its magnet are parallel to one another, the contact will not close no matter how close the magnet gets to it! This is rather obvious really, but I still made the mistake at least once of trying to twist one with respect to the other. The manual suggests a maximum gap of 6mm between the contact and the magnet, and I found this had a goodly safety allowance built into it.

Finally on the door contacts, I found it quite feasible to mount them on the hinge-side of the door, thus putting them more out of the way. Whilst this made it possible to open the door slightly without setting off the alarm, it was impossible to go through the door.

Some Complaints

All the complaints I have about this kit are relatively minor, and didn't prevent me from getting the system installed and working in one day (although there are some bits I will be adding when I have time). However, there are some aspects that could be better thought out.

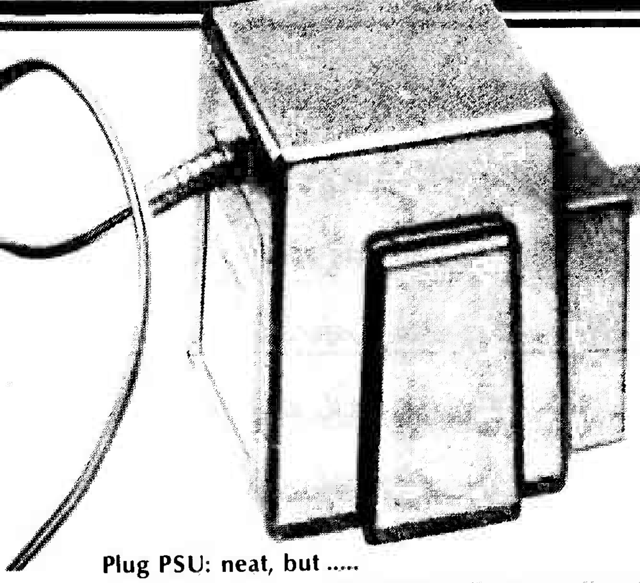
Firstly, I very quickly ran out of the cable clips supplied; but I will readily admit that it was pretty good to be supplied with these in the first place. The rawlplugs supplied were for solid walls, not cavity walls, and whilst this is OK for the external alarm, if possible you want to be able to take the wiring to the back of the control unit, and this means, almost certainly, mounting this unit on a hollow (plasterboard) wall — so how about providing some cavity fixings?

There are two methods of wiring more than one switch on the same circuit, as suggested in the manual, one is to run the lead from the first switch to the next (the switches are all closed in the un-alarmed state, but there are three spare screw terminals on the switches themselves, so wiring them like this causes no problem). However, if you have door switches at opposite ends of your dwelling and the control unit in the middle, it's earier to take the wires to the control unit and join them there. The other method the manual suggests is twisting together the leads to be joined at the central unit, then wrapping with insulating tape — this is far from the most reliable method of joining the leads, and for the electronics-minded installer, the best method would seem to be soldering the leads then covering the joint with heat-shrink (keeping the iron well away from the main unit when you do this). However, I cut a section of terminal block and used this to make the join — but it would have been better if there had been two or three spare terminals in the control unit for this task.

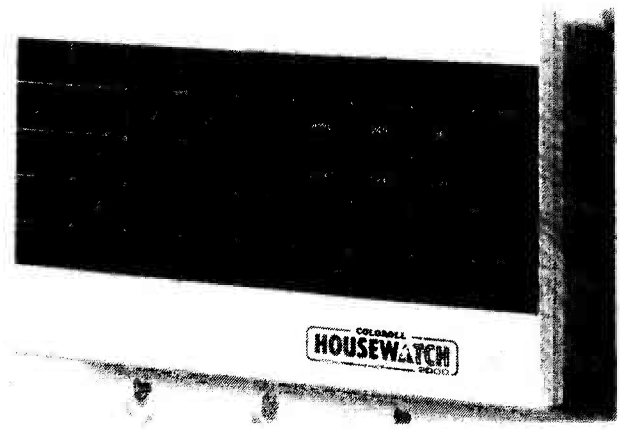
Finally, and I think most seriously, the lead from the PSU is a bit on the short side, being only two metres long. Unless you're very lucky, you're unlikely to have a spare mains socket close enough to the control unit. You can extend the lead from the PSU to the control unit, but this seems to spoil the neat idea of having a plug-mounting PSU. I think that it would have been better to have supplied a wall-fixing transformer unit, with good long input and output leads. I doubt whether anyone who couldn't correctly wire a mains plug should be allowed to attempt to install this unit. In my own case, I solved the problem by installing an extra socket on the ring-main, which just happened to pass close enough to the control unit to reach.

In Operation

At the time of writing I have had the unit in use for less than a week *(such are contributors's deadlines — Ed)* so it is difficult to comment on the long-term reliability. However, the system is extremely straightforward to



Plug PSU: neat, but .....



The control unit is neat and practical

use. As you come through the front door, a bleeping sound reminds you to disable the alarm fairly smartly, or the neighbours will get a nasty shock. So, all you have to do is to remember to set the alarm as you leave — and the system does tell you if any of the door switches are not closed when you try to set it, so you shouldn't be able to go wrong, should you?

Fortunately, I have yet to have a real test of the system. But, at the same time, the little box with 'Housewatch 2000' written on it that sits above my bay window is probably the most effective deterrent one could ask for — although I must say that I am not convinced that it is a good thing for it to be quite a bit smaller than all the other sirens in my street (although it doesn't ruin the appearance of the house, either)!

Conclusion

I can recommend the Housewatch 2000 to ETI readers; there are a few minor niggles about it and a few things that could have been better thought out, but the important aspects are all spot on. Let it suffice to say that I have now stopped worrying about anyone breaking into my flat, and I am contemplating installing one of these systems at my mother's house.

The Coloroll Housewatch 2000 should be widely available through DIY outlets for around £170. If you have any difficulty, please contact Coloroll Ltd, Riverside Mills, Crawford Street, Nelson, Lancashire BBV9 7QT, telephone 0282-67777.

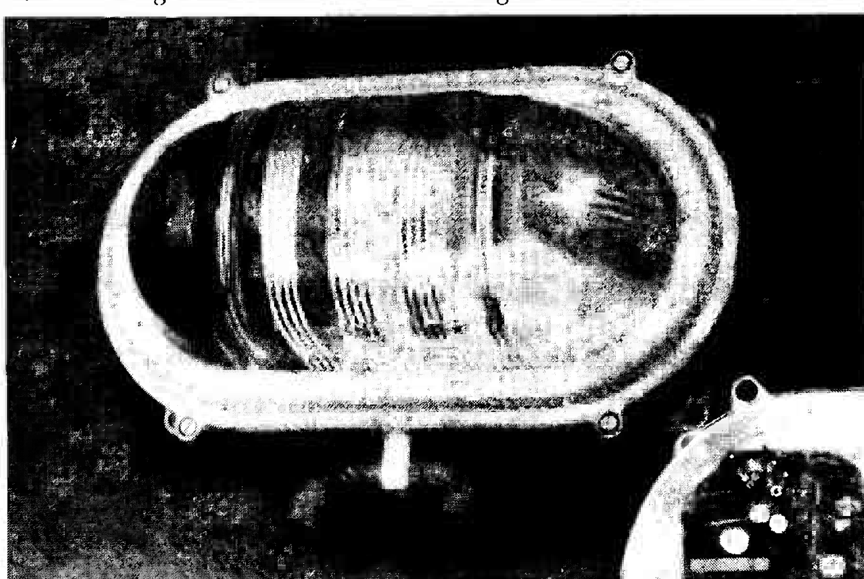
ETI

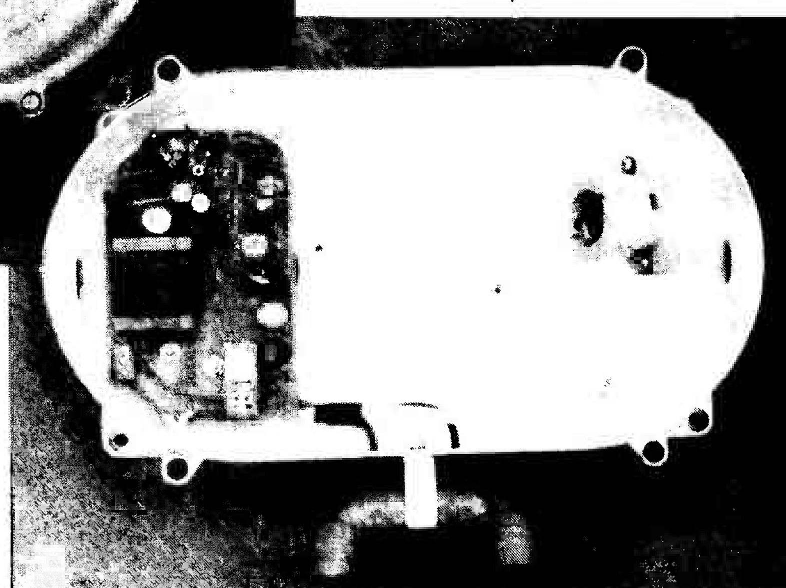
THE ECOLIGHT

Make a burglar go "Eek — a light" with the Ecolight! No, that's not how it got it's name (it stands for ECOnomy LIGHT), but we hope it could have that effect. Design and development credits go to Geoff Philips; the author of the pun wishes to remain anonymous for obvious reasons.

The ETI Ecolight (economy light) looks more or less like a conventional weatherproof bulkhead light fitting. Inside the fitting, however, is an electronic circuit which turns the light on only when it is required. A light sensor makes sure the Ecolight is off during the day and at night the light is turned on only when movement is detected by an ultrasonic beam. The light will remain on as long as there is movement in the beam. When movement ceases, the light remains on for a preset time. The quiesent current drain of the Ecolight makes the running cost approximately ⅓p per day so the Ecolight can be permanently wired to the mains supply (via a 3A fuse).

The obvious application for outside use is as a courtesy porch light: no more fumbling for keys in the dark! The unit also acts as a burglar deterrent as the prowler thinks someone inside the house has turned on the light. The Ecolight is ideal for use in corridors and little used lobbies where it is essential for there to be adequate illumination but cost savings can be made by the light being on only when it is required.





Operation

The Ecolight emits its own ultrasonic sound signal, at a frequency of around 40 kHz. This signal will be reflected off all the objects around the Ecolight and returned to the ultrasonic receiver in the light.

When there is any reasonable-sized object moving in the vicinity of the light, some of the reflected ultrasound will be frequency-shifted, by the Doppler effect. The Doppler effect is what causes the sound of a train or car horn to apparently change in frequency as the train or car pass you. The difference here is that the sound which is having its frequency changed is being 'bounced' off a moving object rather than emitted by it.

At the Ecolight receiver, both the unshifted and shifted ultrasound components arrive. However, in terms of amplitude of signal, the receiver doesn't 'see' two separate signals but one combined signal. This combined signal is not a steady high-frequency signal, but one which is modulated, as the original unshifted and the shifted frequencies move in and out of phase, alternately reinforcing and cancelling (at least partially) each other.

The modulation is at a fre-

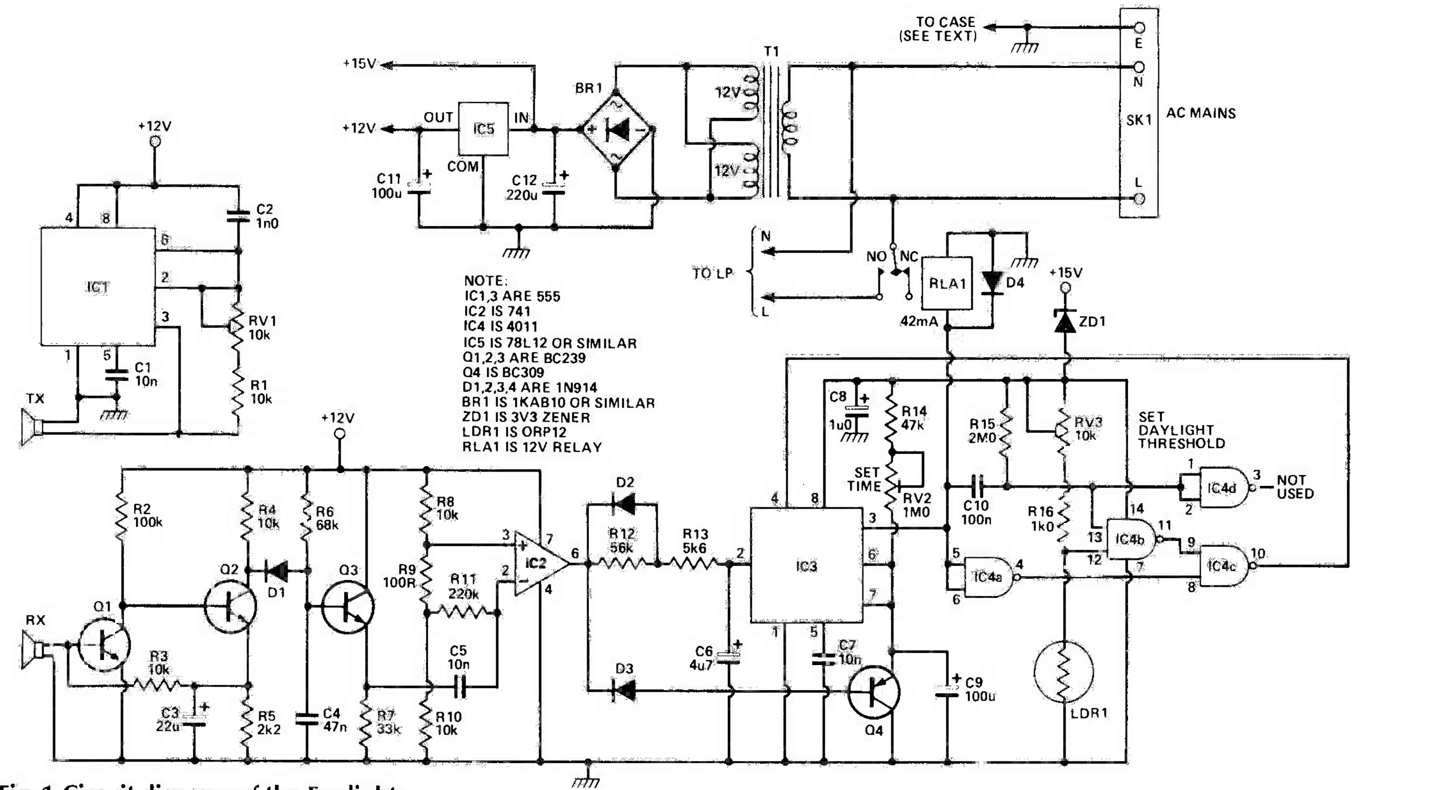


Fig. 1 Circuit diagram of the Ecolight.

quency which is very much lower than the ultrasound frequency (it will depend on the speed of the movement of the objects reflecting sound back to the light). What the control electronics does is to detect this signal, which is only present when there is a moving object close by, and turn on the light in response.

Construction And Testing

Fig. 2 shows the component layout for the control PCB for the Ecolight. Take the usual precautions when handling and soldering the CMOS IC (IC4) otherwise construction of the PCB should pose no problems.

It is a good idea to test the PCB by itself before wiring it into the light fitting. If you don't, you can guarantee that the unit won't work, especially if you've made a neat job of the soldered connections, and you'll end up proving sod's law once again.

Temporarily connect the ultrasonic transducers to the PCB taking care to observe polarity (case is 0V) and also to distinguish between transmitter and receiver (receiver is marked 40R and transmitter 40T). Set RV1 to mid position. Set the on time to minimum (RV2 fully anticlockwise) and the dusk level to max (RV3 fully clockwise). Mask off the daylight sensor (LDR1) with plasticene to fool the Ecolight into thinking it's nighttime. Finally connect 240V mains to X1. Take extra care here. Work on a well-insulated bench and **remember that some of the PCB tracks will be live.** If an oscilloscope is available, look at the collector of Q2 with respect to 0V. The received ultrasonic frequency of approx 40kHz should be seen which should be steady amplitude if there is no moving object in the path of the ultrasonic sensors. RV1 adjusts the frequency of the transmitter oscillator IC1 and gives a degree of sensitivity adjustment to the unit. At the extreme ends of RV1 there are unstable regions of the oscillator which will be seen as fast amplitude variations in the received signal. These regions should be avoided.

HOW IT WORKS

IC1 is connected as medium high frequency oscillator which drives the ultrasonic transmitter transducer, TX. The frequency can be adjusted by RV1.

The received ultrasonic signal from the receiver transducer, RX, is amplifid by Q1 and Q2, which are connected as a high-gain doublet. Bias for Q1 is provided via R3 and R5, and because of the presence of C3, the AC gain of this pair is quite high. The received signal is peak rectified by D1.

If part of the signal is Doppler shifted due to reflection from a moving object, then a beat will occur betwen the unshifted and shifted components of the received signal, resulting in the ultrasonic signal being modulated by the much lower frequency beat signal. D1, C4 and R6 form a detector with a relatively long time constant (about 3ms), and these detect the modulation signal. This is buffered by Q3 and passed to IC2 via C5.

IC2 forms a threshold detector whose level is set by the values of R8,9 and 10 at about 60mV; when the peak value of the detected signal exceeds this value, IC2 will trigger negatively. This starts to discharge capacitor C6 via D2 and R13 (the capacitor is initially charged via R12 and R13, the output of IC2 being high in the presence of no modulation). If the signal exceeds the threshold by a sufficiently large amount for a sufficiently long period, C6 will be discharged enough to trigger the monostable IC3. After this, any disturbance which exceeds the basic threshold level will re-set the monostable capacitor, C9, via D3 and Q4. The period of the monostable is decided by C9, R14 and RV2. The monostable supplies current to relay RLA1 which switches the mains supply to the lamp.

At the onset of daylight, the resistance of LDR1 reduces to the point at which pin 12 of IC4b is reduced below this gate's threshold, IC4b output goes high, and, provided IC4a output is also high, which will be the case when the monostable is not triggered, IC4c output will go low, holding the reset pin of IC3 low and preventing the monostable from triggering. Hence the light will come on only when there is no daylight, but the light will not attempt to inhibit itself from operating. Additionally, R15 and C10 cause pin 13 of IC4b to be held low for a short period after the lamp has extinguished, similarly preventing the monostable from triggering; this is to prevent false re-triggering of the unit due to relay armature movement, supply rail disturbances, etc.

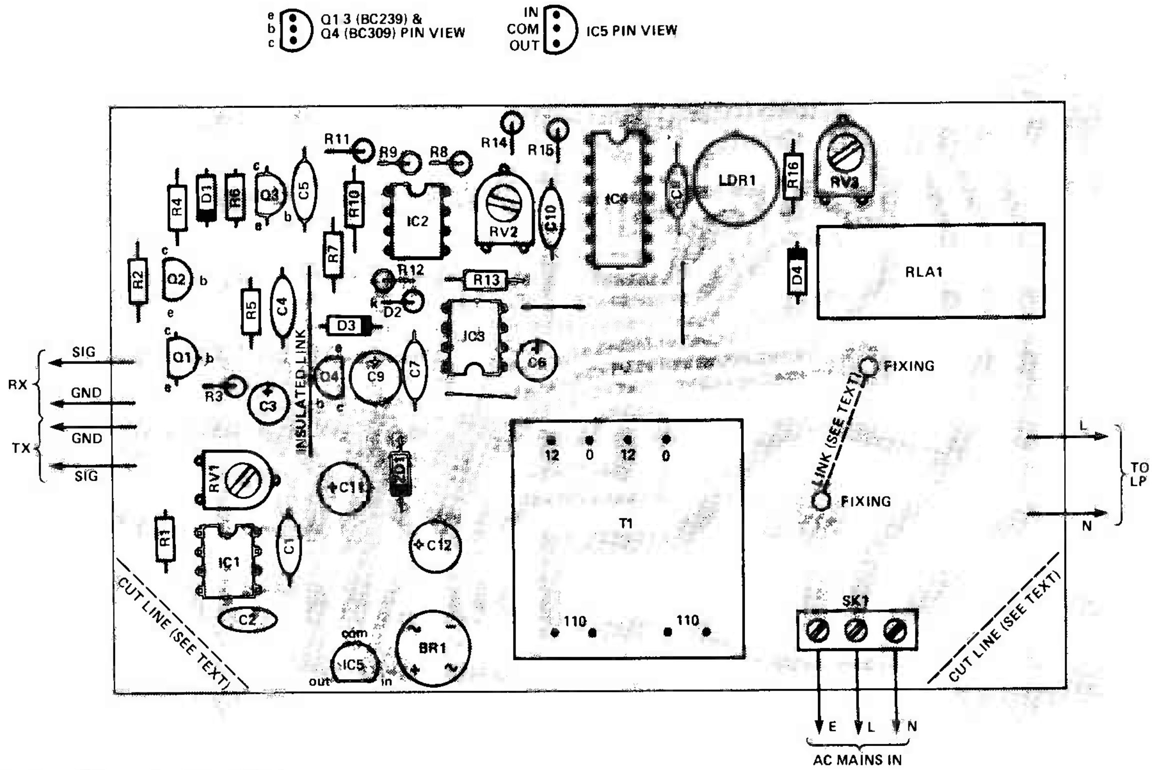


Fig. 2 Overlay diagram of the PCB.

If you do not have access to an oscilloscope do not despair, with RV1 set to mid position switch on and listen for the relay armature to click in. Chase the kids out of the workroom put the cat out and then keep perfectly still. After a few seconds IC3 should time out and the relay will click back to its de-energised state. Move your hand in front of the sensors whereupon the relay should energise. If it doesn't check that no light is leaking onto LDR1 (this device is very sensitive). If the relay is permanently energised and will not drop out, try moving the position of RV1 slightly, as you may be in an unstable region of the oscillator. The output of IC2 is high for no movement and goes low to trigger IC3 and hence energise the relay. Thus, if there is no negative going disturbance at the output of IC2 the fault is in the receiver section, Q3, IC2. If the output of IC2 is seen to switch negatively when there is movement then check the voltage at pin 4 of IC3. If this is at 0V then the timer is being inhibited. Suspect the daylight sensor circuitry. Pin 11 of IC4 should be at logic 0 for the unit to function.

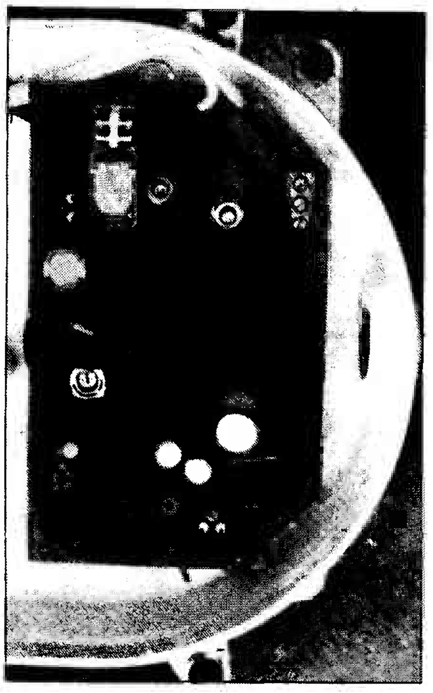
Assuming that you have been successful so far, remove the mask from the daylight sensor and confirm that the unit ceases to function. The PCB is now ready to be fitted into the light fitting.

Assembly Of Unit

The PCB has been designed to fit a Coughtree SP10 light fitting although it should be suitable for any fitting with enough internal space away from the direct heat of the lamp. if the SP10 fitting is to be used then cut two of the corners off the PCB as indicated by the copper strips. Lay the PCB inside the SP10 at the opposite end to the lamp. Drill two M4 clear holes in the SP10 casing using the holes in the PCB next to the relay as a guide for the drill. Fit two M4 screws from the rear of the SP10

PARTS LIST

RESISTORS (all 5% ¼ W carbon film)		**SEMICONDUCTORS**	
R1,3,4,8,10	10k	IC1,3	LM555CN or similar
R2	100k	IC2	741
R5	2k2	IC4	HEF4011P or similar
R6	68k	IC5	LM340LAZ-12 or 78L12
R7	33k	Q1-3	BC239
R9	100R	Q4	BC309
R11	220k	D1-4	1N914
R12	56k	BR1	1KAB10 or similar
R13	5k6	ZD1	BZY88C3V3 or similar
R14	47k		
R15	2M0		
R16	1k0		
RV1,3	10k horizontal lin preset	**MISCELLANEOUS**	
RV2	1M0 horizontal lin preset	TX	Ultrasonic transmitter, ITT SE 05B-40T
		RX	Ultrasonic receiver, ITT SE 05B-40R
CAPACITORS			
C1,5,7	10n polyester	T1	3VA mains transformer, PCB mounting, 0-12V+0-12V
C2	1n0 polyester		
C3	22u 16V electrolytic, PCB type	LDR1	Mullard ORP12
C4	47n polyester	SK1	3-way PCB-mounting connector terminal strip
C6	4u7 16V electrolytic		
C8	1u0 25V electrolytic, axial	RLA1	12V 42mA relay with 240V AC contacts, eg Fujitsu FBR 621 12V
C9,11	100u 25V electrolytic, PCB type		
C10	100n polyester	Bulkhead light fitting (see text), PCB, material to house transducers (see text).	
C12	220u 25V electrolytic, PCB type		



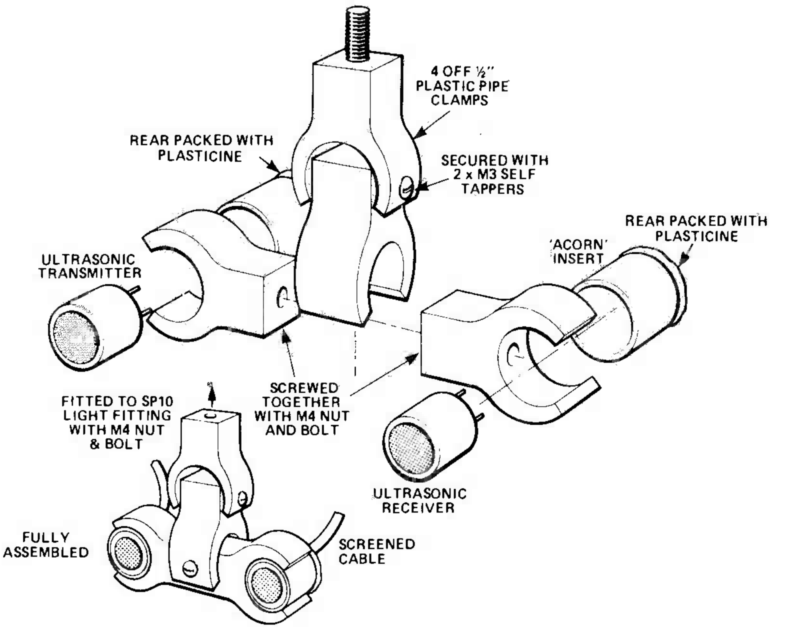


Fig. 3 Alternative method of mounting the transducers.

case and secure the screws so that the PCB can be secured to the SP10 some 10mm away.

The ultrasonic transducers have to be mounted in a suitable manner to allow them to be pointed in the desired direction. For the original prototype, they were mounted in two plumber's copper elbow joints brased together, as can be seen from the photographs. However, the original transducers do not seem to be available any more, having been replaced by larger transducers that won't quite fit in a common size of pipe fitting. Fig. 3 shows the new mounting method, and the transducers supplied in the kit (see 'Buylines') will need to be mounted like this. However, if you choose different transducers, you may be able to use the original method. Whatever you do, note that the transducers must be reasonably well protected, since most types are not waterproof.

BUYLINES

We do not anticipate many problems in locating components for this project, with the possible exception of the transducers. However, we see no reason why the design should not work with the many alternative types of 40 kHz transducers there are on the market.

For the lazy, a full kit of the electronics (including the PCB and the 'Acorn' inserts for the transducers but excluding the light fitting, copper elbow joints and heat shield) is available from G.P. Electronic Services for £21.05 including VAT and p&p. For the slightly more adventurous, G.P. can supply the PCB on its own for the inclusive price of £4.50.

Use screened cable to wire up the transducers to the PCB. Pass the cable through the copper elbows or the back of the 'Acorn' inserts, then through the side of the case of the SP10 via a rubber grommet. Wire up the sensors and the SP10 lamp to the PCB. Fit the PCB in the SP10 via the two M4 screws. Note that the PCB is earthed via these screws making contact with the 0V track; if you use some other fixing method, these two points on the circuit must be connected, and, if the case used is metal, this must be earthed either from this point or directly.

The final job is to wire up 240V mains to the connector X1; note that the live must be fused, so if you are wiring directly to the mains, either use a fused connection unit or find space to fit a panel-mounting fuse. Alternatively, you could always use a fused plug (a 3A fuse should be used).

Fitting And Final Testing

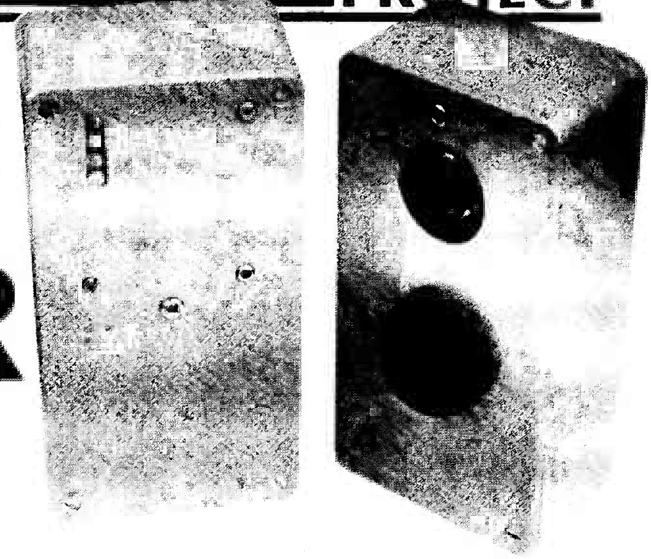
The Ecolight should be securely fixed to a wall away from bushes and plants, which would cause false triggering, and sheltered from high winds. In order to test the unit in daylight it is necessary to mask off the ORP12 device again with plasticene. Angle the ultrasonic sensors in the desired direction and determine the best setting of RV1 for the sensitivity required. Do not set the sensitivity too high, however, as you may be troubled by false triggering in high wind conditions. Once you are happy with the setting of RV1, the on time can be set up by RV2. RV2 should be advanced clockwise to give the required time delay for the light to switch itself off after movement in the ultrasonic beam has ceased.

The dusk level pot may now be set up. Remove the plasticene from the ORP12 and, at dusk, turn RV3 fully anti-clockwise. The Ecolight should now be inhibited. Turn RV3 clockwise whilst moving your hand in front of the beam until the Ecolight just starts to function.

It is recommended that an aluminium heat shield be fitted over the PCB to prevent overheating of the electronic components. A hole will be required in the shield however to allow the ORP12 device to function. Bear this in mind when adjusting the dusk level. Turn RV3 further clockwise if you want the Ecolight to come on earlier in the evening.

ETI

INFRARED INTRUDER ALARM



This interruptible-beam intruder alarm offers all the advantages of infrared operation and yet is simple enough for almost anyone to build. Design by Frederick Howard.

Infrared intruder alarms offer a number of advantages over alternative electronic alarm systems. Unlike ultrasonic systems, they are not generally sensitive to movement outside of the area covered by the beam. This prevents their being triggered by the movement of, for example, curtains stirred by a draught, and with careful positioning they can be arranged so as not to detect the legitimate movements of domestic pets. The invisible infrared beam is not as easily spotted by an intruder as a visible light beam, and the use of a pulsed rather than a continuous source prevents the alarm operation being upset by any steady infrared component present in the ambient light. At the same time infrared alarms retain the advantages of other energy beam systems, being battery operated and portable and thus able to be installed quickly without wiring and to be moved rapidly to monitor a new location when occasion demands.

The block diagram of the ETI Infrared Intruder Alarm is shown in Fig. 1. A multivibrator produces a one millisecond pulse ten times a second and this switches a 50 kHz oscillator which in turn drives the IR (infrared) diodes. The diodes are fitted with an integral lens which focuses their output into a narrow beam. Provision has been made on the PCB for up to four diodes in series to be used, giving a high energy output and a reasonably wide beam, but if the alarm is to be used only over short distances it is possible to use fewer diodes just by inserting links in the vacant positions.

In the receiver, a lens focuses the incoming beam onto an infrared detector diode placed in series with a tuned circuit. The signal from the diode is fed to an amplifier which is also tuned to 50kHz and the output is then fed to the detector. If the beam is interrupted so that no signal arrives at the detector, an audible warning device is energised to sound the alarm. A timing circuit holds the alarm on for one-to-two minutes and then resets it ready to be re-triggered if the beam is disturbed again. Since the circuit requires a little time to stabilise, a further timing circuit holds the alarm off for a short period after switch on.

In normal operation the transmitter and receiver will be placed opposite one another and in direct line, but for short distances the two can be stood side by side and the beam reflected from an opposite wall or other surface. This might be convenient in a narrow hallway or other location where one wall is relatively featureless and where it would otherwise be difficult to conceal one of the units.

Construction

The transmitter and the receiver are both assembled on PCBs and then installed in identical plastic boxes. It does not matter in which order you assemble them since both will have to be substantially complete before you can move on to the setting-up. Begin by soldering the IC sockets and the passive components into place on each PCB, then add the diodes and finally the transistors. The ICs can be installed in their sockets when all the soldering is complete. The IR diodes should be left off of the transmitter PCB until it has been installed in its box. It will save time later on if you solder into place the end of R5 on the transmitter nearest to D3 and Q1, but temporarily connect the other end to the positive supply rather than soldering it into the hole adjacent to R4 as shown.

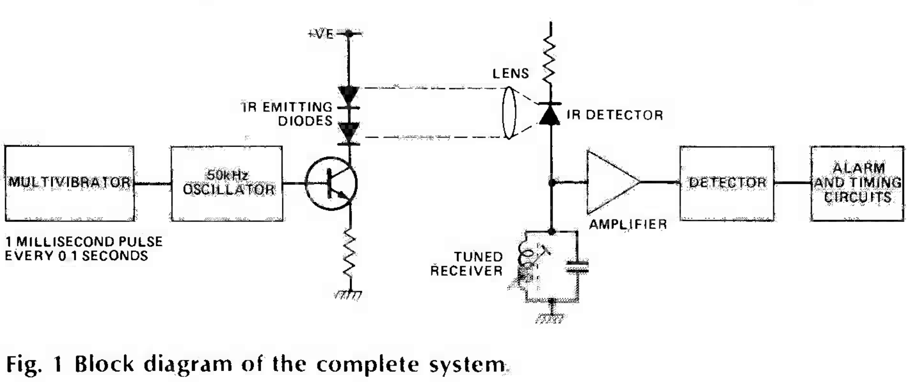


Fig. 1 Block diagram of the complete system.

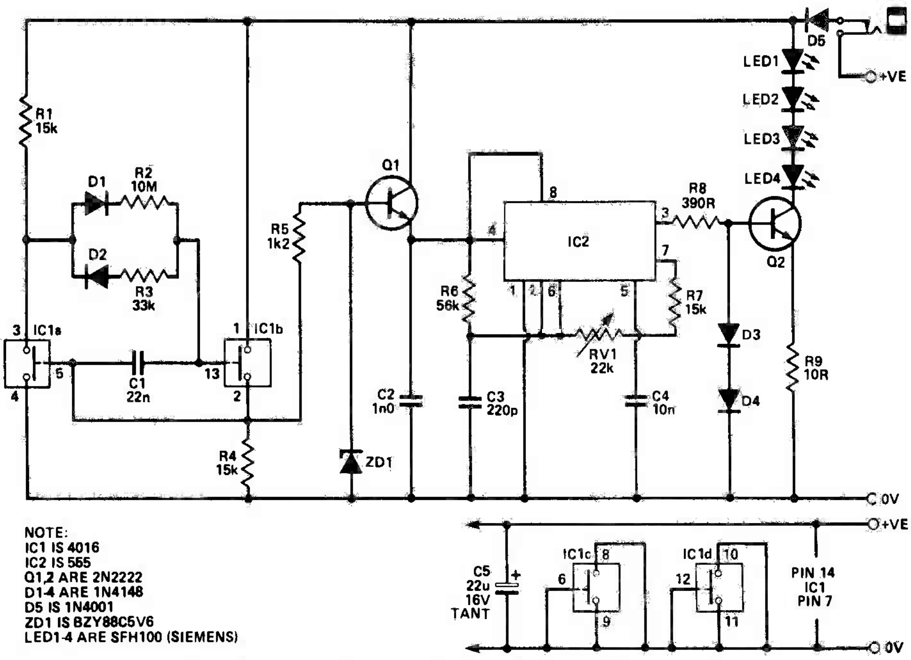


Fig. 2 Circuit diagram of the infrared transmitter.

The drilling details for the transmitter are shown in Fig. 6. Note that only three bolts are used to hold the PCB to the front panel, the fourth corner being occupied by the IR diodes. You may find that you don't need all four IR diodes for your particular application, so it is a good idea to install only one to begin with and to link

across the remaining holes on the PCB. If you do this, you will only need to drill a single hole for the diode rather than the slot shown, and of course, you can easily drill further holes and file out the slot should you later decide that you want to use more diodes. You should install the diode or diodes onto the PCB without soldering and then assemble the board onto the drilled front panel and the blots. Each diode can then be dropped accurately into its hole, the leads bent over on the component side of the board to mark the correct length, and the board then removed from the front panel so the diode can be soldered finally into place.

The drilling details for the receiver case are shown in Fig. 7. Two largish holes are required, one for the audible warning device and one for the lens. If you do not have any other means of making holes of suitable size in plastic, you can always drill a series of small holes and then link them up with a small, round file. If the appearance of the finished unit is important to you, the circle of holes could be made a little smaller than the desired diameter and then enlarged smoothly with a piece of rolled-up sandpaper. Some audible warning devices have a fixing ring which covers the mounting the hole. However, it is perfectly possible to use any audible warning device which will operate from 9V and does not draw too much current, so you may wish to bear this point in mind when choosing.

PARTS LIST — TRANSMITTER

RESISTORS (all ¼W 5%)	
R1,4,7	15k
R2	10M
R3	33k
R5	1k2
R6	56k
R8	390R
R9	10R
RV1	22k horizontal skeleton preset
CAPACITORS	
C1	22n ceramic
C2	1n0 ceramic
C3	220p silver mica
C4	1n0 ceramic
C5	22u 16V tantalum
SEMICONDUCTORS	
IC1	4016
IC2	555
Q1, 2	2N2222
D1-4	1N4148
D5	1N4001
ZD1	BZY88C 5 V6 zener
LED1-4	SFH 100 (Siemens)

MISCELLANEOUS
PCB; plastic case; IC sockets; miniature jack socket with switch and plug to suit; battery holder for 8 x AA cells or equivalent; battery connector; nuts, bolts, etc.

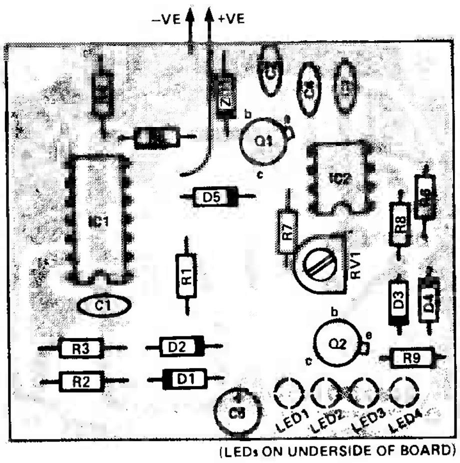


Fig. 3 Overlay diagram of the transmitter PCB.

HOW IT WORKS — TRANSMITTER

Integrated Circuit IC1 consists of four electronic switches, two of which are connected as an assymetric multivibrator. The ratio of charge to discharge time for C1 is controlled by R2 and R3. This ratio results in a narrow positive going pulse of about 1 millisecond, which is fed to the base of Q1 through R5 at a rate of 10 times per second. The base voltage is limited to 5.6 volts by the zener diode ZD1.

IC2 is coupled as a multivibrator producing symmetrical square waves at the output. The frequency of 50 kHz is set by C3 in conjunction with resistors R6, R7, and RV1. IC2 is only switched on when transistor Q1 conducts. The 50 kHz oscillator is thus pulsed on for one millisecond ten times per second. The pulse voltage is limited to 5 volts to ensure frequency stability independent of battery voltage.

The oscillator output is applied to transistor Q2 which controls the current through the infrared emitter diodes, LED1-LED4. The pulse current through the diodes is controlled by D3 and D4 in conjunction with R9. The peak pulse current is about 120 mA, but because they are pulsed at 50 kHz for only 1 millisecond in 100 the total battery drain is about 600 μA.

The lens used in the prototype was obtained from RS and is sold as an inspection lens. This means that the plastic collar in which it is supported is equal in height to its focal length. Almost any other lens could be used provided its focal length can be accommodated within the receiver case — about 30 to 40 mm would be best. If you have a lens lying around but don't know its focal length, simply use it to focus the sun's rays onto a flat surface and then measure the distance of the lens from that surface. (Note that this will only work with the sun and not with artificial lighting; this is because the sun is so far away that its rays are very nearly parallel when they reach us.) If your chosen lens does not have a collar which extends for its full focal length, you will have to add a length of tube of suitable diameter and paint it black inside. Remember also that the top of the detector diode is a millimeter or two above the surface of the PCB and allow for this before gluing the lens assembly to the PCB. Make sure you centre the lens over the diode itself.

The final stage in the assembly of both units is to wire up the battery connectors via the jack sockets. The jack sockets serve as on-off switches, and are so arranged that inserting the plugs disconnects the supplies. This makes it difficult for an intruder to silence the alarm once it has been triggered. The audible warning unit in the receiver also has to be wired up and the units are then ready for testing.

Due to lack of space in this issue, we're afraid that you will have to wait until next month for the overlay for the PCB receiver PCB, the case drilling details, how to set up the alarm, and Buylines.

HOW IT WORKS — RECEIVER

The infrared transmission is directed or reflected onto the IR detector diode LD1, which is mounted at the focus of a simple lens. A 50 kHz resonant circuit, L1 and C1, forms the load for the detector. Only infra-red energy from a 50 kHz source will give a voltage across the load, thus eliminating unwanted signals from lights or heaters. The detector is followed by a 5 stage amplifier, one stage of which has a 50 kHz tuned circuit as the collector load. This possess only the wanted 50 kHz signal and rejects other interfering signals. Transistors are used in preference to integrated circuit amplifiers as they can give a reasonable gain at 50 kHz for only a few microamps of collector current.

A constant signal level for any given input is maintained at the output of the amplifier by rectifying the signal through D1, in conjunction with D2. A negative DC voltage is generated across C10 which is proportional to the signal level. This negative potential is applied to the gate of the field effect transistor Q3 to control the effective resistance between the drain and source of this transistor. This determines the current negative feedback and hence gain of amplifier stage built around Q2. The time constant of the automatic gain control circuit is about 50 seconds.

The signal level at the emitter follower, Q7, is detected by D3 and Q8. For a constant signal level there will be a constant DC voltage on C16. This voltage will decrease when the beam is broken and increase when the beam is restored —the gain of the amplifier being slow to respond compared with the signal level detector time of response, which is of the order of one second for signal decay but almost immediate for signal increase. The sharp increase of DC level at C16 after the beam is restored will be transferred through to the base of Q9, switching on Q9 which in turn switches on Q10 and hence Q11 which energises the alarm. When Q10 goes positive it will hold Q9 on by supplying current through D9 and R26, latching on the whole alarm circuit.

C19, will now commence to discharge through R25. When the potential at pin 5 of IC1 reaches about 5 volts, pin 4 of IC1 will be connected to the zero supply and hence transistors Q9, Q10 and Q11 are all switched off. C19 will now charge via D6, R29 and R31, releasing the switch on pin 4 of IC1 and leaving the circuit in readiness for any further disturbance of the beam.

The circuit needs time to settle to a stable gain and signal level. On initial switch-on, pin 5 of IC1 is held positive by the absence of charge on C19. This holds the base of Q9 to the zero supply line maintaining Q9, Q10 and Q11 in their cut-off state.

When C18 has charged through D6, R29 and R31, the switch on IC1 will open and the circuit will be ready to detect a disturbance of the beam.

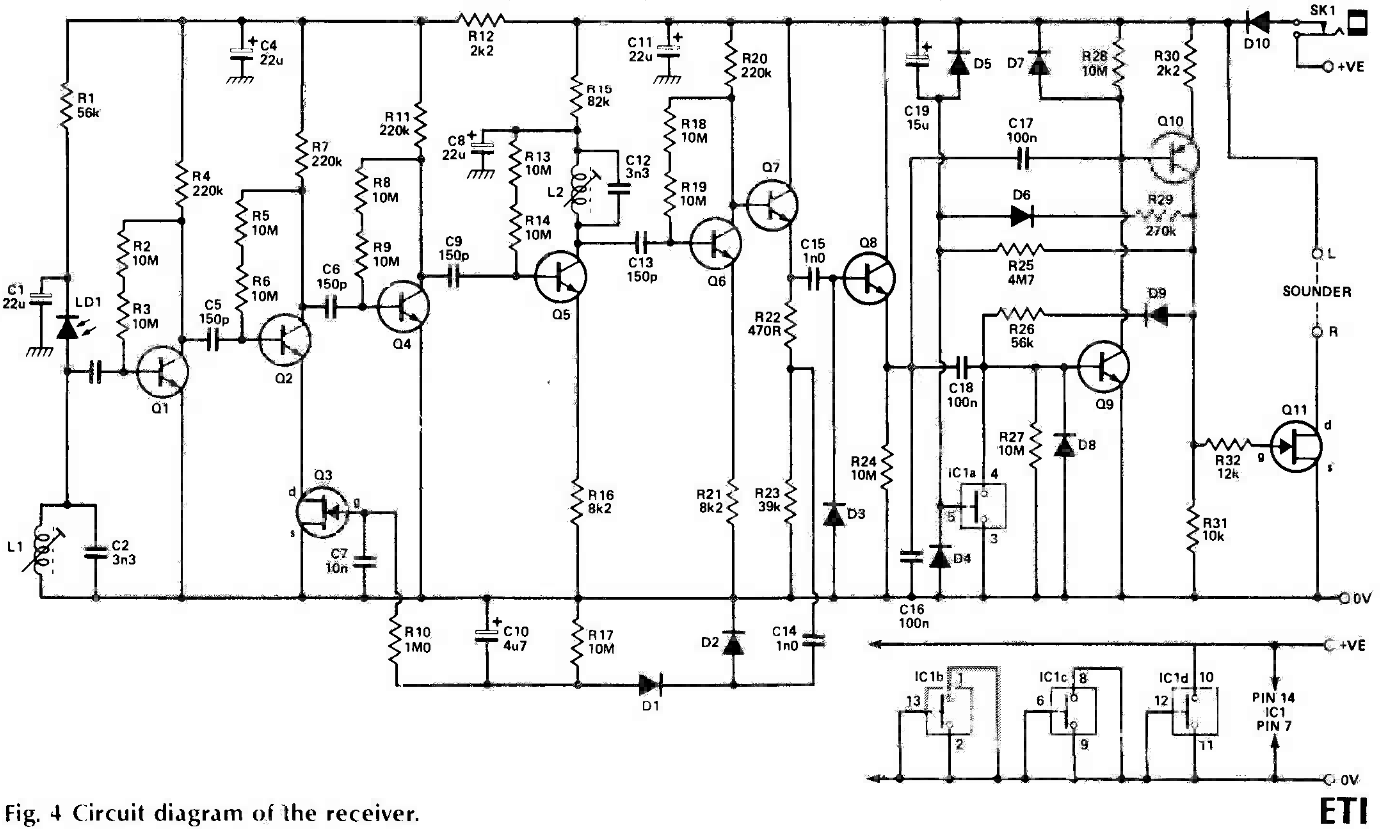
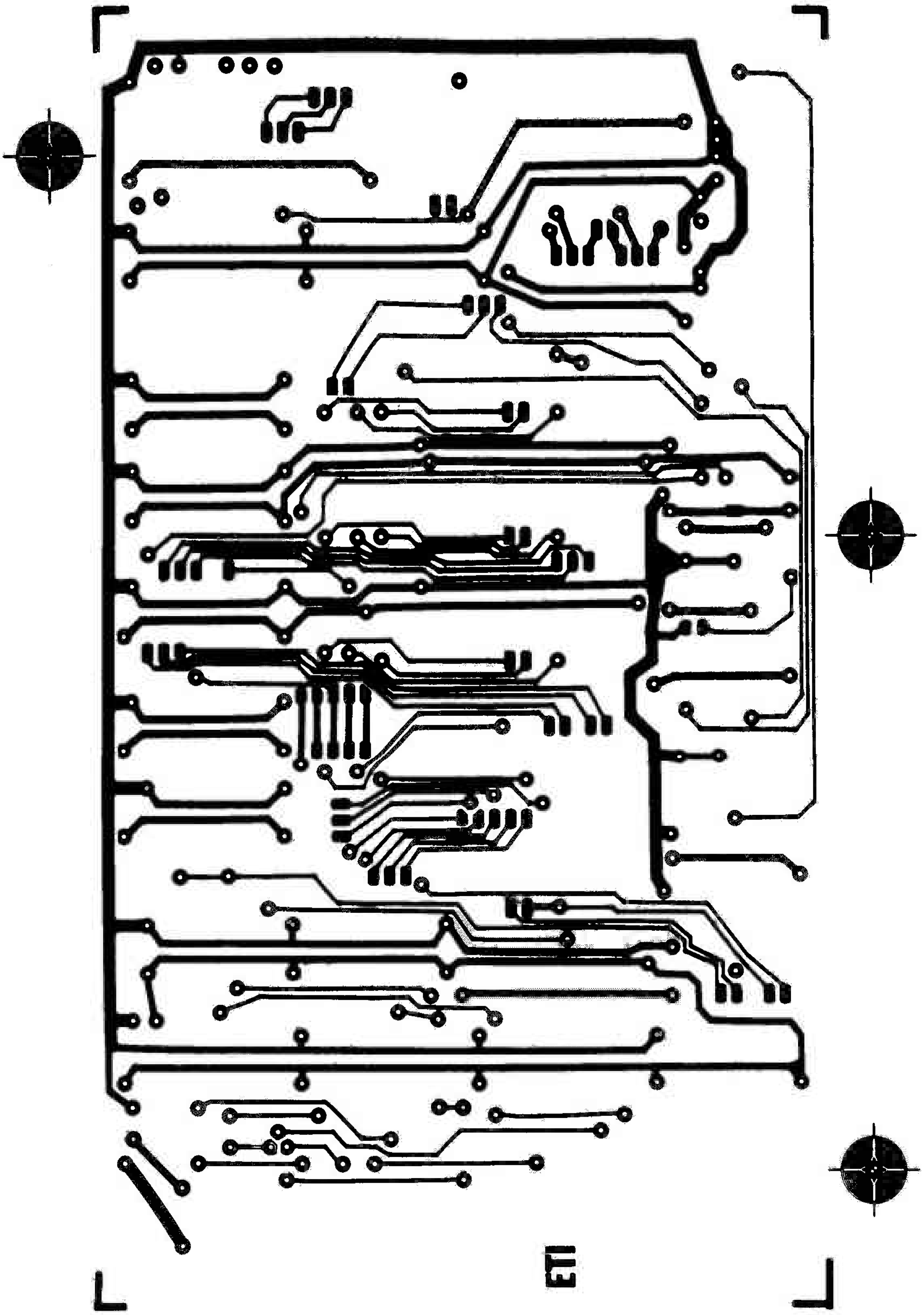


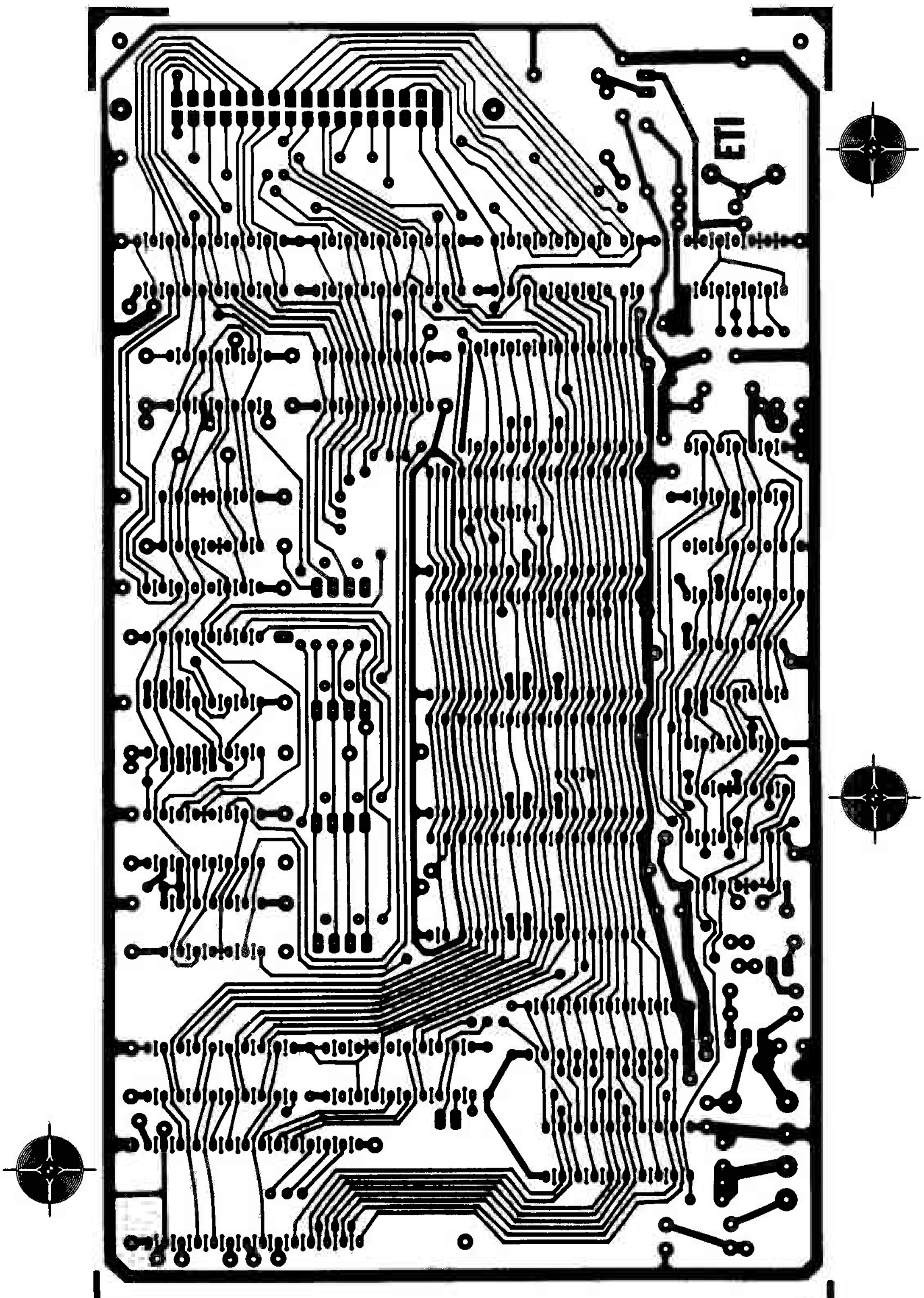
Fig. 4 Circuit diagram of the receiver.

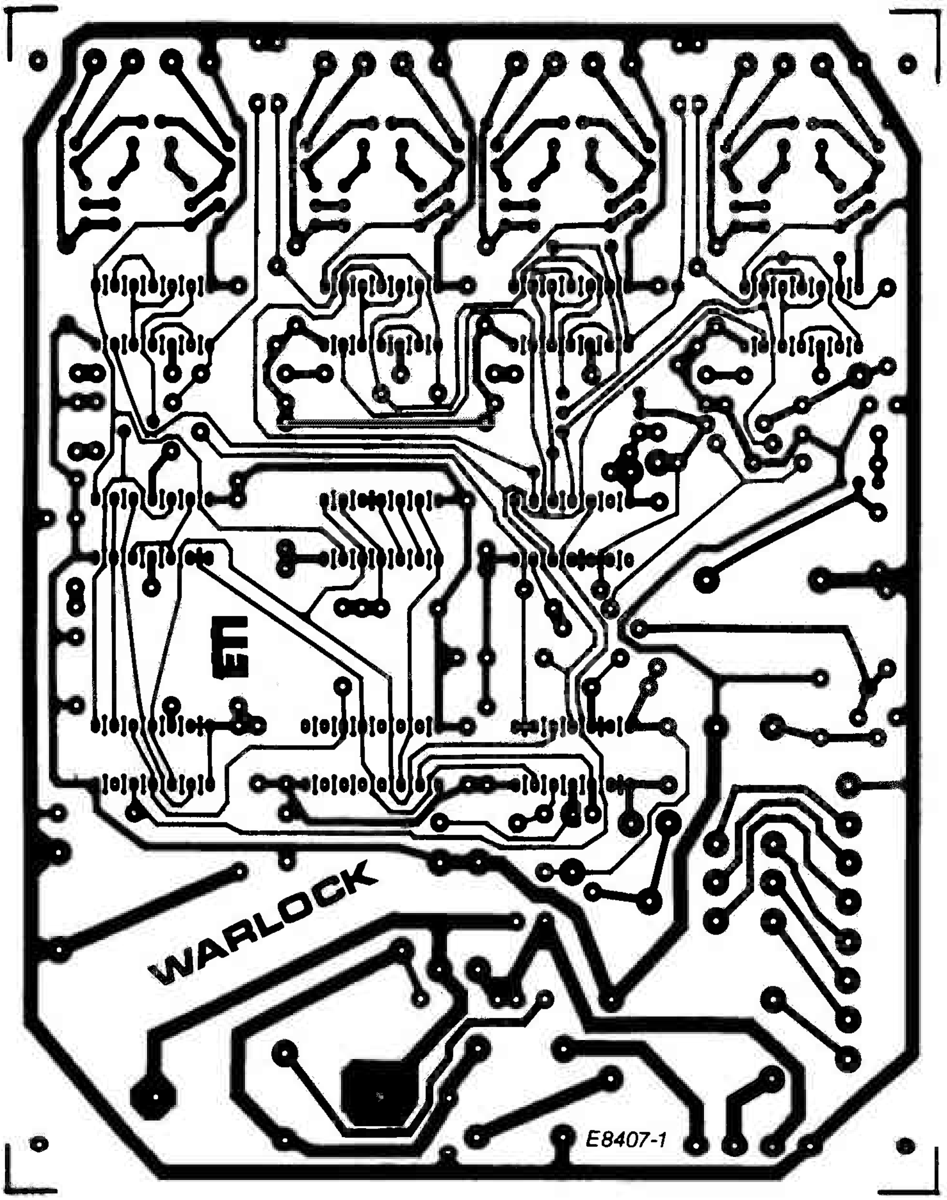
ETI

PCB FOIL PATTERNS

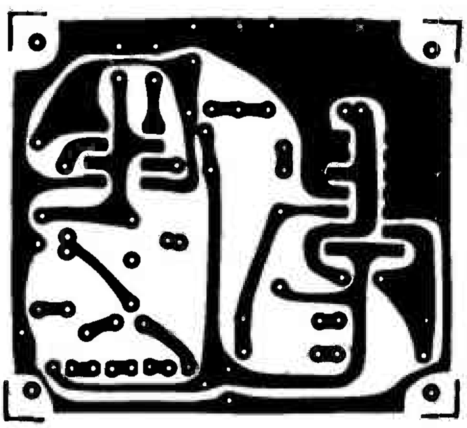


These two foil patterns are for the double-sided Oric/Atmos EPROM board, held over from last month.

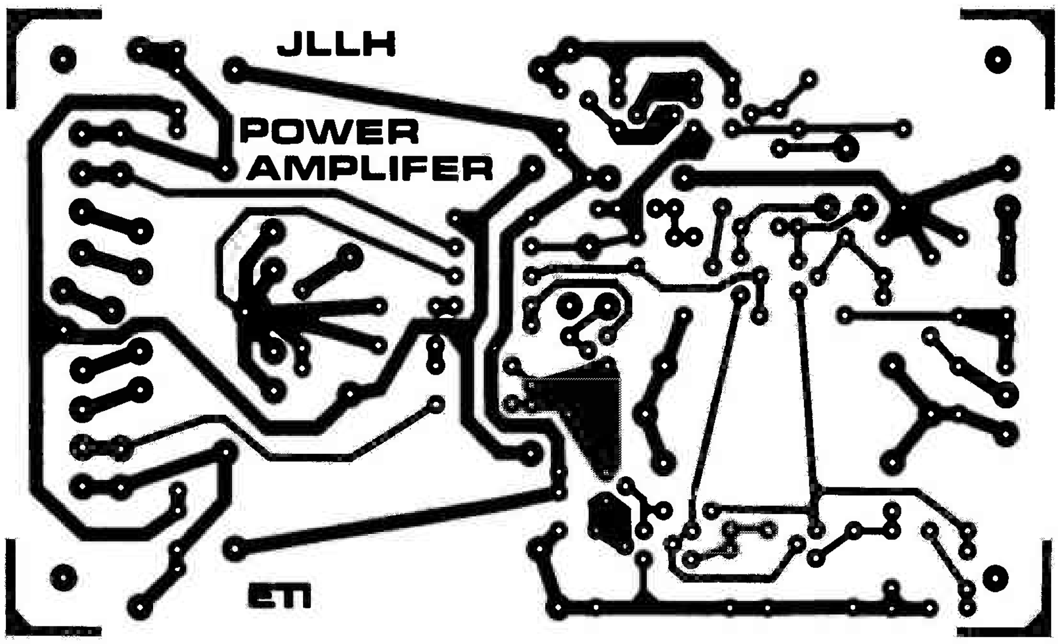




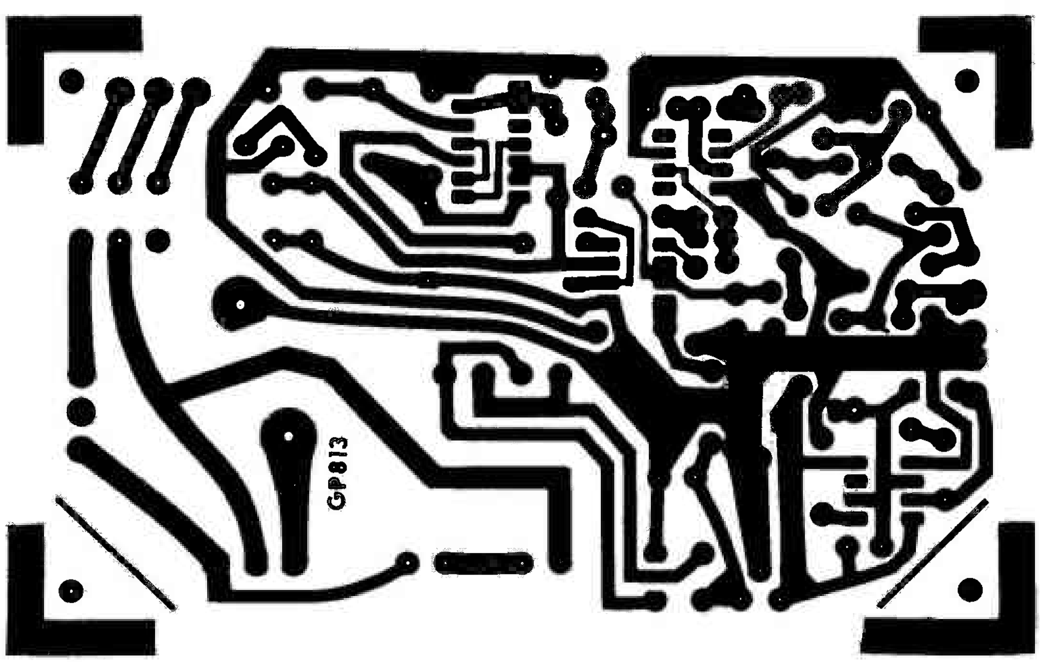
The Warlock alarm board.



The Infrared alarm transmitter board.



The Audio Design power amplifier board.



The Ecolite board.

ETI PCB SERVICE

In order to ensure that you get the correct board, you must quote the reference code when ordering. The code can also be used to identify the year and month in which a particular project appeared: the first two numbers are the year, the third is the month and the number after the hyphen indicates the particular project.

Note that these are all the boards that are available — if it isn't listed, we don't have it.

Our terms are strictly cash with order — we do not accept official orders. However, we can provide a pro-forma invoice for you to raise a cheque against, but we must stress that the goods will not be dispatched until we receive payment.

1979

- ☐ E/794-1 Guitar Effects Unit........3.04
- ☐ E/794-2 Click Eliminator...........7.64

1980

- ☐ E/808-3 Ultrasound Burglar Alarm 3.30
- ☐ E/8010-1 Cassette Interface.......3.37
- ☐ E/8010-2 Fuzz/Sustain Box........3.76
- ☐ E/8012-3 Four Input Mixer.........3.04

1981

- ☐ E/811-1 LED Tacho...............4.75
- ☐ E/811-2 Multi-Option Siren........3.68
- ☐ E/812-2 IR Alarm (4 boards).......7.64
- ☐ E/812-5 Pulse Generator..........4.11
- ☐ E/814-2 Drum Machine (2 boards) 6.44
- ☐ E/814-4 Guitar Note Expander.....3.68
- ☐ E/816-8 Waa-Phase...............1.76
- ☐ E/816-9 Alien Attack..............4.00
- ☐ E/817-1 System A-Input (MM or MC)...................3.05
- ☐ E/817-2 System A — Preamp.......5.95
- ☐ E/817-3 Smart Battery Charger.....2.27
- ☐ E/818-3 Hand Clap Synth..........4.57
- ☐ E/818-5 Watchdog Home Security (2 boards)..............6.11
- ☐ E/819-1 Mains Audio Link (3 boards).....................8.45
- ☐ E/819-4 Laboratory PSU...........5.21
- ☐ E/8110-1 Enlarger Timer...........3.91
- ☐ E/8110-2 Sound Bender...........3.05
- ☐ E/8111-1 Voice Over Unit.........4.57
- ☐ E/8111-2 Car Alarm...............3.23
- ☐ E/8111-3 Phone Bell Shifter........3.40
- ☐ E/8112-4 Component Tester.......1.71

1982

- ☐ E/821-3 Guitar Tuner (2 boards)...6.38
- ☐ E/822-1 Ripple Monitor...........2.21
- ☐ E/822-2 Allez Cat Pest Repeller....1.93
- ☐ E/822-5 Moving Magnet Stage.....4.01
- ☐ E/822-6 Moving Coil Stage........4.01
- ☐ E/823-4 Capacitance Meter (2 boards)....................11.66
- ☐ E/825-1 DV Meg..................3.13
- ☐ E/826-1 Ion Generator (3 boards).....................9.20
- ☐ E/826-4 MOSFET Amp Module.....7.80
- ☐ E/826-5 Logic Lock...............3.52
- ☐ E/826-6 Digital PWM.............3.84
- ☐ E/826-7 Optical Sensor...........2.00
- ☐ E/826-9 Oscilloscope (4 boards).....................13.34
- ☐ E/827-7 TV Bargraph Main.........5.24
- ☐ E/827-3 TV Bargraph Channel......2.62
- ☐ E/827-4 Hotwire..................3.02
- ☐ E/827-5 Bridging Adapter.........2.74
- ☐ E/828-1 Playmate (3 boards).......8.28
- ☐ E/828-4 Kitchen Scales............2.12
- ☐ E/829-1 Auto Volume Control......2.12
- ☐ E/829-2 Dual Logic Probe.........2.22
- ☐ E/8211-4 Pulse Generator.........6.08
- ☐ E/8212-1 ELCB...................2.77
- ☐ E/8212-2 Servo Interface (2 boards)....................6.75
- ☐ E/8212-4 Spectracolumn..........5.54

1983

- ☐ E/831-1 Fuel Gauge...............3.45
- ☐ E/831-2 ZX ADC.................2.59
- ☐ E/831-3 Programmable PSU.......3.45
- ☐ E/833-1 SoundBoard.............12.83
- ☐ E/833-2 Alarm Module............3.62
- ☐ E/833-3 ZX81 User Graphics......1.07
- ☐ E/833-4 Logic Probe..............2.50
- ☐ E/834-1 Real Time Clock..........8.74
- ☐ E/834-2 Thermemeter (2 boards)......................9.74
- ☐ E/834-4 Stage Lighting — Main...13.73
- ☐ E/834-5 Stage Lighting — Display 3.45
- ☐ E/835-1 Compressor/Limiter......6.19
- ☐ E/835-2 Single PSU..............3.16
- ☐ E/835-3 Dual PSU................4.01
- ☐ E/835-4.2 NDFL Amp.............7.88
- ☐ E/835-5 Balance Input Preamp.....3.23
- ☐ E/835-6 Stage Lighting Autofade.......................6.19
- ☐ E/835-7 Stage Lighting — Triac Board.....................4.74
- ☐ E/836-1 to 3 PseudoROM (3 boards)......................3.62
- ☐ E/836/4 Immersible Heater........2.30
- ☐ E/836-5 Atom Keypad.............5.18
- ☐ E/837-1 Flash Sequencer..........2.67
- ☐ E/837-2 Trigger Unit Main Board...2.67
- ☐ E/837-3 Trigger Unit Transmitter...1.66
- ☐ E/837-4 Switched Mode PSU.....16.10
- ☐ E/838-1 Graphic Equalisr..........9.10
- ☐ E/838-2 Servo Fail-Safe (four-off).......................2.93
- ☐ E/838-3 Universal EPROM prog....9.64
- ☐ E/839-1 NiCad Charger/Regen.....3.77
- ☐ E/839-2 Digger...................3.40
- ☐ E/839-3 64K DRAM...............14.08
- ☐ E/8310-1 Supply Protector........2.19
- ☐ E/8310-2 Car Alarm...............3.98
- ☐ E/8310-3 Typewriter Interface.....4.17
- ☐ E/8311-1 Mini Drum Synth........3.07
- ☐ E/8311-2 Alarm Extender..........3.21
- ☐ E/8311-3 Multiswitch.............3.59
- ☐ E/8311-4 Multiple Port............4.34
- ☐ E/8311-5 DAC/ADC Filter.........3.22
- ☐ E/8311-6 Light Pen...............4.60
- ☐ E/8311-7 Logic Clip...............2.51
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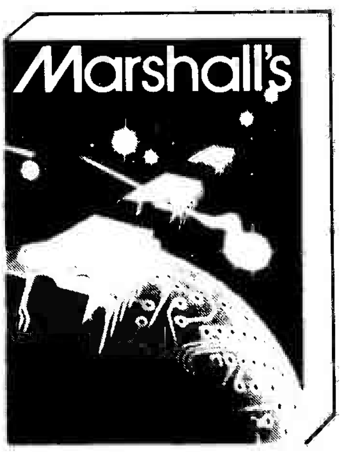

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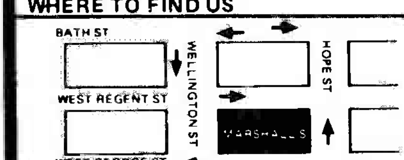

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ADVERTISERS INDEX

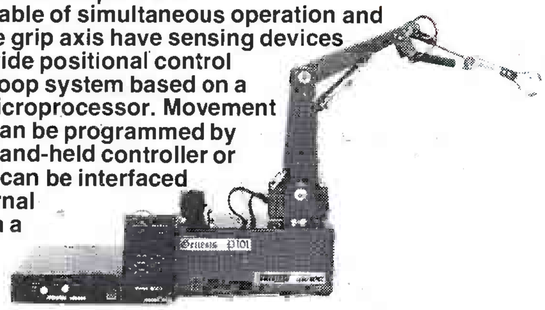
Low-price robots from POWERTRAN

– hydraulically powered
– microprocessor controlled

The UK-designed and manufactured range of Genesis general purpose robots provides a first-rate introduction to robotics for both education and industry.

GENESIS P101

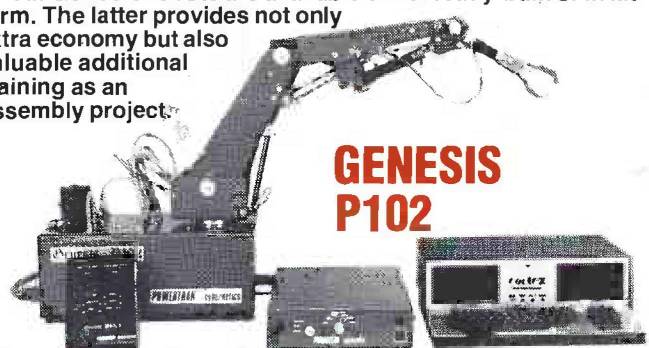
Each robot in the Genesis range has a self-contained hydraulic power source operated from single phase 240 or 120v AC or from a 12v DC supply. Up to six independent axes are capable of simultaneous operation and all except the grip axis have sensing devices fitted to provide positional control by a closed loop system based on a dedicated microprocessor. Movement sequences can be programmed by means of a hand-held controller or the systems can be interfaced with an external computer via a standard RS232C link.



The top-of-the-range P102 has dual speed control, enhanced memory and double acting cylinders for increased torque on the wrist and arm joints. There is position interrogation via the RS232C interface, increasing the versatility of computer control and inputs are provided for machine tool interfacing.

All Genesis robots are available either ready-built or in kit form. The latter provides not only extra economy but also valuable additional training as an assembly project.

GENESIS P102



Cortex 16 bit microcomputer

HEBOT II Turtle-type robot

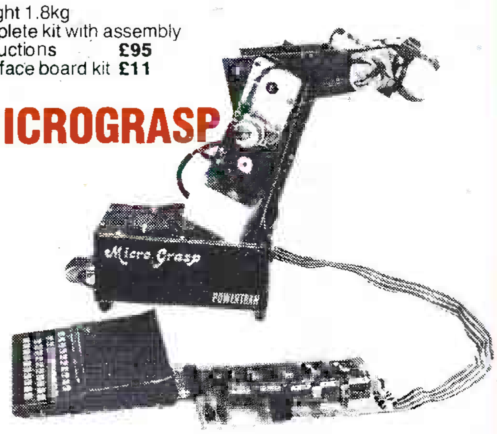
For a little over £100, Herbot II takes programming off the VDU and into the real world. Each wheel is independently controlled by a computer, enabling the robot to perform an almost infinite number of moves. It has blinking eyes, a two-tone bleep and a solenoid-operated pen to chart its moves. Touch sensors, coupled to its shell return data about its environment to the computer enabling evasive or exploratory action to be calculated.

The robot connects directly to an I/O port or, via the interface board, to the expansion bus of a ZX81 or other microcomputer.

HEBOT II

Weight 1.8kg
complete kit with assembly instructions **£95**
Interface board kit **£11**

MICROGRASP



A real programmable robot for under £300! Micrograsp has an articulated arm jointed at shoulder, elbow and wrist positions. The entire arm rotates about its base and there is a motor driven gripper. All five axes are motor driven and four of these are servo controlled giving positive positioning. The robot can be controlled by any microcomputer with an expansion bus – the Sinclair ZX81 being particularly suitable.

MICROGRASP

Weight 8.7kg, max. lifting capacity 100g
Robot kit with power supply **£215.00**
Universal computer interface board kit **£57.00**
23 way edge connector **£3.00**
ZX81 peripheral/RAM pack splitter board **£3.50**

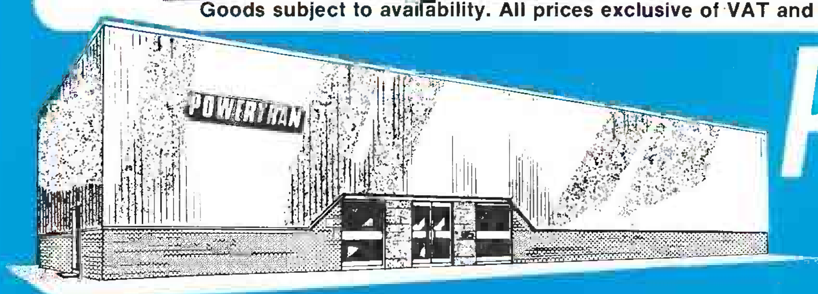
GENESIS P101

Weight 34kg, max lifting capacity 1.8kg
6-axis model (kit form) **£750**
6-axis complete system (kit form) **£1050**

GENESIS P102

Weight 36kg, max lifting capacity 2kg
6-axis system (kit form) **£1476**
Powertran Cortex microcomputer self-assembly kit **£295.00**

Goods subject to availability. All prices exclusive of VAT and correct at time of going to press.



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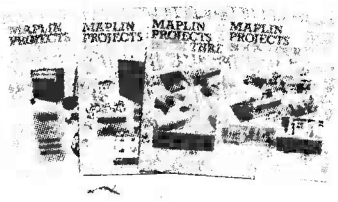
MAPLIN'S TOP TWENTY KITS

THIS MONTH	LAST MONTH	DESCRIPTION OF KIT	ORDER CODE	KIT PRICE	DETAILS IN PROJECT BOOK
1.	(1)	75W Mosfet Amp Module	LW51F	£12.95	Best of E&MM
2.	(2)	Modem	LW99H	£44.95	5 XA05F
		Case also available: YK62S Price £9.95.			
3.	(3)	Car Burglar Alarm	LW78K	£6.95	4 XA04E
4.	(4)	Partylite	LW93B	£9.45	Best of E&MM
5.	(5)	ZX81 I/O Port	LW76H	£9.25	4 XA04E
6.	(7)	Syntom Drum Synthesiser	LW86T	£11.95	Best of E&MM
7.	(6)	Spectrum Keyboard	LK29G	£28.50	9 XA09K
		Also required: LK30H £6.50; Case: XG35Q £4.95 — Total £39.95. Also available complete ready-built: XG36P £44.95.			
8.	(50)	Spectrum Easyload	LK39N	£9.95	10 XA10L
9.	(9)	8W Amp Module	LW36P	£4.45	Catalogue
10.	(11)	Logic Probe	LK13P	£9.95	8 XA08J
11.	(13)	Ultrasonic Intruder Detctor	LW83E	£10.95	4 XA04E
12.	(8)	VIC20/64 RS232 Interface	LK11M	£9.45	7 XA07H
13.	(10)	Harmony Generator	LW91Y	£17.95	Best of E&MM
14.	(14)	Spectrum RS232 Interface	LK21X	£17.95	8 XA08J
15.	(12)	Keyboard for ZX81	LW72P	£23.95	3 XA03D
		Case also available: XG17T £4.95. Complete ready-built: XG22Y £32.50			
16.	(16)	Noise Gate	LK43W	£9.95	Best of E&MM
17.	(28)	Burglar Alarm	LW57M	£49.95	2 XA02C
18.	(15)	Hexadrum	LW85G	£19.95	Best of E&MM
19.	(17)	Guitar Tuner	LW90X	£10.75	Best of E&MM
20.	(30)	Synwave Sounds Synth	LW87U	£10.95	Best of E&MM

Over 80 other kits also available. All kits supplied with instructions.
The descriptions above are necessarily short. Please ensure you know exactly what the kit is and what it comprises before ordering, by checking the appropriate Project Book mentioned in the list above.

MAPLIN'S FASCINATING PROJECTS BOOKS

Full details in our Project Books Price 70p each.



In Book 1 (XA01B) 120W rms Mosfet Combo-Amplifier • Universal Timer with 18 program times and 4 outputs • Temperature Gauge • 6 Vero Projects. **In Book 2 (XA02C)** Home Security System • Train Controller for 14 trains on one circuit • Stopwatch with multiple modes • Miles-per-Gallon Meter. **In Book 3 (XA03D)** ZX81 Keyboard with electronics • Stereo 25W Mosfet Amplifier • Doppler Radar Intruder Detector • Remote Control for Train Controller. **In Book 4 (XA04E)** Telephone Exchange for 16 extensions • Frequency Counter 10Hz to 600MHz • Ultrasonic Intruder Detector • I/O Port for ZX81 • Car Burglar Alarm • Remote Control for 25W Stereo Amp. **In Book 5 (XA05F)** 300 Baud Duplex Modem to European Standard • 100W 240VAC Inverter • Sounds Generator for ZX81 • Central Heating Controller • Panic Button for Home Security System • Model Train Projects • Timer for External Alarm. **In Book 6 (XA06G)** Speech Synthesiser for ZX81 & VIC20 • Module to Bridge two of our Mosfet Amps to make a 350W Amp • ZX81 Sound on your TV • Scratch Filter • Damp Meter • Four Simple Projects. **In Book 7 (XA07H)** Modem (RS232) Interface for ZX81/VIC20/Commodore 64 • Digital Enlarger Timer/Controller • DXers Audio Processor • Sweep Oscillator • CMOS Crystal Calibrator. **In Book 8 (XA08J)** Modem (RS232) Interface for Dragon 32 & Spectrum • Synchime • I/O Ports for Dragon 32 • Electronic Lock • Minilab Power Supply • Logic Probe • Doorbell for the Deaf. **In Book 9 (XA09K)** Keyboard with Electronics for ZX Spectrum • Infra-Red Intruder Detector • Multimeter to Frequency Meter Converter • FM Radio needs no alignment • Hi-Res Graphics for ZX81 • Speech Synthesiser for Oric 1 • VIC20 Extendiboard • ZX81 ExtendiRAM • Dynamic Noise Limiter for Personal Cassette Players • TTL Levels to RS232 Converter • Logic Pulser • Pseudo-Stereo AM Radio • Ni-Cad Charger Timer • Adder-Subtracter • Syndrum's Interface • Microphone Pre-Amp Limiter. **In Book 10 (XA10L)** Cassette Easyload for ZX Spectrum • 80m Amateur Receiver • Auto Waa-Waa Effects Unit • Oric 1 Modem Interface • 2.8kW Mains Power Controller • Extendiport for Dragon 32 • 12V Fluorescent Tube Driver • 32-Line Extension for Digi-Tel.

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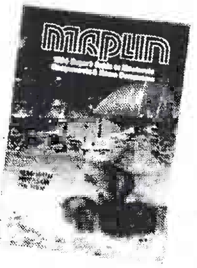

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