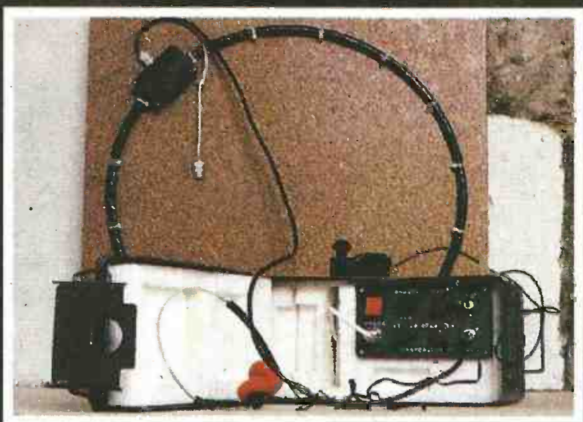
AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

MAY 1986 £1.20

...COMMUNICATIONS...COMMUNICATIONS...COMMUNICATI...



THE TROGLOGRAPH

Talking through rock with very low frequencies

80 M DIRECT CONVERSION RECEIVER

EXPAND YOUR MODEM WITH OUR BAUD RATE CONVERTER

HELMET INTERCOM

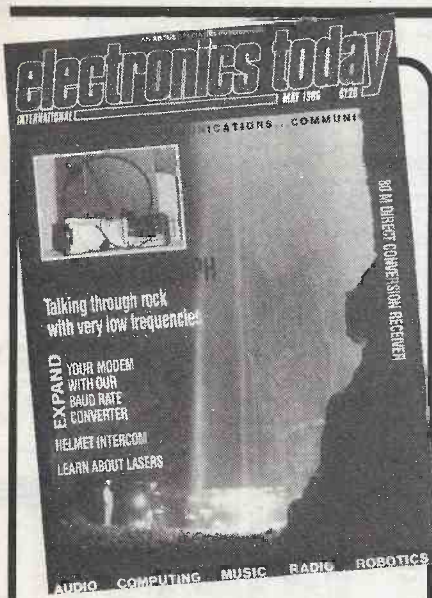
LEARN ABOUT LASERS

Do-It-Yourself Automatic Testing

AUDIO....COMPUTING....MUSIC....RADIO....ROBOTICS...

electronics today INTERNATIONAL

MAY 1986 VOL 15 NO 5



EDITORIAL AND ADVERTISEMENT OFFICE
1 Golden Square, London W1R 3AB. Telephone 01-437 0626.
Telex 8811896.

FEATURES

PROJECTS

ETCETERA

INFORMATION

Due to continued illness, we very much regret that the promised part of the Digital Sound Sampler has had to be held over for yet another month. Our apologies to all readers interested in pursuing this project. We assure you that we will bring you the conclusion of this project as soon as possible.

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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 lags	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
DPDT moment	200p

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIGITAST Switch
Assorted Colours
75p 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: (Make-a-switch)
Make a multiway 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

ULTRASONIC TRANSDUCERS

40 Khz 475p

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				
12 inches	198p	215p	315p	480p
24 inches	210p	235p	345p	540p
3ft	290p	370p	480p	525p

3ft **Female Header** Socket Jumper Leads 36

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

GAS/SMOKE DETECTORS

TGS812 or TGS813
£6 each
Holders for above **40p**

VERO

VERO BOARDS 0.1"

2½ × 1	30p
2½ × 3¾	95p
2½ × 5	110p
3¾ × 3¾	110p
3¾ + 5	125p
3¾ × 17	420p
4¾ × 17	550p
VO Board	195p
DIP Board	395p
Vero Strip	95p

VERO WIRING

PEN — Spool	380p
Spare Spool	75p
Combs	8p
Pen + Spool + Combs	599p

PHOTO DECs

Veroblock	480p
S Dec	350p
Eurobreadboard	590p
Bimboard	575p
Superstrip S52	1350p

VERO PINS per 100

Single Ended	55p
Double ended	60p
Wire Wrap S/E.	155p
Wire Wrap D/E	255p

DALO ETCH RESIST PEN
Plus spare tip 100p

VERO TOOLS
Spot face cutters 150p
Pin insertion tool 185p

FERRIC CHLORIDE
1 lb bag Anhydrous
125 + 50p p&p

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double-sided
6" × 6"	100p	125p
6" × 12"	175p	225p

DIL SOCKETS

Pin	Low Prof	Wire Wrap	Turned Pin
8	8p	20p	18p
14	10p	23p	28p
16	10p	40p	28p
18	16p	40p	33p
20	20p	58p	37p
22	22p	60p	39p
24	25p	68p	42p
28	28p	78p	52p
40	30p	89p	72p

EDGE CONNECTORS

	.1"	.156"
2 × 6 way	-	75p
2 × 12 way	-	160p
2 × 15 way	-	165p
2 × 18 way	175p	160p
2 × 22 way	.200	170p
2 × 23 way	150p	-
2 × 25 way	250p	245p
2 × 28 way	180p	-
2 × 30 way	280p	-
2 × 36 way	300p	-
2 × 40 way	320p	-
2 × 43 way	400p	-
2 × 75 way	600p	-

ANTEX SOLDERING IRON

C-15W	600p	CS17W	[illegible]
G-18W	620p	XS25W	650p
Spare tips, assorted size			100p
Spare elements			245p
Iron stand with sponge			195p

SIL SOCKET
0.1" pitch
20 way
65p

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female Card Edge Conct
10 way	65p	65p	65p	100p
16 way	75p	75p	80p	—
20 way	90p	90p	95p	185p
26 way	105p	110p	115p	230p
34 way	115p	130p	135p	320p
40 way	140p	145p	150p	335p
50 way	165p	170p	175p	350p
60 way	195p	210p	225p	495p

EURO CONNECTORS

Gold Flashed Contacts	Female Strt Pins	Socket Angle Pins	Male Strt Pins	Plug Angle Pins
DIN41617 31 way	125p	—	—	175p
DIN41612 2 x 32 A + B	200p	—	175p	185p
DIN41612 2 x 32 A + C	225p	—	185p	210p
DIN41612 3 x 32 A + B + C	280p	290p	295p	300p

DIL PLUG (Header)

	Solder	IDC
14 pin	40p	95p
16 pin	45p	100p
24 pin	85p	135p
28 pin	150p	200p
40 pin	200p	255p

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

ZIF TEXTOOL DIL SOCKETS

24 pin	550p
28 pin	695p
40 pin	800p

'D' CONNECTORS

	9 way	15 way	25 way	37 way
Male				
Solder lugs	55p	80p	120p	150p
Angle pins	110p	175p	225p	300p
PCB pins	100p	100p	180p	250p
Female				
Solder lugs	90p	125p	180p	275p
Angle pins	150p	200p	280p	390p
PCB pins	100p	125p	195p	355p
Covers	75p	70p	70p	85p

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

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
0–300V AC
520p

CRYSTALS

32.768KHz	100
100KHz	400
200KHz	370
455KH	370
1MHz	265
1.008M	275
1.28MHz	450
1.6MHz	200
1.8MHz	545
1.8432M	2)0
2.0MHz	225
2.4576M	200
3.12MHz	240
3.278M	150
3.5794M	95
3.6864M	300
4.0MHz	140
4.032MHz	290
4.19430M	150
4.433619M	100
4.608MHZ	200
4.80MHz	200
5.0MHz	150
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	140
6.5536MHz	225
7.0MHz	150
7.168MHz	175
7.7328MHz	250
7.68MHz	200
8.0MHx	140
8.089333M	395
8.86723M	175
9.00MHz	200
10.0MHz	170
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	150
12.528M	300
14.31814M	170
15.0MHz	155
16.0MHz	200
18.0MHz	150
18.432M	150
19.968MHz	150
20.0MHz	150
24.0MHz	150
24.930MHz	325
26.69M	150
27.648M	170
27.145M	180
38.6667M	240
48.0MHz	240
100.0MHz	295

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-113 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 40Ω, 64Ω or 80Ω	80p
6" x 4" 8Ω	200p
7" x 5" 8Ω	225p
8" x 5" 8Ω	250p

VIDEO MONITORS

- ZENITH — 12" Green, Hi-Resolution Popular £72
- MICROVITEC 1431. Standard Res, Colour RGB input 14" incl cable £179
- MICROVITEC 1451. 14" Medium resolution £229
- KAGA 12". Med-res. RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc £225 (car £7)
- KAGA 12". As above but Hi-Resolution £310 (car £7)
- Connecting Lead for KAGA £3

Carriage £7 Securicor

TRANSFORMERS

3-0-3V; 6-0-6V, 9-0-9V; 12-0-12V; 15-0-15V @ 100mA 130p

PCB mounting. Miniature, Split bobbin
3VA: 2x6V/0.25A; 2x9V/0.15A, 2x12V/0.12A; 2x15V/0.2A 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/1A3; 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)
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 955p (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	50p
12V	7812	45p	7908	50p
15V	7815	45p	7912	50p
18V	7818	45p	7915	50p
24V	7824	45p	7918	50p
			7924	50p

100mA TO92 Plastic package

5V	78LO5	30p	79LO5	45p
6V	78LO6	30p	—	—
8V	78LO8	30p	—	—
12V	78L12	30p	79L12	45p
15V	78L15	50p	79L15	45p

ICL7660	245p	TAA550	50p
RC4194	375p	TDA1412	150p
RC4195	160p	TL497A	185p
LM309K	135p	78H05 + 5V/5V	550p
		78H12+12V/5A	695p
LM317K	250p		
LM317KP	450p	78HG+5V to+25V/5V 5A	550p
LM323K	450p		
LM337	175p	79HG-5V to-24V/5A	785p
LM723 Var	30p		
78S40	225p		

SOLDERCON PINS

Ideal for making SIL or DIL Sockets

100 pins	35p
500 pins	100p

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

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 CONNECTORS

	IDC	SOLDER
24 way IEEE plug	465p	480p
24 way IEEE skt	485p	480p
36 way Centronics plug	375p	390p
36 way Centronics skt	480p	450p

BT TELEPHONE CONNECTOR

LJU 1/4A	Mini Line Master	435p
LJU 1/6A	Mini Line Slave	295p
LJU 2/4A	Line Master	370p
LJU 2/6A	Line Slave	250p
LJU 3/4A	Flush Master	370p
LJU 3/6A	Flush Slave	240p
LJU 10/3A	Dual Splitter	550p
4 WAYBT Plug		65p

CMO

4000	20
4001	20
4002	20
4006	70
4007	25
4008	60
4009	40
4010	40
4011	20
4012	20
4013	30
4014	50
4015	40
4016	25
4017	45
4018	55
4019	35
4020	50
4021	55
4022	60
4023	20
4024	35
4025	20
4026	90
4027	30
4028	40
4029	45
4030	20
4031	125
4032	65
4033	130
4034	145
4035	70
4036	250
4037	115
4038	75
4039	270
4040	45
4041	55
4042	45
4043	45
4044	50
4045	110
4046	60
4047	50
4048	50
4049	25
4050	25
4051	50
4052	60
4053	60
4054	70
4055	70
4056	85
4057	1000
4059	400
4060	70
4061	500
4062	986
4063	80
4066	25
4067	230
4068	20
4069	20
4070	25
4071	20
4072	20
4073	20

4075	25
4076	60
4077	25
4078	25
4081	20
4082	20
4085	60
4086	60
4089	120
4093	25
4094	70
4095	70
4096	100
4097	260
4098	70
4099	110
4160	95
4161	96
4162	96
4163	96
4174	96
4175	105
4194	105
4408	850
4409	850
4410	725
4411	750
4412	805
4415	590
4419	280
4422	770
4435	850
4440	900
4450	360
4451	350
4490	450
4500	395
4501	40
4502	90
4503	45
4504	100
4505	350
4506	100
4507	45
4508	130
4510	55
4511	55
4512	55
4513	150
4514	115
4515	115
4516	50
4517	275
4518	50
4519	35
4520	50
4521	110
4522	125
4526	70
4527	60
4528	45
4529	80
4530	90
4531	120
4532	65
4534	365
4536	250
4538	70
4539	80
4541	95

4543	65
4548	40
4549	390
4553	210
4554	180
4555	50
4556	50
4557	250
4558	120
4559	340
4560	110
4561	104
4562	350
4566	160
4568	250
4569	175
4572	45
4580	255
4581	125
4582	99
4583	100
4584	40
4585	65
4597	330
4599	155
40085	90
40097	45
40098	42
40100	215
40101	130
40102	140
40103	412
40104	120
40105	220
40106	40
40107	55
40108	325
40109	100
40110	235
40114	240
40161	194
40163	75
40173	100
40174	75
40175	75
40181	220
40182	80
40192	75
40193	90
40194	70
40195	75
40244	196
40245	196
40257	196
40373	220
40374	220
45106	586

OPTO

OCP71	120
ORP12	85
ORP61	85
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	100p
Green/Yellow	115p
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	200

ISOLATORS

IL74	75
ILD74	145
ILQ74	275
TIL111/2/4	70
ILCT6 Darlington	135
TIL117	125
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	130
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	225
SLOTTED Optical Switch similar to RS Comp's	295

ACCESS & VISA

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Just phone your orders through, we do the rest.
Tel: 0923 50234

SPECIAL OFFER

	1+	10+
2764-250nS	195p	185p
27128-250nS	295p	285p
6116LP-3	185p	150p
6264LP-150nS	395p	385p

SPDOS

The only professional Disc Interface for the Spectrum Micro.

SPECIAL OFFER THIS MONTH for ONLY £75

COMPUTER CORNER

- EPSON FX80 Printer £259
- EPSON FX100 Printer £429
- EPSON LX80 Printer £210
- CENTRONICS (NLQ) Printer £107
- KAGA/TAXAN KP810 Printer £195
- KAGA/TAXAN KP910 Printer £335
- BROTHER HR15 Daisywheel £315

Cable for above printers to interface with BBC Micro £7

- TEX EPROM ERASER — Erases up to 25 Eproms. Has a built in safety switch £30
- SPARE UV Lamp Bulb £8
- C12 Computer CASSETTES in Library cases 32p
- 8½" & 9½" Fan Fold paper (1000 sheets) £7 (Carr. 150p)

(Securicor Carriage charge on printers is £7)

CALL IN AT OUR SHOP FOR A DEMONSTRATION ON ANY OF THE ABOVE ITEMS. BE SATISFIED BEFORE YOU BUY OR WRITE IN FOR OUR DESCRIPTIVE MICRO PERIPHERALS LEAFLET.

BBC MICRO WORDPROCESSING EXAMPLE PACKAGE

A complete wordprocessing package (which can be heavily modified to your requirements, maintaining large discount). We supply everything you need to get a BBC Micro running as a word-processor. Please call in for a demonstration.

Example Package:
BBC model B Plus, Watford DDFS+ upgrade, Wordwise Rom, Twin 800K Mitsubishi drives in beige, Zenith 12" Hi-res. monitor (Green), Brother HR15 daisywheel printer, Database & Spreadsheet software, 10 Discs, 500 sheets fan-fold paper, 4 way mains trailing sockets, manuals, leads & a carrying for the BBC.

Only: £999

5¼" DRIVES for the BBC Micro

(All Drives are supplied cased with Power Supply and Utilities Disc

- **CS200** — Epson Single 200K, 40 track Double sided £89
- **CS400S** — Mitsubishi Single 400K, Double sided 40/80 track switchable £103
- **CD400** — Epson dual 400K, 40 track Double sided £140
- **CD800S** — Mitsubishi dual 800K, Double sided 40/80 track switchable £186
- **TWIN Disc drive case** with Power supply and Cables to house your own drives £35
- All Single Drives with Power supply are supplied in a twin case for later inclusion of a second drive. (Securicor Carriage on Drives £7)
- **DISC INTERFACE KIT** complete £59
- **DFS Manual** (comprehensive) (NO VAT) £7

BBC & MICROCOMPUTER & ACCESSORIES

BBC Model B PLUS £365

We stock the full range of BBC Micro peripherals, Hardware & Software like, Disc Drives (Top quality Epson & 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 descriptive leaflet.

Rapid Electronics

Fast component distribution

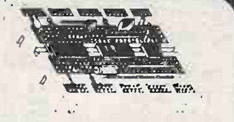
Unit 1,
Hill Farm Industrial Estate
Boxted, Colchester
Essex CO4 5RD

Telephone orders: 0206 36412
Telex: 987756

LINEAR

		ICM7555	55	LM386	85	ML924	290	SL486	240	TL084	90
		LF347	90	LM387	90	ML925	290	SL490	280	TL170	50
555 CMOS	55	LF351	40	LM393	45	ML926	275	SN76477	380	TL170	50
556 CMOS	150	LF353	70	LM710	48	ML927	275	SPO256AL2	425	ULN20003	80
709	35	LF356	90	LM711	48	ML928	275	Data on above	50	ULN2004	80
741	16	LM301A	30	LM725	270	ML929	275	TBA800	70	ULN2803	130
748	35	LM311	45	LM741	16	NE531	135	TBA810	65	XR2206	395
AY-3-8910	390	LM318	110	LM747	60	NE555	20	TBA820M	60	ZN414	75
AY-3-8912	430	LM324	40	LM1458	35	NE556	45	TCA940	65	ZN423	100
CA3046	60	LM334Z	85	LM2917	170	NE565	95	TDA1022	270	ZN424	70
CA3080E	65	LM335Z	130	LM3909	85	NE566	95	TL061	40	ZN425E	340
CA3130E	75	LM339	40	LM3914	190	NE567	100	TL062	65	ZN426E	200
CA3140E	38	LM348	60	LM3915	190	NE570	230	TL064	95	ZN427E	580
CA3240E	100	LM358	40	LM13600	40	NE571	195	TL071	32	ZN428E	435
ICL7106	680	LM377	210	MC3302	75	NE5532	160	TL072	55	ZN435E	360
ICL7611	100	LM380	80	MC3340	130	NE5534	105	TL074	105	ZN448E	525
ICL8038	395	LM381	130	MF10CN	330	RC4136	65	TL081	28	ZN459	190
ICL8211A	200	LM382	130	ML922	415	RC4558	45	TL082	45	ZN1034E	190

BREADBOARDS



Protobloc breadboards are extremely useful for quick construction of electronic circuits without soldering. All sockets are on a 2.54mm pitch enabling DIL circuits and a wide range of components to be plugged in to the board. The contact pattern contains two separate contact groups each of rows of 5 interconnected contact sockets. Bus strips are provided for power use. All contact positions are clearly marked on an alphanumeric grid. Supplied complete with approx. 20 layout sheets. Two sizes are available:

length	width	tie points	rows	max no.16 pin devices	prices
80mm	60mm	390	29	3	395p
172mm	65mm	840	64	7	695p

CAPACITORS

Mini polyester 63V DC type. 1n, 2n2, 4n7, 10n, 22n, 5p; 47n, 100n, 6p; 220n, 9p; 470n, 13p.

Electrolytic. Radial head type 1u, 2u2, 4u7 @ 63V 5p; 100u, 22u @ 25V 5p; 47u 25V 7p; 100u 25V 8p; 220u 25V 13p; 470u 16V 14p. 1000u 16V 20p; 1000u 25V 30p; 2200u 16V 34p; 2200u 25V 42p.

Tantalum bead. 0.1u, 0.47u, 1u @ 35V 6p; 2u2 @ 25V 6p; 4u7 @ 25V 8p; 10u @ 25V 14p; 22u @ 16V 18p; 47u @ 16V 40p.

Ceramic disc 50V. 100p-10n 3p each; 100n 25V 6p

TRANSISTORS

				BC214L	10	BD131	40	MPF102	40	TIP42A	45	2N2904A	28
				BC237	5	BD132	40	MPSA12	29	TIP120	60	2N2905	28
				BC238	5	BD139	35	TIP29A	35	TIP121	60	2N2905A	28
AC127	30	BC148	10	BC327	6	BD140	35	TIP29C	35	TIP122	60	2N2907	24
AC128	30	BC169C	10	BC328	6	BF180	35	TIP30A	35	TIP2955	70	2N2907A	24
AC176	25	BC171	10	BC337	6	BF244B	35	TIP30C	35	TIP3055	60	2N2926	10
AC187	25	BC178	16	BC338	14	BF337	35	TIP31A	40	VN10KM	65	2N3053	28
AC188	25	BC179	18	BC477	22	BFR80	23	TIP31C	40	VN46AF	94	2N3054	55
BC107	10	BC182	10	BC478	22	BFX85	30	TIP32A	35	VN66AF	110	2N3055	50
BC107B	12	BC182L	10	BC479	22	BFX88	30	TIP32C	40	VN88AF	120	2N3702	9
BC108	10	BC183	10	BC517	30	BFY50	25	TIP33A	65	ZTX109	11	2N3703	10
BC108C	12	BC183L	10	BC547	5	BFY51	25	TIP33C	75	ZTX300	14	2N3704	9
BC109	10	BC184	10	BC548	5	BFY52	27	TIP34A	70	ZTX500	13	2N3705	10
BC109C	12	BC184L	10	BC549	10	BRY39	50	TIP34C	80	ZTX502	18	2N3773	195
BC140	29	BC212	10	BC557	5	BSY95A	30	TIP35A	105	2N2221A	25	2N3819	32
BC141	30	BC212L	10	BC558	5	BU208	170	TIP35C	125	2N2222A	20	2N3866	90
BC142	28	BC213	10	BcY70	16	MJ2955	99	TIP36A	115	2N2369	18	2N3904	10
BC143	30	BC213L	10	BCY71	16	MJE340	50	TIP36C	130	2N2646	60	2N3906	10
BC147	10	BC214	10	BCY72	16	MJE3055	70	TIP41A	45	2N2904	28	2N5457	30

MICRO

		27128-250	300	6800	200	6522	330
		27256-250	480	6802	280	6532	520
		6116LP3	150	6809	600	6551	540
2716	320	6264LP15	320	6810	140	8085A	320
2532	430	4164-15	160	6821	140	8156	380
2732 one time programmable	280	41256-15	300	6840	360	8251	350
		Z80A CPU	160	6850	165	8253	370
		Z80A PIO	160	6852	240	8255	320
2732	380	Z80A CTC	160	6875	500	8259	400
2764-250	240	Z80A SIO	520	6880	100	MC1488	60
2764-BBC	240	Z80A DMA	520	6502	370	MC1489	60

IDC CONNECTORS

	PCB plug st	PCB plug rt ang	skt	Edge conn
16 way	80	85	90	—
20 way	90	95	90	—
26 way	110	110	105	—
34 way	120	130	130	165
40 way	140	150	145	—

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	5
Pair ultrasonic transducers	396
20mm panel fuseholder	25
6 or 12V electronic buzzer	65
66mm 8 ohm min speaker	70
66mm 64 ohm min speaker	75
12 way 'chocolate block'	21
Red or amber panel neon	28

PCB EQUIPMENT

We offer a comprehensive range of equipment

Expo Reliant 12V PCB drill	675
Expo Titan 12V PCB drill	1040
Drill stand to suit	1250
Variable speed power supply	1440
0.8, 1.0 or 1.4mm drills	60

Photo-etch PCB (Professional quality)

	single sided	double sided
100 x 160mm	180	200
233.4 x 220mm	560	640
305 x 457mm	1180	1320

Plain fibre glass board

	single sided	double sided
100 x 160mm	70	75
233.4 x 220	160	175
203 x 95	80	90
203 x 306	200	220

Etch resist pen 70p
Full range of PCB transfers also available — see catalogue

RESISTORS

Carbon film	1+	25+
1/4W 5% 4.7ohm-10M	2p	1p
1/2W 5% 4.7ohm-4M7	3p	2p
Metal film		
1/4W 1% 10ohm-1M	3p	3p

25+ price applies to 25+ per value
SIL resistor networks
8 resistor 9 pin type 20p

COMPONENT KITS

Our component kits offer a considerable saving when buying a complete range of components. Ideally suited for re-stocking etc

0.25W Resistor kit. Contains 1000 0.25W 5% resistors from 4.7ohms thru to 10M. Quantities depend upon popularity i.e. 10×10r, 30×470r, 30×10K, 25×470K **Just £7.90 each**

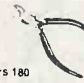
Ceramic capacitor kit. Total of 240 miniature ceramic capacitors from 22pF thru to 0.1uF. **Just £6.90 each**

Polyester capacitor kit. Total of 110 miniature polyester capacitors from 0.01u to 0.47uF **Just £6.90 each**

Radial electolytic kit. Total of 93 miniature radial electrolytics from 1u 63V thru to 2200u 16V **Just £7.50 each**

Preset kit. Total of 110 miniature horizontal mounting presets from 100R thru to 1M. **Just £6.90 each**

TOOLS



Low cost side cutters 180
Low cost pliers 180
Both the above represent exceptional value. We have seen similar tools advertised at £5!!!

Bib wire stripper	180
Automatic wire stripper	590
Light duty cutters	380

VERO

Veroboard. Size 0.1in matrix

2.5 x 1	26	2.5 x 3.75	95
3.75 x 5	120	3.75 x 17	390
4.75 x 17	495	VQ board	190

Veropins per 100
single sided 55 double sided 65
Spot face cutter 150

RIBBON CABLE

Grey	per foot	100ft reel
10 way	14	650
16 way	25	1050
20 way	28	1310
26 way	38	1720
34 way	58	1950
40 way	68	2650
50 way	90	3320

BRIDGE RECTIFIERS

1A 50V	20	2A 200V	40
1A 200V	25	2A 400V	45
1A 400V	30	6A 100V	80
1A 800V	38	6A 400V	85

CABLES

20 metre pack single core connecting cable ten different colours	75p
Speaker cable	10p/M
Standard screened	16p/M
Twin screened	24p/M
3 core 2.5A mains cable	23p/M
Four core screened	35p/M

REGULATORS

78L05	30	LM338K	680
78L12	30	LM723	40
78L15	30	79LO5	50
7805	40	79L12	50
7812	45	79L15	50
7815	45	7905	45
LM317K	230	7912	45
LM317T	90	7915	45
LM323K	420	78HO5	550

RELAYS

Ultraminiature SPDT relay rated 2A 6 or 12V	105
Ultraminiature DPDT relay rated 2A 6 or 12V	160
Miniature relay SPDT rated 10A 6 or 12V	160
Miniature relay DPDT rated 5A 6 or 12V	180

SOCKETS

	Low profile	Wire wrap
8 pin	4p	28p
14 pin	7p	48p
16 pin	8p	55p
18 pin	9p	65p
20 pin	10p	75p
22 pin	12p	80p
24 pin	13p	85p
28 pin	14p	100p
40 pin	18p	140p

NEW CATALOGUE

Our new fully illustrated 96 page catalogue is now available. Contains over 3400 stock lines at the most competitive prices in the market. We now sell more components that all the other mail order companies put together! When you have our new catalogue it's easy to see why! Price just £1 including postage (includes £1 discount voucher) or free with orders over £20 in value. Send for your copy now!

AVAILABLE NOW

OPTO

3 or 5mm red	8		
3 or 5mm green	11		
3 or 5mm yellow	11		
3 or 5mm clips	3		
5mm superbright	30	TIL32	40
5mm tricolour	30	TIL38	35
ILD74	95	TIL78	40
ILO74	185	TIL100	75
MOC3020	180	ORP12	85

Seven segment displays

0.3in common anode or cathode	95
0.5in common anode or cathode	100
0.56in common anode or cathode	105
10 bar DIL LED array (20pin DIL) High efficiency red	140

DIODES

BY127	12	1N4001	4
OA47	10	1N4002	5
OA90	8	1N4006	7
OA91	7	1N5401	12
OA200	8	1N5404	14
OA202	8	1N5406	15
1N914	4	400mW zeners	6
1N4148	3	1.3W zeners	13

AUDIO CONNECTORS

DIN	Plug	Skt	Jack	Plug	Skt
2 pin	8	8	2.5mm	10	9
3 pin	13	13	3.5mm	10	9
5 pin	14	13	.25in	17	20
Phono	10	14	Stereo	25	25

4mm plugs and sockets red or black
Plugs 12 Sockets 12
4mm terminals 36

D CONNECTORS

	9 way	15 way	25 way	37 way
Plug solder lugs	35	40	55	100
Rt. angle PCB plug	85	130	200	260
Socket solder lugs	45	50	65	120
Rt angle PCB skt	115	170	290	350
Cover	70	80	80	95

BOXES

Black ABS with lid and screws

71×46×22mm	50
95×71×35mm	93
140×90×55mm	150

LS00

		LS13	25	LS47	60	LS95	50	LS157	35	LS193	55	LS273	55
		LS14	35	LS48	65	LS96	75	LS158	35	LS195	55	LS279	50
		LS15	20	LS73	33	LS122	45	LS161	55	LS221	70	LS283	60
LS00	18	LS20	20	LS74	25	LS123	45	LS163	55	LS240	65	LS365	40
LS01	20	LS21	20	LS75	30	LS125	38	LS164	55	LS241	60	LS366	40
LS02	20	LS26	20	LS76	30	LS126	38	LS166	85	LS242	60	LS367	40
LS04	18	LS27	20	LS78	28	LS132	45	LS170	100	LS244	55	LS373	60
LS05	20	LS30	20	LS83	45	LS138	38	LS173	45	LS245	55	LS374	60
LS08	20	LS32	20	LS85	50	LS139	38	LS174	45	LS247	60	LS375	40
LS09	20	LS37	20	LS86	22	LS148	100	LS175	45	LS251	45	LS390	55
LS10	20	LS38	20	LS90	25	LS151	35	LS190	60	LS257	45	LS393	55
LS11	20	LS40	20	LS92	35	LS154	120	LS191	55	LS259	70	LS541	95
LS12	20	LS42	35	LS93	30	LS155	45	LS192	55	LS266	32	LS670	110

DIN 41612

Gold flashed contacts	Rt ang plug	wirewrap socket
64 way A+B	110	170
64 way A+C	115	175
96 way A+B+C	150	245

CONNECTORS

ZX81 23 way edge connector	150
Spectrum 28 way edge conn	200
24 way IEEE male	350
36 way Centronix male	330

POTENTIOMETERS

Single pots 470ohms-2M2	38
Stero pots 1K-2M2	110
Switched pots 1K-2M2	105
Slider pots 5K-500K (60mm)	70
Min. hor. presets 100-1M	7
Single turn cermet 100-1M	30
20 turn cermet 10ohms-500K	65

CRYSTALS

		5.008MHz	100
1MHz	275	6.0MHz	85
1.008M	270	6.144MHz	110
1.8432M	180	8.0MHz	85
2.0M	180	10.0MHz	85
2.4576	85	12.0MHz	85
3.276	85	16.0MHz	85
4.0MHz	90	18.0MHz	100

SOLDERING IRONS

High quality desolder tool	480
Antex CS 17W soldering iron	480
Antex XS 25W soldering iron	500
Iron stand to suit CS or XS	170
10 metres 22 swg solder	75
0.5Kg reel 22 swg solder	750

SWITCHES

Low cost DIL switch
4 way 8 pin 70
6 way 12 pin 80
8 way 16 pin 90

Submin toggle switches
SPST 55 SPDT 60 DPDT 65

Miniature toggle
SPDT 60 SPDT centre off 65
DPDT 70 DPDT centre off 75

Standard toggle
SPST 35 DPDT 48

Miniature push to make 15
Miniature push to break 25

Slide switches DPDT
Miniature 14 Standard 16

CMOS

		4012	15	4025	18	4046	48	4070	20	40106	35	4526	45
		4013	24	4026	90	4047	50	4071	18	4502	50	4528	40
		4015	40	4027	22	4049	23	4072	18	4507	45	4532	50
4000	15	4016	20	4028	35	4050	23	4073	18	4508	95	4538	40
4001	15	4017	35	4029	40	4051	45	4076	50	4510	45	4543	40
4002	15	4018	40	4030	20	4052	45	4077	30	4511	50	4553	215
4006	40	4020	40	4040	40	4060	45	4081	15	4514	85	4555	35
4007	15	4022	40	4042	30	4066	25	4082	15	4516	45	4566	35
4009	25	4023	15	4043	45	4068	18	4093	22	4518	45	4584	35
4011	15	4024	30	4044	45	4069	15	4098	50	4520	45	4585	50

TTL

		7408	28	7430	28	7448	80	7476	40	7495	60	74163	80
		7413	38	7432	30	7450	28	7483	48	7496	80	74175	80
		7414	48	7433	38	7451	28	7485	80	7497	150	74177	80
7400	25	7416	38	7437	30	7453	28	7486	38	74121	40	74190	70
7401	28	7417	38	7438	35	7454	28	7489	140	74123	50	74191	75
7402	25	7420	28	7440	28	7460	28	7490	40	74132	50	74192	75
7404	25	7421	50	7442	70	7472	35	7491	70	74150	135	74193	70
7405	28	7422	28	7444	105	7473	35	7492	55	74154	135	74194	75
7406	40	7427	30	7446	130	7474	35	7493	45	74157	70	74195	75
7407	40	7428	30	7447	88	7475	45	7494	80	74161	80	74196	75

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DIGEST

256K CMOS DRAM from Hitachi

Hitachi have introduced a 256K DRAM (dynamic random access memory) which uses CMOS technology.

The device offers the high capacity and high packing density of dynamic memories coupled with the low power requirements of CMOS, including the possibility of battery back-up.

The new DRAM is designated the HM51256 and is available in two versions, suffix P and suffix LP. The low power LP version draws between 40 and 60ma maximum in active mode (depending on access speed) and requires refreshing once every 32ms rather than once every 4ms as most conventional NMOS 256K DRAMs do. This reduces the average stand-by current from the 11mA required by NMOS devices to 300uA.

The access times available are 100, 120 and 150ns but a high speed page mode allows these devices to achieve access times of 55, 65 and 80ns respectively.

the HM51256P/LP is available in a plastic 16-pin DIL package and is pin-compatible with Hitachi's existing HM50256 256K DRAM.

Also new from Hitachi is a 32K x 8 pseudostatic RAM which they claim is much nearer in operation to true static RAMs than are existing pseudo-static types.

The HM65256BP requires minimal refresh control circuitry and can be interfaced directly with a microprocessor. It offers access times of 60, 75 or 100ns, a power consumption of 175mW (typical) in active mode, and is expected to cost around one-fifth as much as a 256K static RAM. The device is available in a 28-pin DIL package, a skinny DIP or a SOP plastic package.

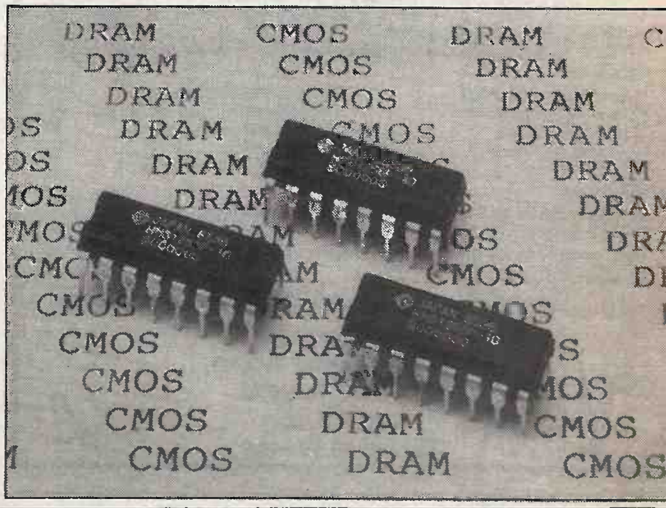
For further information on either of these products contact John Vickerton at Hitachi Electronic Components (UK) Ltd, Hitec House, 221-225 Station Road, Harrow, Middlesex HA1 2XL, tel 01-861 1414.

ETI PCB Service

Eagle-eyed readers may have noticed that the PCB Service page is not included in this issue.

We will hasten to point out that this does not, we hope, mark a new round of problems with our suppliers, but rather reflects the popularity of the service. A considerable backlog of orders built up during the period for which the service was unavailable, and the number of orders received since the service restarted has exceeded all our expectations. The result is that we are finding it difficult to meet the 28-day delivery deadline on orders, as some readers have already discovered to their cost.

Because of this, we have decided not to advertise the service this month in order to give our suppliers a chance to catch up a bit. We advise those readers who were thinking of ordering boards from us to hold on until things are straightened out, by which time we will be in a position to process their orders promptly.



Instrument Cases With Battery Compartments

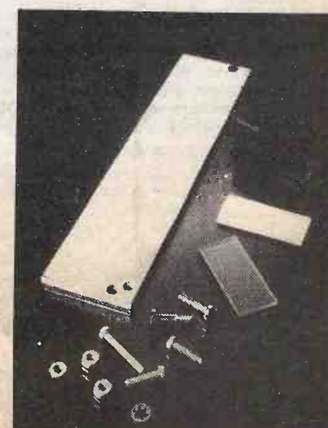
The latest addition to BICC-Vero's line-up of instrument cases is a range of stylish, two-tone ABS enclosures which include an otpional battery compartment.

Known as the Lux range, the cases are moulded in textured ABS and offer a choice of two-tone grey or two-tone brown colour schemes. One section of the three-part construction is designed to unclip from the outside and provide access to the optional battery compartment which can hold up to four AA cells.

The cases are designed to hold standard 100 x 160mm Eurocards and come in two sizes, 150 x 118 x 57mm and 190 x 148 x 67mm. The larger size will accept up to six Eurocards. The front panel is of aluminium and can either be fitted into a retaining slot in the case or screwed into place for greater security. The safe operating temperature of the Lux range is –20 to 90°C.

Also new from BICC-Vero is a development kit which contains ten blank front panels for Eurocards along with all the necessary handles, screws, etc. It is designed to allow greater freedom in the siting of front panel controls on Eurocards, allowing the handle and other attachments to be placed in non-standard positions or even dispensed with entirely. The panel sizes available are 3U x 4, 5, 6 and 12HP widths and 6U x 4, 6 and 10HP widths.

BICC-Vero Electronics, Unit 5, Industrial Estate, Flanders Road, Hedge End, Southampton SO3 3LG, tel 04892 - 5824.



Creditable Stereo

The idea of the 'credit card' radio has been around for a little while now and several companies have bRought out AM and mono FM models in this style. Now Sony have gone a stage further and introduced a radio receiver which is no larger than any of the other models on sale but offers full FM stereo reception.

The SRF 201 has the outline dimensions of a standard credit card (around 3½" x 2¼") and is just 3mm (⅛") thick. Three tiny buttons on the top edge control power on/off, volume increase and volume decrease while tuning is achieved by means of a knob set into the front surface of the radio and projecting slightly at one side. The two padded earpieces are joined by thin, lightweight wire and are connected to the radio by means of a flat, moulded connector which slides onto one corner.

The radio has internal rechargeable batteries and a separate charger unit is included. This takes the form of a black plastic box about the size of a cigarette packet with a slot on the front into which the radio clips. The radio can be used normally whilst charging is taking place and all of the controls remain accessible. The charger operates either from the mains by means of an adaptor (not supplied) or from four AA-size cells, allowing the radio to be carried about even when it is being charged.

Sony were happy to lend us an SRF 201 and the ETI staff were just as happy to try it out for a couple of weeks. The sound quality is quite excellent and the volume level obtainable is enough to satisfy all but the most diehard of aural masochists. The earpieces are very light and generally quite comfortable but a number of people had difficulty perusading them to stay in place. Not everyone, it seems, has ears which conform to the Sony model.

The sensitivity is pretty good but, as might be expected, it is often impossible to find a signal strong enough to ensure continuous stereo. As a result, when walking around with the radio on, the reception tends to change from stereo to mono and back again with each change in direction.

This problem is exacebrated a little by tuning difficulties. Because the tuning knob is quite small and has no reduction drive, it is not easy to set it accurately to give the best reception. It was generally felt that Sony might have done better to use a large knob which extended to both sides of the radio. It would then be possible to twiddle the knob between thumb and index finger which would give much greater control.

These criticisms aside, the SRF 201 represents a considerable achievement and is undoubtedly well made and presented. However, at a recommended retail price of £69.95 we supsect it is destined to remain soemthing of a novelty.

Bright Buoys

Many of the navigation buoys around Britain's coast will soon be powered by electricity derived from the action of the waves.

The lighthouse authority Trinity House have been conducting tests in the Harwich area using a device called the Whale Wave Activated Turbine Generator. They now plan to extend the test to cover the North West coast, the North Sea area and the Isle of Wight, after which they hope to use the turbine to power about 100 of the 400 lighted buoys they are responsible for.

The generator is based upon a device known as the Wells turbine which is named after its inventor, Dr Alan Wells, a former professor at Queen's University, Belfast. It relies on a flow of air to drive it but, unlike other turbines, the blades always turn in the same direction regardless of the way the air flows.

This makes it ideal for use on buoys. The conventional nagivation buoy has an open tube running right through it and extending some three metres or so into the water. The tube is designed to add stability. The turbine will be placed at the top of this tube, about two metres above the water level. Movement of the buoy causes the water column to rise and fall and so produces a flow of air which will drive the turbine.

Trinity House say they are sufficiently convinced of the turbine's reliability to allow it to be used to protect shipping. Buoys powered by batteries or gas cylinders have to be serviced at intervals of six months or less, and the increasing use of radar beacons and other electrical equipment is reducing battery life still further. It is hoped that the wave-powered buoys will only need servicing every three years or so apart from routine checks on moorings.

The manufacturers of the turbine, Munster Simms Engineering Ltd of County Down, Ireland, say they have received enquiries from many lighthouse authorities around the world. They point out that the system has many possibilities including, eventually, the supply of electricity to mains grids.

Automatic Wire Stripper

We have featured so many wire strippers in these pages that it is hard to believe anyone still thinks the market is worth getting into, but Plasplugs are apparently undaunted. They have launched their new product with considerable publicity and sent several free samples to ETI.

The tool is designed to remove the insulation from single and multicore round cables in one action. The wire is inserted into the jaws to the desired length (graduations along the jaws act as a guide) and the handle then squeezed until the insulation is fully removed. A second aperture carries a blade which will cut cleanly through cables of up to 5/16" (8mm) diameter.

We found that the samples supplied generally worked well and stripped away insulation on both stranded and solid-cored wire without visible damage to the insulation. However, whilst the tool worked well on cables of 0.5mm² and above (3A mains cable, 16/0.2 stranded wire, etc), it was less efficient with some of the thinner connecting wires often used in electronics. Because of this, it will probably be of more use to the DIY enthusiast involved with domestic mains wiring than to the electronics hobbyist.

The Plasplugs Automatic Wire Stripper will be available from DIY and hardware stores, etc, and the recommended retail price is £3.95.

Low-Profile PCB Mounting Transformers

The latest additions to Avel-Lindberg's range are a series of 6 and 12 VA PCB-mounting transformers which are less than one inch high.

Fully encapsulated in flat thermoplastic cases, the transformers conform to what is known as the 'American footprint' for pin spacing and feature four moulded holes which allow them to be screwed to the board for additional security.

The ZFL6 (6VA) and ZFL12 (12VA) ranges are available with either 110, 115 or 120 volt dual primary windings and 5, 6, 6.3, 8, 9, 10, 12, 15, 17 and 18 volt dual secondary windings. The construction uses separate, non-concentric bobbins to give low inter-winding capacitance and complete immersion in epoxy resin enables them to withstand a proof test at 5000V AC. The maximum operating temperature is +40°C, the insulation is to class E and both ranges conform to IEC 65 class 2, BS415 class 2 and VDE 0551 class 2.

The ZFL6 range have maximum dimensions of 22m (0.86") high x 53mm (2.09") x 44m (1.73"). Maximum dimensions for the ZFL12 range are 24mm (0.93") high x 68mm (2.67") x 57mm (2.24").

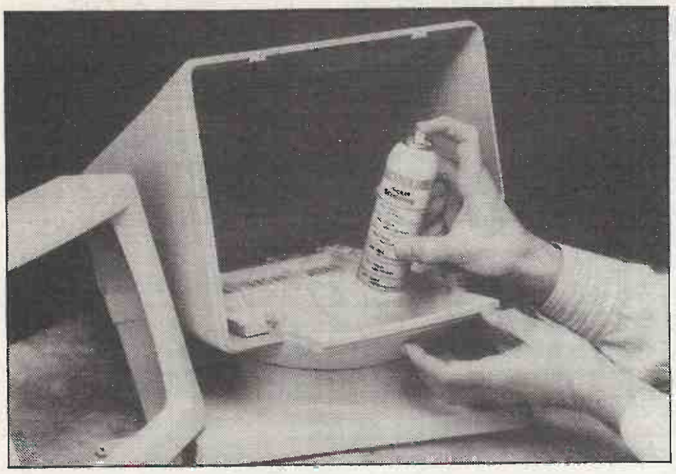
Also available from Avel Lindberg is a leaflet which describes their range of ultra-thin transformers in ratings from 0.8VA to 30VA. The 0.8VA type is claimed to be the thinnest transformer in the world and was featured in News Digest in ETI January 1984.

Avel-Lindberg Ltd, South Ockendon, Essex, England RM15 5TD, tel 0708 – 853 444.

● A group with the catch title of UK National Coordinating Committee on Satellites in Education has got together to, well, coordinate the use of satellites in education. They are stressing the possibilities offered by satellites not just in science and technology courses but also in geography and modern language teaching, and are keen to liase with teachers and others who have ideas for projects or research. Their 40-page Guide For Teachers costs £3.50 inclusive from AMSAT (UK), 94 Herongate Road, Wanstead Park, London E12 5EQ (cheques payable to SEUK) and their strategy paper is available free-of-charge from Dr John Gilbert, Department of Educational Studies, University of Surrey, Guildford GU2 5XH.

● *We have run out of the digital panel meters which were on special offer in last month's issue, but mensurative readers may be interested to hear that Electronics and Computer Workshop Ltd offer a 3-digit DPM kit for £17.90 inclusive. Known as the K2032, it will display readings from −99mV to +999mV full scale, has positive and negative overflow indications and features a resolution of ±1mV and non-linearity of 0.1%. The input resistance is 100M and it requires a 5V DC supply at 250mA. ECW Ltd, 171 Broomfield Road, Chelmsford, Essex CM1 1RY, tel 0245 – 262 149.*

● **The Health and Safety Executive say that more accidents are caused by defective plugs, leads and sockets than by faults in the appliances to which they are connected. Because of this, they have issued a Guidance Note called Flexible Leads, Plugs, Sockets, Etc which gives practical advice on safe working procedures, repairs and sensible precautions. The note is designated GS37 and costs £2.25 from HMSO bookshops. Also available is a leaflet on health and safety requirements which is aimed at the self-employed and those running small businesses. Contact the Health and Safety Executive, Regina House, 259–269 Old Marylebone Road, London NW1 5RR, tel 01-723 3418.**



Spray-On EMI RFI Screening

Computer cabinets, VDU enclosures and countless other electronic equipment housings can now be provided with electrical screening quickly and easily using Electrolube's spray-on Nickel Screening Compound.

The compound comes in 200ml (250g) aerosol containers and can be used on ABS and most other commonly-used plastics. It becomes touch-dry in about fifteen minutes at room temperature and goes on to develop its full electrical properties over 24 hours or so. It forms an electrically-conductive dark grey coating which has a surface resistivity of 0.7 ohms per square and offers 50dB attenuation (typical) to 100MHz signals.

Electrolube expect the compound to be used for post-production screening in industry and point out that it is ideal for use on moulded housings with complex shapes.

Electrolube Limited, Blakes Road, Wargrave, Berkshire RG10 8AW, tel 073 522 3014.

● *Science & Technology Products Ltd only list a small selection of items in their catalogue but claim that they can supply to order a wide range of equipment and parts for electronics, physics, chemistry, biology, astronomy, etc, etc. The list includes military spec and other hard-to-obtain semiconductors, vacuum devices such as GM and camera tubes, standard and non-standard connectors, switches, transducers and much more. They also offer a custom transformer service. For details contact them at PO Box 192, Poole, Dorset BH15 4AL.*

● *It's not often we get any feedback from the companies whose products we feature in Digest, so we're very grateful to EMC Datacare for their recent letter. We described their clamp-on RF choke in our September 1985 issue, and according to their figures (obtained by asking potential purchasers where they had heard of the device) the item drew at least a dozen or more responses. Admittedly this is nowhere near as many as were gained from some of the more specialised trade journals, but what particularly caught our attention was the fact that our article was in print and producing responses long before those in any of the other monthlies. Indeed, the only publication to print the article ahead of us was the weekly trade journal* **Electronic Times**. *So remember, folks, where electronics news is concerned, you read it here first! (Well, probably.)*

● **Anyone faced with a mean photo-multiplier tube might like to take a tip from Thorn EMI Electron Tubes, who describe two methods of calculating the mean gain of such devices in their technical paper RP-076. Contact them at Bury Street, Ruislip, Middlesex HA4 7TA, tel 08956-30771.**

● Electronic Brokers have produced a six-page colour catalogue describing the Grundig range of test equipment for which they were recently appointed UK distributors. The catalogue covers television servicing equipment and oscilloscopes and includes what is claimed to be the world's first oscilloscope with automatic software controlled timebase selection. For copies contact Electronic Brokers Ltd, 140–146 Camden Street, London NW1 9PB, tel 01-267 7070.

Subscription Order Form

To: ETI Subscriptions Department, Infonet Ltd, Times House, 179 The Marlowes, Hemel Hempstead, Herts HP1 1BB.

Please commence my subscription to Electronics Today International. I enclose a cheque*/Postal Order*/International Money Order* for the appropriate fee, made out to ASP Ltd.

Please debit my Access*/Barclaycard* account number

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Signature ....

(* delete as appropriate)

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Binder Order Form

To: ASP Readers' Services, PO Box 35, Wolsey House, Wolsey Road, Hemel Hempstead, Herts HP2 4SS.

Please send me.......................................binder(s) for ETI. I enclose a cheque*/Postal Order*/International Money Order* to the value of £5.20 per binder ordered, made out to ASP Ltd (* please delete as appropriate).

Total money enclosed £..

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To: ETI Backnumbers Department, Infonet Ltd, Times House, 179 The Marlowes, Hemel Hempstead, Herts HP1 1BB.

Please supply me with the following backnumber(s) of ETI

Month .... Year ....

Month .... Year ....

Month .... Year ....

I enclose cheque*/Postal Order*/International Money Order* to the value of £1.60 per magazine ordered, made out to ASP Ltd (* delete as appropriate).

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PLEASE NOTE THAT BACKNUMBERS ARE HELD FOR ONE YEAR ONLY AND SOME ARE NOW OUT OF STOCK.

THIS COUPON IS VALID UNTIL 31st May 1986

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To: ETI Photocopies Department, 1 Golden Square, London W1R 3AB.

Please supply me with the following photocopies:

Month. . . . . Year. . . . . Article . . . .

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THIS COUPON IS VALID UNTIL 31st May 1986

NEWS:NEWS:NEWS:NEWS:

DIARY

Low Energy Ion Beams — April 7–10th

University of Sussex, Falmer, Brighton. See March '86 ETI or contact the Meetings Officer of the Institute of Physics, 47 Belgrave Square, London SW1 8QZ, tel 01-255 6111.

Design of Printed Circuits — April 7–11th

Cranfield Institute of Technology, Bedford. See April '86 ETI or contact Brian Phelps on 0234-750113 extension 2737.

The Internepcon Production Show — April 8–10th

NEC, Birmingham. Exhibition and conference devoted to electronic production technology, including CAD and ATE equipment and two special features on surface mounted technology. For details contact Cahners at the address below.

CAD/CAM '86 — April 8–10th

NEC, Birmingham. Exhibition and conference covering computer aided design, manufacture and testing. The conference includes symposia organised by the Institution of Mechanical Engineers and the IEE's CADMAT Unit as well as a series of CADCAM First-Time Seminars. For details contact EMAP International Exhibitions Ltd, Abbot's Court, 34 Farringdon Lane, London EC1R 3AU, tel 01-608 1161.

British Electronics Week — April 29–May 1st

Earls Court and Olympia, London. See April '86 ETI or contact Evan Steadman Services Ltd, The Hub, Emson Close, Saffron Walden, Essex CB10 1HL, tel 0799-26699.

Communications '86 — May 13–15th

Metropole Hotel, NEC, Birmingham. Exhibition and conference organised by the IEE which aims to provide a forum for designers and other engineers involved in communications. For details contact the IEE at the address below.

Ichiban: The Japanese Approach To The Training Of Technicians And Engineers — May 15th

Royal Angus Thistle Hotel, Birmingham, 6.00 pm. Lecture organised by the IEE. For details, contact them at the address below.

Electrical Insulation Conference — May 19–22nd

Brighton. See March '86 ETI or contact the British Electrical and Allied Manufacturers Association, Leicester House, 8 Leicester Street, London WC2H 7BN, tel 01-437 0678.

Hertz and Randall — Pioneers of Radiation — May 29th

Institution of Electrical Engineers, London, 6.00 pm. Lecture by Dr. M.J. Lazarus of Lancaster University. For details contact the IEE at the address below.

Advanced Infrared Detectors And Systems — June 3–5th

Institution of Electrical Engineers, London. See March '86 ETI or contact the IEE at the address below.

Network '86 — June 10–12th

Wembley Conference Centre, London. For details see March '86 ETI or contact Online at the address below.

Power Electronics And Variable Speed Drives — June 10–12th

Institution of Electrical Engineers, London. Conference covering the integration of microprocessors, power electronics and machines. For details contact the IEE at the address below.

Addresses:

Cahners Exhibitions Ltd, Chatsworth House, 59 London Road, Twickenham, Middlesex TW1 3SZ, tel 01-891 5051.

Institution of Electrical Engineers, Savoy Place, London WC2 0BL, tel 01-240 1871.

Online Conferences Ltd, Pinner Green House, Ash Hill Drive, Pinner, Middlesex HA5 2AE, tel 01-868 4466.

ETI

01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Micro Computer System

BBC Master Series
AMB15 BBC MASTER Foundation computer 128K .... £435 (a)
AMB12 BBC MASTER Econet computer 128K (only ANFS) .... £348 (a)
AMC06 Turbo (65C102) Expansion Module .... £87 (b)
ADF13 Rom Cartridge .... £13 (d)
ADF10 Econet Module .... £49 (c)
ADJ22 Ref. Manual Part I .... £14.50 (c)
ADJ23 Ref. Manual Part II .... £14.50 (c)
ADJ24 Advanced Ref. Manual .... £19.50 (c)

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BBC B PLUS with 128K .... £389 (a)
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UPGRADE KITS
Econet Kit .... £55 (d)
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1.2 OS ROM .... £7.50 (d)
DNFS ROM .... £17.50 (d)
ADFS Rom (for B with 1770 DFS & B Plus .... £26 (d)
64K Upgrade Kit for B Plus .... £35 (d)

ECONET ACCESSORIES
Econet Starter Kit .... £85 (d)
Econet Socket Set .... £34 (c)
File Server Level 1 .... £75 (d)
File Server Level II .... £210 (d)
Printer Server Rom .... £41 (d)
10 Station Lead set .... £26 (c)
Adv. Econet User Guide .... £10 (d)

ACORN ADD-ON PRODUCTS
Z80 2nd Processor .... £329 (a)
6502 2nd Processor .... £169 (a)
Teltext Adaptor .... £125 (b)
IEEE Interface .... £278 (b)

COMMUNICATIONS ROMS
Termulator .... £25 (d)
Communicator .... £49 (d)
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BBC FIRMWARE & SOFTWARE
Database Management Systems
Word Processors — Languages
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For full details on the wide range of above packages please write to us.

TORCH UNICORN products including the IBM Compatible GRADUATE in stock
For detailed specification or information on our comprehensive BBC range please write to us.

PRINTERS

EPSON
LX-80NLQ .... £195 (a)
FX85 (80col) NLQ 8K RAM £315 (a)
Optional Tractor Feed .... £20 (c)
FX105 (136col) .... £449 (a)
JX80 4 colour printer .... £435 (a)
LQ800 (80col) .... £595 (a)
LQ1500 (136col) 2K buffer .... £875 (a)
LQ1500 (136col) 32K buffer .... £950 (a)

PLOTTERS
Epson H180: A4 colour Plotter .... £345 (a)
Hitachi 672: A3 4 colour Plotter .... £465 (a)

TAXAN KAGA:
KP810 80 Col NLQ .... £195 (a)
KP910 156 Vol NLQ .... £339 (a)
JUKI 6100 Daisy Wheel .... £289 (a)
HR15LX (Serial) .... £295 (a)
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Interfaces: 8143 RS232 .... £28.00 (c)
8148 RS232 + 2K .... £57.00 (c)
8132 Apple II .... £60.00 (c)
8165 IEEE + cable .... £65.00 (c)
Serial & Parallel Interfaces with larger buffers available.
Ribbons: RX/FX/MX80 .... £5.00 (d)
RX/FX/MX100 .... £10.00 (d)
LX80 .... £6.00 (d)
Spare pens for H180 .... £7.50/set (d)
FX80 Tractor Attachment £37 (c)

KAGA TAXAN
RS232 Interface + 2K Buffer .... £85 (c)
Ribbon KP810/910 .... £6.00 (d)

JUKI:
RS232 Interface .... £65 (c)
Spare Daisy Wheel .... £14.00 (d)
Ribbon .... £2.50 (d)
Sheet Feeder .... £182 (a)
Tractor Feed Attachment .... £129 (a)

BROTHER HR15:
Sheet Feeder .... £189 (a)
Tractor Feeder .... £99 (a)
Ribbons Carbon or Nylon .... £4.50 (d)
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BBC Printer Lead:
Parallel (42") .... £7.00 (d)
Serial .... £7.00 (d)
Printer Leads can be supplied to any length.

MODEMS

— All modems listed below are BT approved

MIRACLE 3000:
A new range of microprocessor based modems offering of upto 2400 baud, full duplex. Features include 'HAYES' protocol compatibility, auto answer, auto dial, speed buffering, printer port, data security option etc. Mains powered.
WS3000 V2123 (V21 & V23) .... £295 (b)
WS3000 V22 (as above plus 1200 baud full duplex) .... £495 (b)
WS3000 V22bis2400 (as above plus 2400 baud full duplex) .... £650 (b)

MIRACLE 2000
A world standard modem covering V21, V23 (Bell 103/113/108 outside UK) and including 75, 300, 600, 1200 baud ratings. Optional Auto dial, auto answer cards, complete control from computer keyboard. WS2000 £125 (b)

Auto Dial Card .... £30 (d)
Auto Answere Card .... £30 (d)
SKI Software Control Kit .... £10 (d)

GEC DATACHAT 1223:
BABT approved modem complying with CCITT V23 standard. Supplied with software .... £86 (b)

Data Cables for above modems available for most computers.

Serial Test Cable
Serial Cable switchable at both ends allowing pin options to be re-routed or linked at either end using a 10 way switch making it possible to produce almost any cable configuration on site.
Available as M/M or M/F — £24.75 (d)

DISC DRIVES

These are fully cased and wired drives with slim line high quality mechanisms. Drives supplied with cables manuals and formatting disc suitable for the BBC computer. All 80 track drives are supplied with 40/80 track switching as standard. All drives can operate in single or dual density format.

PD800P (2 × 400K/2 × 640K 40/80T DS) with built in monitor stand .... £279 (a)
PD800 (2 × 400K/2 × 640K 40/80T DS) .... £249 (a)
TS400 1 × 400K/1 × 640K 40/80T DS .... £109 (b)
PS400 with psu 1 × 400K/1 × 640K 40/80T DS .... £129 (b)

3.5" DRIVES
1 × 400K/1 × 640K 80T DS TS35 1 .... £109 (b)
2 × 400K/1 × 640K 80T DS TD35 2 .... £199 (b)
PS35 1 with psu .... £129 (b)
PD35 2 with psu .... £209 (b)

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High quality discs that offer a reliable error free performance for life. Each disc is individually tested and guaranteed for life. Ten discs are supplied in a sturdy cardboard box.

5¼" DISCS
40 SS DD £12 (d) — 40T DS DD £16 (d)
80T SS DD £21 (d) — 80T SS DD £22 (d)

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80T DS DD £38 (d)

DISC ACCESSORIES

FLOPPICLENE Disc Head Cleaning Kit with 20 disposable cleaning discs ensures continued optimum performance of the drives ... 3½" £16 (d), 5¼" £14.50 (d)
Single Disc Cable .... £6 (d)
10 Disc Library Case .... £1.80 (c)
40 Disc Lockable Box .... £14 (c)
Dual Disc Cable .... £8.50 (d)
30 Disc Case .... £6 (c)
100 Disc Lockable Box .... £19 (c)

MICROVITEC

All 14" monitors now available in plastic or metal cases, please specify your requirement.

14" RGB
1431 Std Res .... £179 (a)
1451 Med Res .... £235 (a)
1441 Hi Res .... £375 (a)

14" RGB with PAL & Audio
1431 AP Std Res .... £205 (a)
1451 AP Med Res .... £275 (a)

Swivel Base for Plastic 14" Microvitecs .... £20 (c)

20" RGB with PAL & Audio
2030CS Std Res .... £380 (a)
2040CS Hi Res .... £685 (a)

KAGA TAXAN 12" RGB

SUPERVISION III with amber/green option .... £345 (a)
MITSUBISHI XC1404 14" RGB Med Res IBM & BBC Compatible .... £249 (a)

MONOCHROME MONITORS:

SANYO DM8112CX Hi Res 12" Green Screen .... £95 (a)
KAGA KX1201G Hi Res 12" Etched Green Screen .... £99 (a)
KAGA KX1203A Hi Res 12" Etched Amber Screen .... £105 (a)
PHILIPS BM7502 12" Hi Res Green Screen .... £75 (a)
PHILIPS BM7522 12" Hi Res Amber Screen .... £79 (a)
Swivel Base for Kaga Monochrome fitted with Digital Clock .... £21 (c)

SPECIAL OFFER

2764-25 .... £2.20
27128-25 .... £2.75
6264LP-15 .... £3.75

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All prices in this double page advertisement are subject to change without notice.
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Please add carriage 50p unless indicated as follows:
(a) £8 (b) £2.50 (c) £1.50 (d) £1.00

Serial Mini Patch Box
Allows an easy method to reconfigure pin functions without rewiring the cable assy.
Jumpers can be used and reused. — £22 (d)

Serial Mini Test
Minitors RS232C and CCITT V24 Transmissions, indicating status with dual colour LEDs on 7 most significant lines.
Connects in Line. — £22.50 (d)

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INTELLIGENT FAST EPROM COPIER

Copies up to eight eproms at a time and accepts all single rail eproms up to 27256. Can reduce programming time by 80% by using manufacturer's suggested algorithms. Fixed Vpp of 21 & 25 volts and variable Vpp factory set at 12.5 volts. LCD display with alpha moving message. **£395(b).**

SOFTY II

This low cost intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV — has a serial and parallel I/O routines. Can be used as an emulator, cassette interface.
Softy II .... £195(b)
Adaptor for 2764/2564. **£25.00(c)**

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All erasers with built in safety switch and mains indicator.
UV1B erases up to 6 eproms at a time .... £47(c)
UV1T as above but with a timer .... £59(c)
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UV141 as above but with a timer .... £88 (b)

CONNECTOR SYSTEMS

I.D. CONNECTORS
(Speedblock Type)

No of ways	Header Plug	Receptacle	Edge Conn.
10	90p	85p	120p
20	145p	125p	195p
26	175p	150p	240p
34	200p	160p	320p
40	220p	190p	340p
50	235p	200p	390p

D CONNECTORS
No of Ways

	9	15	25	37
MALE:				
Ang.Pins	120	180	230	350
Solder	60	85	125	170
IDC	175	275	325	-
FEMALE:				
St Pin	100	140	210	380
Ang.pins	160	210	275	440
Solder	90	130	195	290
IDC	195	325	375	-
St Hood	90	95	100	120
Screw Lock	130	150	175	-

TEXTOOL ZIF
SOCKETS
24-pin £7.50
28-pin £9.00
40-pin £12

EDGE CONNECTORS

	0.1"	0.156"
2 × 6-way (commodore)	—	300p
2 × 10-way	150p	—
2 × 12-way (vic 20)	—	350p
2 × 18-way	—	140p
2 × 23-way (ZX81)	175p	220p
2 × 25-way	225p	220p
2 × 28-way (Spectrum)	200p	—
2 × 36-way	250p	—
1 × 43-way	260p	—
2 × 22-way	190p	—
2 × 43-way	395p	—
1 × 77-way	400p	500p
2 × 50-way(S100conn)	600p	—

EURO CONNECTORS

DIN 41612	Plug	Socket
2 × 32 way St Pin	230p	275p
2 × 32 way Ang Pin	275p	320p
3 × 32 way St Pin	260p	300p
3 × 32 way Ang Pin	375p	400p
IDC Skt A + B		400p
IDC Skt A + C		400p

For 2 × 32 way please specify spacing (A + B, A + C).

MISC CONNS
21 pin Scart Connector 200p
8 pin Video Connector 200p

AMPHENOL CONNECTORS

	Solder	ZDC
36 way plug	500p	475p
36 way skt	550p	500p
24 way plug IEEE	475p	475p
24 way skt IEEE	500p	500p

PCB Mtg Skt Ang Pin
24 way 700p — 36way 750p

GENDER CHANGERS
25 way D type
Male to Male £10
Male to Female £10
Female to Female £10

RS 232 JUMPERS
(25 way D)

24" Single end Male	£5.00
24" Single end Female	£5.25
24" Female Female	£10.00
24" Male Male	£9.50
24" Male Female	£9.50

4-way 90p 6-way
8-way 120p 10-way

RIBBON
(grey/metre)

10-way	40p	34-way	160p
16-way	60p	40-way	180p
20-way	85p	50-way	200p
26-way	120p	64-way	280p

DIL HEADERS

	Solder	IDC
14 pin	40p	100p
16 pin	50p	110p
18 pin	60p	-
20 pin	75p	-
24 pin	100p	150p
28 pin	160p	200p
40 pin	200p	225p

TECHNOLINE VIEWDATA SYSTEM

Using 'Prestel' type protocols for information and orders phone 01-450 9764. 24 hour service, 7 days a week.

74 SERIES

7400	30p
7401	30p
7402	30p
7403	30p
7404	36p
7405	30p
7406	40p
7407	40p
7408	30p
7409	30p
7410	30p
7411	30p
7412	30p
7413	50p
7414	70p
7416	36p
7417	40p
7420	30p
7421	60p
7422	36p
7423	36p
7425	40p
7426	40p
7427	40p
7428	43p
7430	30p
7432	36p
7433	30p
7437	30p
7438	40p
7439	40p
7440	40p
7441	90p
7442A	70p
7443A	100p
7444	110p
7445	100p
7446A	100p
7447A	100p
7448	120p
7450	36p
7451	35p
7453	38p
7454	38p
7460	55p
7470	50p
7472	55p
7473	55p
7474	50p
7475	60p
7476	45p
7480	65p
7481	180p
7483A	105p
7484A	125p
7485	110p
7486	42p
7489	210p
7490A	55p
7491	70p
7492A	70p
7493A	55p
7494	110p
7495A	60p
7496	80p
7497	210p
74100	190p
74107	50p
74109	75p
74110	75p
74111	55p
74116	170p
74118	110p
74119	170p
74120	100p
74121	55p
74122	70p
74123	80p
74125	65p
74126	55p
74128	55p
74132	75p
74136	70p
74141	90p
74142	250p
74143	270p
74144	270p
74145	110p
74147	170p
74148	140p
74150	175p
74151A	70p
74153	80p
74154	140p
74155	80p
74156	100p
74157	80p
74159	175p
74160	110p
74161	80p
74162	110p
74163	110p
74164	120p
74165	110p
74166	140p
74167	400p
74170	200p
74172	420p
74173	140p
74174	110p
74175	105p
74176	100p
74178	150p
74179	150p
74180	100p
74181	340p
74182	140p
74184	180p
74185A	180p
74190	130p
74191	130p
74192	110p
74193	115p
74194	110p
74195	80p
74196	130p
74197	110p
74198	220p
74199	220p
74221	110p
74251	100p
74259	150p
74265	380p
74273	200p
74276	140p
74278	170p
74279	90p
74283	105p
74285	320p
74290	90p
74293	90p
74298	180p
74351	200p
74365A	80p
74366A	80p
7436A	80p
74367A	80p
74368A	70p
74376	160p
74390	110p
74393	112p
74490	140p

74LS SERIES

74LS00	24p
74LS01	24p
74LS02	24p
74LS03	24p
74LS04	24p
74LS05	24p
74LS08	24p
74LS09	24p
74LS10	24p
74LS11	24p
74LS12	24p
74LS13	34p
74LS14	50p
74LS15	24p
74LS20	24p
74LS21	24p
74LS22	24p
74LS24	50p
74LS26	24p
74LS27	24p
74LS28	24p
74LS30	24p
74LS32	24p
74LS33	24p
74LS37	24p
74LS38	24p
74LS40	24p
74LS42	50p
74LS43	150p
74LS47	80p
74LS48	90p
74LS49	100p
74LS51	24p
74LS54	24p
74LS55	24p
74LS73A	30p
74LS74A	35p
74LS75	45p
74LS76A	36p
74LS83A	70p
74LS85	75p
74LS86	35p
74LS90	48p
74LS91	90p
74LS92	55p
74LS93	54p
74LS95B	75p
74LS96	90p
74LS107	40p
74LS109	40p
74LS112	45p
74LS113	45p
74LS114	45p
74LS122	70p
74LS123	80p
74LS124/629	140p
74LS125	50p
74LS126	50p
74LS132	65p
74LS133	50p
74LS136	45p
74LS138	55p
74LS139	55p
74LS145	95p
74LS147	175p
74LS148	140p
74LS151	65p
74LS152	200p
74LS153	65p
74LS154	160p
74LS155	65p
74LS156	65p
74LS157	50p
74LS158	65p
74LS160A	75p
74LS161A	75p
74LS162A	75p
74LS163A	75p
74LS164	75p
74LS165A	110p
74LS166A	150p
74LS168	130p
74LS169	100p
74LS170	140p
74LS173A	100p
74LS174	75p
74LS175	75p
74LS181	200p
74LS183	190p
74LS190	75p
74LS191	75p
74LS192	80p
74LS193	80p
74LS194A	75p
74LS195A	75p
74LS196	80p
74LS197	80p
74LS221	90p
74LS240	80p
74LS241	80p
74LS242	90p
74LS243	90p
74LS244	80p
74LS245	110p
74LS247	110p
74LS248	110p
74LS249	110p
74LS251	75p
74LS253	75p
74LS256	90p
74LS257A	70p
74LS258A	70p
74LS259	120p
74LS260	75p
74LS261	120p
74LS266	60p
74LS273	125p
74LS279	70p
74LS280	190p
74LS283	80p
74LS290	80p
74LS292	900p
74LS293	80p
74LS295	140p
74LS297	£9
74LS298	100p
74LS299	220p
74LS321	370p
74LS323	300p
74LS324	320p
74LS348	200p
74LS352	120p
74LS353	120p
74LS356	210p
74LS363	180p
74LS364	180p
74LS365	50p
74LS366	50p
74LS367	50p
74LS368A	50p
74LS373	90p
74LS374	90p
74LS375	75p
74LS377	130p
74LS378	95p
74LS379	130p
74LS381	450p
74LS385	325p
74LS390	60p
74LS393	100p
74LS395A	100p
74LS399	140p
74LS445	180p
74LS465	120p
74LS467	120p
74LS490	150p
74LS540	100p
74LS541	100p
74LS608	700p
74LS610	1900p
74LS612	1900p
74LS624	350p
74LS626	225p
74LS628	225p
74LS629	125p
74LS640	200p
74LS640-1	300p
74LS641	150p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS644	350p
74LS645	200p
74LS645-1	400p
74LS668	90p
74LS669	90p
74LS670	170p
74LS682	250p
74LS684	350p
74LS687	350p
74LS688	350p
74LS783	£21

74S SERIES

74S00	50p
74S02	50p
74S04	50p
74S05	50p
74S08	50p
74S10	50p
74S11	75p
74S20	50p
74S22	50p
74S30	50p
74S32	80p
74S37	60p
74S38	60p
74S40	50p
74S51	45p
74S64	45p
74S74	70p
74S85	300p
74S86	100p
74S112	150p
74S113	120p
74S114	120p
74S124	300p
74S132	100p
74S133	60p
74S138	180p
74S138	180p
74S139	180p
74S140	100p
74S151	150p
74S153	150p
74S157	200p
74S158	200p
74S163	300p
74S169	550p
74S174	300p
74S175	320p
74S188	180p
74S189	180p
74S194	300p
74S195	300p
74S196	350p
74S200	450p
74S201	320p
74S225	520p
74S240	400p
74S241	400p
74S244	500p
74S251	250p
74S257	250p
74S258	250p
74S260	100p
74S261	200p
74S283	270p
74S287	225p
74S288	200p
74S289	225p
74S299	550p
74S373	400p
74S374	400p
74S387	225p

4000 SERIES

4000	20p
4001	24p
4002	25p
4006	70p
4007	25p
4008	60p
4009	45p
4010	60p
4011	24p
4012	25p
4013	36p
4014	60p
4015	70p
4016	36p
4017	55p
4018	60p
4019	60p
4020	80p
4021	60p
4022	70p
4023	30p
4024	48p
4025	24p
4026	90p
4027	40p
4028	60p
4029	75p
4030	35p
4031	125p
4032	100p
4033	125p
4034	250p
4035	70p
4036	70p
4037	110p
4038	100p
4039	250p
4040	60p
4041	55p
4042	50p
4043	60p
4044	60p
4045	100p
4046	60p
4047	60p
4048	55p
4049	36p
4050	35p
4051	65p
4052	60p
4053	60p
4504	80p
4055	80p
4056	85p
4059	400p
4060	70p
4063	85p
4066	40p
4067	230p
4068	25p
4069	24p
4070	24p
4071	24p
4072	24p
4073	24p
4075	24p
4076	65p
4077	25p
4078	25p
4081	24p
4082	25p
4085	60p
4086	75p
4089	120p
4093	35p
4094	90p
4095	90p
4096	90p
4097	270p
4098	75p
4099	90p
4501	36p
4502	55p
4503	36p
4504	95p
4505	360p
4506	90p
4507/4030	35p
4508	120p
4510	55p
4511	55p
4512	55p
4513	150p
4514	110p
4515	110p
4516	55p
4517	220p
4518	48p
4519	32p
4520	60p
4521	115p
4522	80p
4526	70p
4527	80p
4528	65p
4529	100p
4531	75p
4532	65p
4534	380p
4536	250p
4538	75p
4539	75p
4541	90p
4543	70p
4551	100p
4553	240p
4555	36p
4556	50p
4557	240p
4560	140p
4566	140p
4568	240p
4569	170p
4572	45p
4583	90p
4584	48p
4585	60p
4724	150p
14411	750p
14412	750p
14416	300p
14419	260p
14490	420p
14495	450p
14500	650p
14599	200p
22100	350p
22101	700p
22102	700p
40014/4584	
40106	48p
40085	120p
40097	36p
40098	40p
40100	150p
40101	125p
40102	130p
40103	200p
40104	120p
40105	150p
40106	48p
40107	55p
40108	320p
40109	20p
40110	225p
40114	225p
40147	280p
40163	100p
40173/4067	120p
40174	100p
40175	100p
40192	100p
40244	150p
40245	150p
40257	180p
40373	180p
40374	180p
80C95	75p
80C97	75p
80C98	75p

LINEAR ICs

AD7581	£15
ADC0808	1190p
AM7910DC	£25
AN103	3200p
AY-1-5050	100p
AY-3-1350	350p
AY-3-8010	480p
AY-3-8912	500p
CA3019A	100p
CA3028A	110p
CA3046	70p
CA3059	325p
CA3060	50p
CA3080E	70p
CA3086	60p
CA3089E	210p
CA3090AQ	375p
CA3130E	80p
CA3130T	130p
CA3140E	45p
CA3140T	100p
CA3160E	90p
CA3161E	200p
CA3162E	600p
CA3189E	270p
CA3240E	150p
CA3280G	270p
D7002	£8
DAC1406-8	300p
DAC0800	300p
DAC0808	300p
DG308	300p
HA1366	180p
ICL7106	675p
ICL7611	95p
ICL7650	400p
ICL7660	250p
ICL8038	400p
ICM7216B	£22
ICM7217	750p
ICM7555	80p
ICM7556	140p
LC7120	300p
LC7130	300p
LC7137	350p
LF347	120p
LF351	60p
LF353	90p
LF355	80p
LF356N	110p
LF357	100p
LM10C	450p
LM301A	30p
LM307	45p
LM308CN	75p
LM310	225p
LM311	60p
LM318	150p
LM319	180p
LM324	45p
LM334Z	115p
LM335Z	140p
LM336	180p
LM339	40p
LM348	60p
LM358P	50p
LM377	300p
LM380N-8	150p
LM380	150p
LM381AN	170p
LM382	200p
LM383	325
LM384	220
LM386N-1	100p
LM387	270p
LM389	180p
LM391	160p
LM392N	110p
LM393	385p
LM394CH	360p
LM709	36p
LM710	48p
LM711	100p
LM723	60p
LM725CN	300p
LM733	65p
LM741	22p
LM747	70p
LM748	30p
LM1011	480p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	300p
LM1872	300p
LM1886	550p
LM1889	450p
LM2917	300p
LM3302	90p
LM3900	60p
LM3909	100p
LM3911	180p
LM3914	350p
LM3915	340p
LM3916	340p
LM13600	150p
M51513L	230p
M51516L	450p
MB3712	200p
MC1310P	150p
MC1413	75p
MC1458	45p
MC1495L	300p
MC1496	70p
MC3340P	200p
MC3401	70p
MC3403	65p
MF10CN	300p
MK50240	900p
MK50398	790p
ML920	500p
ML922	400p
MM6221A	400p
NE531	120p
NE544	180p
NE555	22p
NE556	60p
NE564	400p
NE565	120p
NE566	150p
NE567	125p
NE570	400p
NE571	300p
NE592	90p
NE5532P	150p
NE5533P	160p
NE5534P	120p
NE5534AP	150p
OP-07EP	500p
PLL02A	500p
RC4136	55p
RC4151	200p
RC4558	55p
S566B	220p
SAA1900	£16
SFF96364	800p
SL490	300p
SN76033N	300p
SN76489	400p
SN76495	400p
SP0256AL2	700p
TA7120	120p
TA7130	140p
TA7204	150p
TA7205	90p
TA7222	150p
TA7310	150p
TBA231	120p
TBA800	80p
TBA810	80p
TBA820	80p
TBA820M	75p
TBA920	200p
TBA950	225p
TC9109	500p
TCA210	350p
TCA220	350p
TCA940	175p
TDA1010	225p
TDA1022	400p
TDA1024	110p
TDA1170S	300p
TDA2002	325p
TDA2003	180p
TDA2004	240p
TDA2006	320p
TDA2020	320p
TDA2030	250p
TDA2593	500p
TDA3810	750p
TDA7000	350p
TEA1002	700p
TL061CP	40p
TL062	60p
TL064	90p
TL071	40p
TL072	70p
TL074	110p
TL081	35p
TL082	55p
TL083	75p
TL084	100p
TL094	200p
TL170	50p
UAA1003-3	935p
UA758	320p
UA2240	120p
UAA170	170p
UCN4801A	550p
ULN2003A	75p
ULN2004A	75p
ULN2068	290p
ULN2802	180p
ULN2803	180p
ULN2804	180p
UPC575	275p
UPC592H	200p
UPC1156H	300p
UPC1185H	500p
XR210	400p
XR2206	400p
XR2207	375p
XR2211	575p
XR2216	675p
XR2240	120p
ZN409	180p
ZN414	80p
ZN419P	175p
ZN423E	130p
ZN424E	130p
ZN425E8	350p
ZN426E	300p
ZN427E	600p
ZN428E	450p
ZN429E8	225p
ZN447E	£9.50p
ZN449E	300p
ZN450E	750p
ZN459CP	300p
ZN1034E	200p
ZN1040E	660p
ZNA134J	£23
ZNA234E	950p

VOLTAGE REGULATORS

FIXED PLASTIC

		+ve		-ve	
1A					
5V		7805	45p	7905	50p
6V		7806	50p	7906	50p
18V		7808	50p	7908	50p
12V		7812	45p	7912	50p
15V		7815	50p	7915	50p
18V		7818	50p	7918	50p
24V		7824	50p	7924	50p
5V	100mA	78L05	30p	79L05	45p
8V	100mA	78L08	30p		
12V	100mA	78L12	30p	79L12	50p
15V	100mA	78L15	30p	79L15	50p

OTHER REGULATORS

Fixed Regulators		
LM309K	1A 5V	140p
LM323K	3A 5V	350p
78H05KC	5A 5V	575p
78H12	5A 12V	640p
78P05	10A 5V	900p
Variable Regulators		
LM305AH		250p
LM317T	TO-220	150p
LM317K	TO3	240p
LM337T	3A+VAR	225p
LM350T	5A+VAR	400p
LM396K	10A+VAR	£15
LM723N		50p
78HGKC	5A+VAR	650
79HGKC	5A+VAR	675p
78GUIC	1A+VAR	225p
79GUIC	1A+VAR	250p
Switching Regulators		
ICL7660		250p
SG3524		300p
TL494		300p
TL497		300p
78S40		250p

COMPUTER COMPONENTS

CPU

1802CE	650p
2650A	1050p
6502	450p
6502A	450p
65C02A	£15
6502B	800p
6800	250p
6802	300p
6803-2	£12
6809	650p
6809E	£8
68B09	£10
68B09E	£12
68000-LB	£36
8035	350p
8039	420p
80C39	700p
8080A	420p
8085A	300p
80C85A	750p
8086	£22
8088	1750p
8741	£12
8748	£16
TMS9980	£14.50
TMS9995	£12
Z80	250p
Z80A	290p
Z80B	550p
Z80CMOS (CMOS Z80)	750p

SUPPORT DEVICES

2651	£12
3242	800p
3245	450p
6520	300p
6522	350p
6522A	550p
6532	480p
16551	550p
6821	150p
68B21	250p
6829	£12.50
6840	375p
68B40	600p
6850	160p
68B50	250p
6852	250p
6854	650p
68B54	500p
6875	500p
8154	850p
8155	380p
8156	380p
8205	225p
8212	200p
8216	160p
8224	300p
8226	425p
8228	550p
8243	280p
8250	950p
8251A	325p
8253C-5	350p
8255AC-5	320p
8256	£18
8257C-5	400p
8259C-5	400p
82S129	175p

Electrically programmable and erasable PROMS

2816-30	£15
9306	450p

EPROMs

2516+5v	350p
2516-35	550p
2532	450p
2532-30	550p
2564	800p
2708	400p
2716+5v	350p
2716-35	550p
2732	450p
2732A-2	900p
2732A-35	550p
2764-25	200p
27C64-25	£10
27128-25	300p
27128-30	800p
27256	£12
TMS2716	500p

CRT CONTROLLER

CRT5027	£18
CRT5037	£12
CRT6545	£9
EF9364	£8
EF9365	£25
EF9366	£25
EF9367	£36
MC6845	650p
MC6845SP	650p
MC6847	650p
SFF96364	£8
TMS9918	£15
TMS9928	£10
TMS9929	£10

INTERFACE ICs

AD558CJ	775p
AD561J	£20
AD7581	£15
ADC0808	1190p
AM25S10	350p
AM25LS2521	350p
AM25LS2538	350p
AM26LS31	120p
AM26LS32	120p
D7002	£8
DAC80-CB1-V	£28
DM8131	600p
DP8304	350p
DS3691	350p
DS8830	140p
DS8831	150p
DS8832	150p
DS8833	250p
DS8835	280p
DS8836	150p
DS8838	225p
MC1488	60p
MC1489	60p
MC3446	250p
MC3459	450p
MC3470	475p
MC3480	850p
MC3418L	990p
MC3486	250p
MC3487	250p
MC4024	550p
MC4044	550p
MC14411	950p
MC14412	750p
ULN2003	75p
ULN2004A	75p
ULN2068	290p
ULN2802	190p
ULN2803	180p
uLN2804	190p
75107	90p
75108	90p
75109	120p
75110	90p
75112	160p
75113	120p
75114	140p
75115	140p
75121	140p
75122	140p
75150P	120p
75154	120p
75159	220p
75160	500p
75161	350p
75162	400p
75172	300p
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Access

READ/WRITE

Pot Shop

Dear Sir,

With reference to K.G. Vergis' letter 'Scope for Improvement' (Read/Write, ETI March 1986).

Neosid Small Orders, PO Box 86, Welwyn Garden City, stopped trading in 1983. The PO Box number address was discontinued when further communications became a matter for the postal authorities to return to sender.

Whilst I sympathise with your correspondent's dilemma, I regret there is nothing I can do to assist at this stage as regards return of the postal order. However, if you will furnish K.G. Vergis' full address we will be pleased to send an ET30 pot core with our compliments.

Would-be purchasers should in the first instance write to me and I will arrange supplies.

M.J. Bass
Neosid Limited.

We were delighted to receive the above letter and have passed on K.G. Vergis' address as requested. We have also spoken to Neosid to confirm the offer made at the end of the letter. Mr Bass tells us that although his company no longer has a small orders department they will be happy to deal with individual orders for the ET30. Readers who require this pot core for the ETI Oscilloscope should telephone Neosid on 0707 - 325011 and ask for the sales desk. — Ed.

Hi-fi Praise

Dear Sir,

I'd like to react to all the complaints about the John Linsley Hood Audio Design Amplifier by saying 'Stick with it — it is well worth the effort.' I have built up the amplifier and preamplifier myself and have nothing but praise for the design.

Regarding the difficulty with components, the small signal MOSFET type VN1210M is manufactured by Siliconix. Readers outside the UK should try their agents (Electrolink in South Africa).

Finally, I wish to congratulate ETI. The audio design series was well presented, easy to follow, and had few errors.

I thank you.
Yours faithfully,
Hugh Hacking,
Johannesburg,
South Africa.

Simply Not Good Enough

Dear Sir,

I have been a regular reader of ETI since it first appeared in the early seventies. However, I feel that the quality of the projects over the past year leaves a lot to be desired. Many have either been esoteric projects at extortionate cost or re-hashes of past designs. I feel that some simpler projects and new ideas are sorely needed. To this end, I enclose a list of items I would like to see in the pages of ETI:

1) Digital recording of audio signals in the picture circuits of a VCR for high quality.

2) In car graphic equaliser/power booster/quadraphonic simulator.

3) Video enhancer and booster.

4) Car exhaust gas analyser.

5) Home computer based engine fault diagnostic aid.

6) Home computer to VCR Interface.

7) Extension to the above to allow control down a telephone line.

8) Use of a home computer for sub-titling on video recordings and for superimposition of messages and time on the picture.

9) Circuits to allow decoding of VCR composite Video to RGB to allow direct coupling to an RGB equipped TV.

10) Switch, amplifier and distribution centre for TV/VCR/aerials.

11) Interface circuits and software for widely available surplus hard disk drives.

12) Projects for the Amstrad computer range, for example, interfacing a standard 5¼" drive to the CPC6128.

13) Comprehensive central heating controller, possibly using a ZX81.

14) Digital audio mixer/sound processor circuits.

15) Touch screen system for a home computer using a network of infra-red LEDs and diodes surrounding the screen.

F.R. Felgate,
Camberley,
Surrey.

Thank you for your suggestions for simple (?) projects. We will bear them in mind. — Ed.

PROMises, PROMises ...

Dear Sir,

Some time ago I constructed an EPROM programmer from a design published in the August and September 1984 issues of ETI. As it happened, I had to modify the front end to use it with my BBC micro. Much of the software had to be re-written, but after a lot of midnight oil it now all works.

I was highly delighted when in the May 1985 issue you published an upgrade to the board. I sent off and received the PC board and duly made up the modification. Then, in the July 1985 issue it was mentioned that a version for the BEEB was about to be produced, with the driving software in Sideways ROM. Since then I have seen nothing more on the subject. I have held off modifying my working board to include the update so as not to break down the programmer for a second time. Can you please let me know if this article will appear?

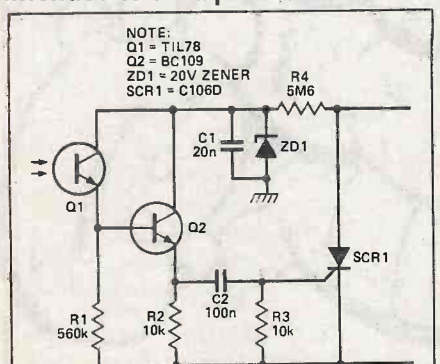
Yours faithfully,
M.D.J. Foreman,
Frenchay,
Bristol.

We are still expecting to publish a design for an EPROM programmer to use with the BBC computer, but at the moment it is not possible to say when it will appear. Our apologies to all frustrated BEEB owners but we can assure you that it will be worth waiting for. — Ed.

AUNTIE STATIC'S PROBLEM CORNER

Dear Auntie,
I have built a flashgun slave trigger unit, but I can't get the circuit to work. I have tested the circuit with my multi-meter, but the results are so spurious that I cannot pinpoint the error. I am now reaching desperation point over what should be such a simple project (this is my fourth attempt!) I have sent my circuit, so will you please have a look at it and tell me what I am doing wrong.
Yoursh faithfully,
Gerry Barlow B.Sc.,
Colwyn Bay,
Clwyd.

Before I begin, I must point out that in general we do not encourage readers to send us circuits for modification or repair. If we started doing it regularly, we'd have no time to design any projects! We made an exception in Mr. Barlow's case, but this is not intended to set a precedent.



The circuit, as it arrived, is shown above. It derives its power supply from the trigger input of the flash gun — on the slave flash unit sent in by Mr. Barlow about 150V was present under open circuit conditions. This voltage comes from a very high source resistance and a load of 3M3 is enough to reduce the voltage to less than half and also to prevent the gun from triggering — hence the 5M6 resistor in the trigger circuit. The available current would not be enough to fire SCR1, which requires 200μA gate current, so C1 is included as a 'reservoir'. ZD1 prevents the voltage across C1 from rising above 20V. Q1 has a high resistance in darkness and a low resistance in light, so the idea of the circuit is that the flash from the master gun is picked up by Q1, causing a sudden rise in voltage at the top of R1 which fires the SCR via Q2 and C2, in turn triggering the slave flash gun. This is the theory, anyway.

Naturally, Mr Barlow's first instinct was to get out his multi-meter and try to trace the fault. Unfortunately, a standard 20k per volt multi-meter on the 20V range will have a resistance of 400k. This resistance is quite low enough to discharge C1 to a greater or lesser extent whenever any readings are made on the circuit. The results will bear very little relation to the actual operating voltages, and will not be directly comparable with each other since C1 will discharge by varying amounts depending on where the readings are made. The way round this is to connect a temporary voltage supply of, say, 18V across C1. Not 20V, by the way, as the zener will then be on the point of conduction, with possibly disastrous results. You could, of course, use a supply of about 25V and a series resistor, but unless you suspect that ZD1 is not working, which is quite easy to test anyway, why bother? You will still have to take the meter resistance into account when measuring the voltage across R1, but at least the readings will now make some kind of sense.

With the 18V test supply connected, the voltage across R1 was checked with various light levels. Two things would make the value of R1 unsuitable: if it was too low, very intense lighting would be required to raise the voltage across it by an appreciable amount, and if it was too high, normal room lighting would take the voltage across it almost to the supply rail level and leave little margin for a voltage rise when the master flash goes off. In fact, the value of 560k is fine in both respects and was not changed.

Although the value of R2 was perfectly good with the 18V supply connected, it was too low for reliable operation when powered by the flash gun. As the slave flash would not necessarily be used in pitch darkness, allowance must be made for the fact that there will be some voltage developed across R2 from background lighting falling on Q1. A quick calculation shows that a drop of about 250mV across R2 would be enough to sink all the current from R4, discharge C1, and prevent the circuit from working at all.

Are there any disadvantages in raising the value of R2? As its only purpose is to provide a discharge path for C2 after the trigger has operated, the main requirement is that the time constant of R2 + R3 and C2 should be small enough to allow a reasonably quick recovery. The value could be raised to several megohms from this point of view so there is no need to worry. The final value settled on was 100k, which is quite adequate to cure the discharge problem and leaves plenty of room for increasing the values of C2 and R3.

If you feel that R2 has some other function besides discharging C2 — perhaps you think in some vague way that emitter followers need emitter resistors — I suggest that you try removing R2 from the circuit. Make sure that the 'left hand' plate of C2 is discharged to ground, then try using the trigger. You'll find it will work perfectly well once but won't fire a second time. To make it work again, you will have to discharge C2 to ground (which is the function of R2, as I have said ...)

C1 must store enough charge to operate the circuit and maintain conduction in the SCR during the entire triggering period. The value of C1 was a little low to do this reliably and the value was raised to 100n. This still gives a charge time via R4 which is less than the time Mr Barlow's flash gun needs to recharge.

To test the values of C2 and R3 I simply attempted to trigger the flash, with the 18V supply in place, by shorting the collector and emitter of Q2. Once again, triggering was unreliable with the original values and the solution was to increase C2 and R3 to 470n and 100k respectively, bearing in mind the recovery time of C2 as already mentioned. R3 could have been replaced by a 200k preset as a 'sensitivity' control.

The final component values for the circuit were: R1 560k, R2 100k, R3 100k, R4 5M6, C1 100n, C2 470. — Auntie.

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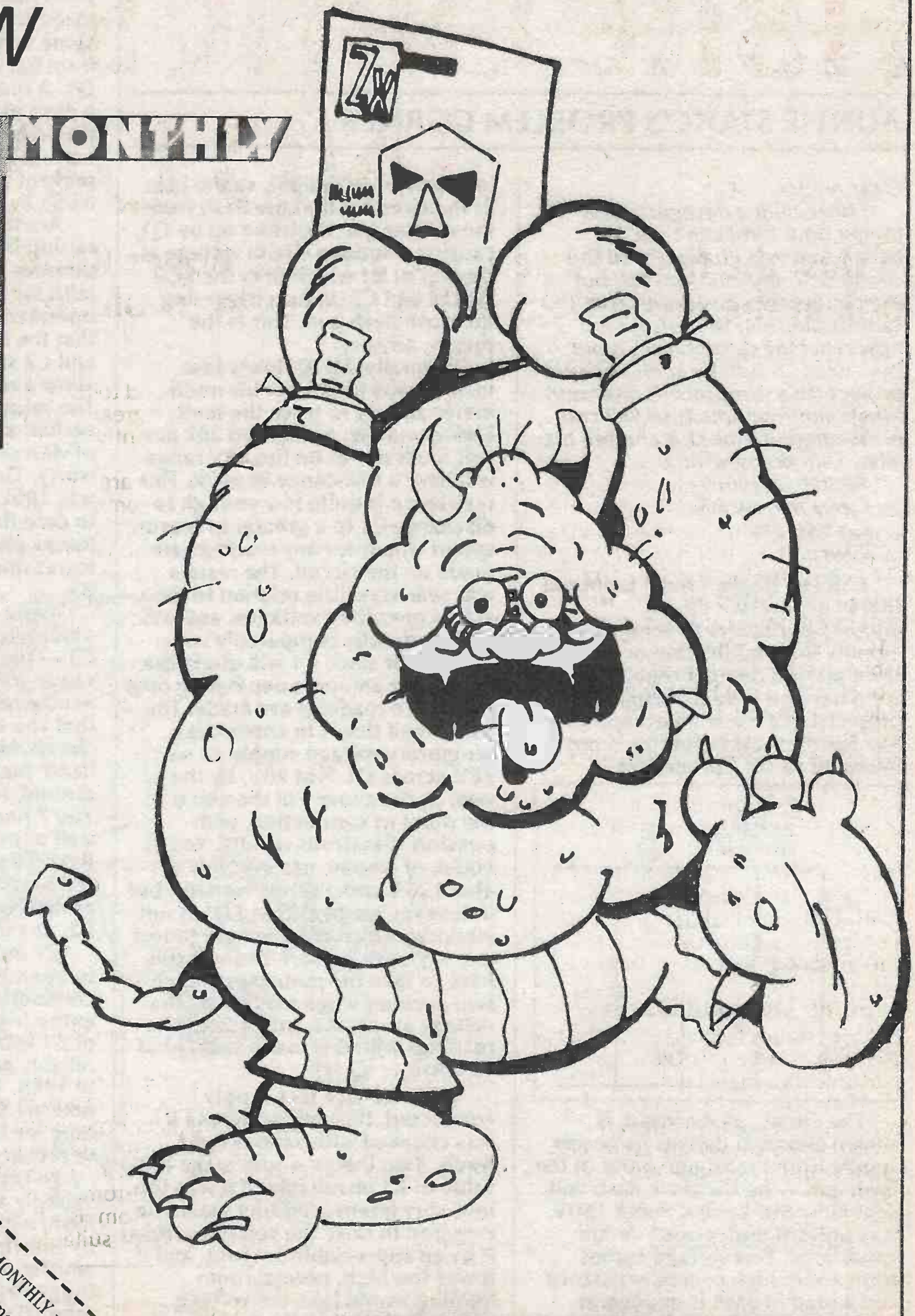

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FIBRE OPTICS AND LASERS

In this, the first of a series of articles, Roger Bond takes a close look at the technologies that are set to revolutionise our communications systems.

Heard the one about the Englishman, the American and the Japanese? They are all racing each other to get higher and higher bit rates down optical fibre.

In 1982 British Telecom engineers at Martlesham, near Ipswich, showed how an optical signal could be sent at 140 Mbit/s over a distance of 100 km without repeaters. A bit rate of 140 Mbit/s is sufficient to handle a 625 line television signal or 1920 telephone circuits. In spring 1983 the Japanese transmitted at 445 Mbit/s over 134 km without a repeater and with an error rate of only 1 in 10^9. Then in September 1983 the US Bell Laboratories transmitted at 420 Mbit/s over 161 km with an error rate of only 5 in 10^9. At these high information rates it is possible to transmit thirty volumes of the Encyclopedia Britannica in one second, and at the above error rates, one letter of the alphabet might be wrong for every five encyclopedia sets.

Why the sudden interest in optical communications? An optical ray has the advantage of wide bandwidth and immunity from electrical noise. For example, the maximum bandwidth obtained from operating on a carrier of 10kHz is 10 kHz for each sideband. The maximum bandwidth obtainable from a carrier of 10^{14} Hz is 10^{14} Hz for each sideband, and it is in this frequency range (the infra red) that lasers operate.

Some Light On The Laser

Laser stands for light amplification by the stimulated emission of radiation. Light travels in discrete bundles or photons, and light falling on photosensitive materials will stimulate electrons. The opposite is also true. If electrons are sufficiently stimulated, light will be emitted.

Figure 2a shows an atom consisting of a positive nucleus and a negative electron circling the nucleus. If energy is supplied to the electron it will revolve around the nucleus at a greater distance from the centre. If the energy is sufficiently great, the electron could escape from the nucleus.

When atoms are close together as in a solid, the energy levels become energy bands (Fig. 2b). At absolute zero temperature, the valency band would be filled and there would be no electrons in the conduction band.

The valency band determines which group of the periodic table an element belongs to. Between the valence and conduction bands is a forbidden gap. Electrons cannot possess energies within this gap. Therefore, in giving up its energy and dropping across this gap, an electron causes light to be emitted of the same wave-length as the gap. For communications over optical fibre this wavelength is 0.85 μm or 1.3 μm.

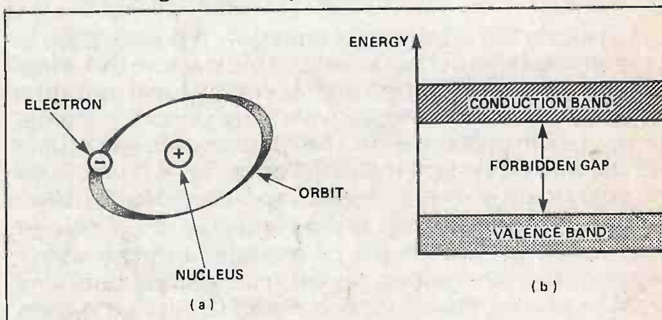


Fig. 2 Energy band model of atom.

In lasers, the stimulation is achieved by a process known as pumping, in which electrons are deliberately raised to higher energy levels. The normal distribution of electrons is shown in Fig. 3a, and it will be seen that there are fewer electrons in outer orbits than there are in inner orbits around an atom.

If such an atom is stimulated using an electromagnetic signal of suitable wavelength, electrons will

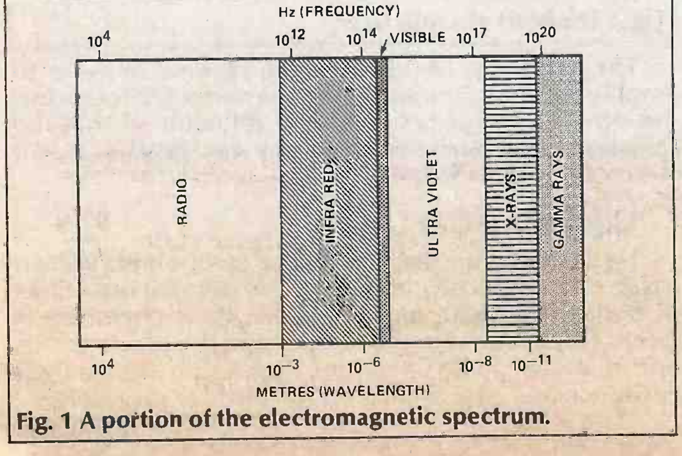


Fig. 1 A portion of the electromagnetic spectrum.

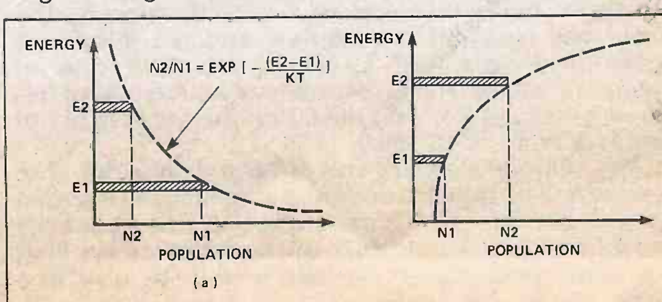


Fig. 3 Electron distribution, normally and after population inversion.

move to the outer orbits until there are more of them there than in the inner orbits, a situation known as a population inversion (Fig. 3b). The electrons will not be stable in this state and will fall back to their previous energy levels within a few nanoseconds producing a spontaneous emission of light. As a result, this system produces pulsed rather than continuous emission.

Although pulsed lasers have their applications, most of the useful lasers emit coherent light. Coherent light can be described as being of the same frequency and travelling in the same direction, parallel and in phase. That is why lasers can burn holes in metal.

As examples of incoherent radiation consider the sun or a light bulb. Various frequencies at random intervals are emitted. The power obtained from focusing the sun's rays is well known to anyone who has tried to burn a hole in paper using a magnifying glass. Not only is a laser prefocused (parallel) but it continues to remain so. For instance, a spot light may diverge by 2° whereas a laser diverges by only a few seconds of arc. That is one reason for using a laser to communicate with say, astronauts on the moon. Light from a spotlight would be completely dissipated over the distance.

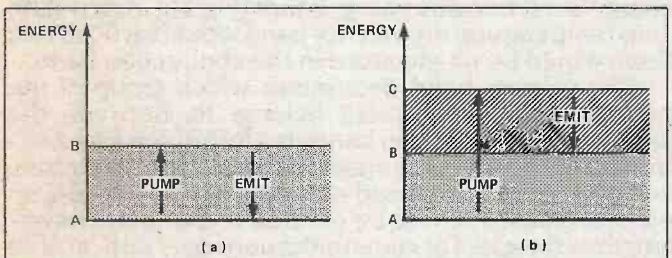


Fig. 4 Pulsed and metastable electron pumping.

To obtain this continuous emission, it is necessary to achieve what is known as a metastable state. In this, electrons are raised to a much higher energy level and then remain there for a comparatively long period, microseconds or even milliseconds. The difference between this and the pulsed system is illustrated in Fig. 4. If electrons will not remain at energy level C, spontaneous emission will take place as before. If they will stay at C (a factor determined by the choice of material and the wavelength of the stimulating signal), continuous pumping can take place between levels A and C. All that is then required to achieve continuous emission is to stimulate the atoms with another signal whose wavelength is equivalent to the gap between B and C. In this way, a continuous population inversion will be maintained between these two levels.

Masers

Before going on to look at the different types of lasers, we will consider briefly the device which preceded them, the maser.

Maser stands for microwave amplification by the stimulated emission of radiation, and the difference between masers and lasers is therefore one of frequency. While the former operate at microwave frequencies (about 10^{12} Hz) the latter operate at light frequencies (around 10^{14} Hz).

The ammonia maser was invented in 1954. The designers were trying to design an amplifier, but it ended up as an oscillator which worked at only one frequency and refused to be tuned even over a narrow range. That was when the designers decided it could be used as a clock.

The world's best clocks at that time accumulated errors of one second in ten years but the ammonia maser accumulated an error of only one second over 10,000 years. Today, caesium and rubidium provide even more accurate clocks.

Masers were used in satellite communication and radio astronomy where a weak signal had to be detected in the presence of noise. The maser is ideal for this since it generates little noise itself compared to klystrons and travelling wave tubes. It saturates at power levels above 10^{-5} watts. In 1960 the Echo I satellite was used merely as a reflector to bounce the signal. 10kW was beamed up at it and only 10^{-14} was reflected back. Later, Telstar amplified the signal before transmitting it back to earth, but even then the received signal was only 10^{-13} watt.

Molecular vibration stops at absolute zero, so the maser is operated at 1.5°K (−271.5°C) by immersing it in a helium bath. The maser used at the satellite station in Cornwall was ruby with 0.05% chromium. This front end amplifier has largely been replaced by parametric amplifiers, but that is a different story.

Crystal Lasers

The ruby laser was the first to be operated successfully by Maiman in 1960. Ruby is aluminium oxide $Al_2 0_3$ with some of the aluminium atoms replaced by 0.05% chromium for effective lasing.

The ruby crystal was a rod 10 cm long and 1 cm in diameter (Fig. 5). Pumping and hence population inversion was obtained by means of an xenon flash tube spiralled around the crystal. A few kilovolts was discharged through the tube from a bank of capacitors of around 100 microfarads.

This flash energy was in the green and blue end of the colour spectrum which is the absorption band for ruby. Provided sufficient energy was supplied, the ruby crystal emitted its characteristic red in the visible part of the colour spectrum, at a wavelength of 10^{-8} cm.

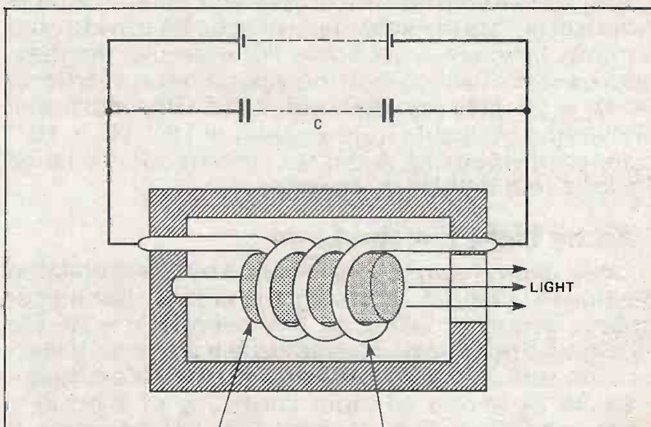


Fig. 5 The heart of a ruby laser.

The end faces of the rod were silvered in order to amplify the light. One end acted as a perfect reflector but the other end was only a partial reflector so that the radiation could burst through. Ruby was ideal because it is easy to cut and shape.

Liquid And Gas Lasers

Liquid lasers employ a group of compounds known as the rare earth chelates which give out vast quantities of fluorescent light. Unfortunately, their chemistry is rather complicated and quite outside the scope of this article, so we can do little more than acknowledge their existence and pass rapidly on to consider gas lasers.

The gas laser was invented in 1961 and the prototype used a mixture of helium and neon in the ratio 5:1 (Fig. 6). Helium and neon were chosen because they have similar energy levels, and population inversion can be obtained by energy transfer from one to the other. The tube was 1 metre long and of 1.5 cm internal diameter. Mirrors were mounted on the inside ends and were capable of adjustment so that they were parallel to each other.

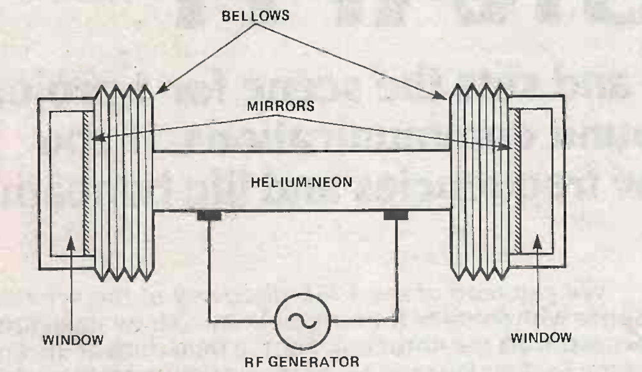


Fig. 6 Helium-neon laser.

The object of using mirrors is to amplify the light by bouncing it back and forth. Nothing could be simpler, it's all done with mirrors and since we are dealing with light it seems logical to use mirrors. However since the gas is at low pressure, the mirrors have to be adjusted in a virtual vacuum which is not easy. This is now overcome by using external spherical mirrors.

Carbon dioxide is also used in gas lasers and in general, gas lasers are more directional and monochromatic than solids like ruby. Monochromatic means approximating to a single frequency, and this is possible because gases do not have the physical imperfections of solids. Gas lasers can also emit a continuous beam at room temperatures without the need for cooling.

Semiconductor Lasers And LEDs

So far we have only dealt with laser light sources. In considering semiconductor lasers, however, it is convenient to look also at LEDs since they share the same technological base and have important applications in fibre optic communications.

The main difference between light emitting diodes and lasers is that LEDs emit spontaneously whereas lasers have to be stimulated. This can be seen in the characteristic curves of Fig. 7.

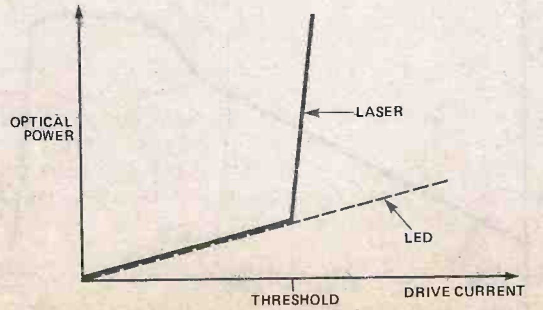


Fig. 7 Characteristics of semiconductor lasers and LEDs.

Stimulated emission is of higher fidelity than spontaneous emission because photons stimulate other photons of the same wavelength. Hence the linewidth of lasers is 1 nm (10^{-9} m) whereas the linewidth of LEDs is about 20nm. This means that the useful bandwidth of LEDs is limited since sidebands are produced which overlap. For the widest possible bandwidth, a single pure frequency is required.

The output of a LED is linear and can therefore be used to transmit an analogue signal. The laser curve rises slowly until a breakpoint or threshold is reached, then the emission takes off. Because of the shape of the laser curve, it is more suitable for transmitting digital signals in which the light is switched on and off.

LEDs operate in the 0.85 μm to 0.95 μm range, the infra-red. Figure 8 shows a high radiance light emitting diode (HRLED), also called a Burrus diode. The difference between this and an ordinary LED is that a well is etched in the top. The well is usually 50 μm is diameter and a 50 μm optical fibre fits snugly into it, reducing coupling losses.

Edge light emitting diodes (ELEDs) are even more efficient than Burrus diodes. The Burrus diode uses a homojunction, a construction in which several layers of gallium arsenide (GaAs) with opposite charges are sandwiched together. ELEDs use heterojunctions , which have alternate layers of gallium arsenide and gallium aluminium arsenide. Figure 9 shows a double heterojunction.

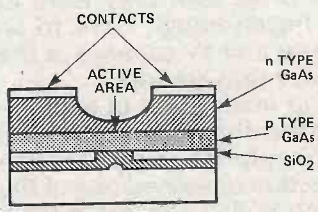


Fig. 8 HRLED.

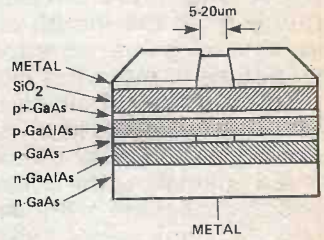


Fig. 9 ELED.

The important feature is the stripe etched on the top which helps concentrate the emission from a very small area. The reflex index of the stripe needs to be uniform so that the output characteristic is a straight line.

The first semiconductor lasers were homojunctions, then heterojunctions were used and now double heterojunctions. The design is similar to that of ELEDs, but there is one big difference. The stripe in the ELED does not extend the whole length of the chip whereas it does in the laser.

The effect of having a stripe over the full length is to provide feedback and hence laser action. If the stripe does not extend to the end, the region without a stripe acts as an absorption region and light is absorbed here. Therefore there is no feedback and no lasing. The threshold current is the minimum current required to produce lasing and both the geometry of the stripe (5 to 20 μm) and the double heterojunctions help to reduce the required current.

The laser chips are around 400 μm square with perpendicular ends as near perfect as possible and silvered as with all lasers. When a photon is emitted it reflects off the mirrored surface and, if it meets an electron about to emit a photon, stimulated emission takes place releasing more photons.

The wavelength of the emission can be altered slightly by changing the concentration of aluminium. The active region is below the stripe and contains 5% aluminium. The other regions contain 35% aluminium and help the device to expand without cracking as heat is generated. The heat sinks are copper, soldered with indium. Typical outputs are around 5 mW and a laser's life at room temperature is about 10 years. **ETI**

THE ETI TROGLOGRAPH

Mike Bedford gets down real low and sets the scene for a project using VLF for surface-to-underground communications. If you want to know more about very low frequencies and life beneath the Pennines, read on ...

A loud cheer rang through the night air as the long awaited words came over the Molephone — the connection had been made. It was Saturday 28th May 1983 and the words in question came from a group of potholers 300 feet below informing the surface party that they had made the link up between Gaping Gill and Ingleborough Cave. An hour or so later they were to emerge from the mouth of Ingleborough Cave to an overwhelming array of reporters and TV cameras as the first people to make this elusive through trip.

This was the culmination of many years of exploration in the two caves in which the distance between the known extremities of the two systems gradually diminished but making the connection remained one of the greatest challenges in British potholing. The final push at making the link during 1982 and 1983 made considerable use of the Molephone, a newly developed piece of equipment allowing voice communication and radio location through solid rock.

This historic through trip has been named Dr Mackin's Delivery by the Bradford Pothole Club in recognition of the assistance given by the developer of the Molephone, and without which the feat would have been virtually impossible.

Cave Law

Gaping Gill is situated on the lower slopes of Ingleborough in the Yorkshire Dales National Park and must be considered one of the most famous potholes in Britain. The first descent of this 340 foot shaft was made in 1895 by the Frenchman Edward Martel who reported that no obvious passages radiated from the huge cavern which he found.

Throughout this century the cave system has attracted numerous potholers who proved that in marked contrast to Martel's initial reports, the main chamber is the hub of a sizeable array of passages and chambers totalling 7½ miles in length (excluding Ingleborough Cave) and ranking among the largest systems in the country.

Gaping Gill features prominently in the annals of caving folklore, being a cave of superlatives — the deepest shaft in Britain, the tallest waterfall, the largest cave chamber and also the second largest in the vast Mud Hall. Tales abound of Eric Hensler's solo exploration of the hundreds of yards of 18-inch high passages which now bear his name. In 1953, crowds fearing for his sanity eagerly awaited the return of Geoff Workman after his 14-day lone encampment in Sand Cavern aimed at discovering the effects on the human body of such a period cut off from our natural clock, the sun.

We can read of the 1968 discovery of the Whitsun Series with some of the longest known straw stalactites, accessed via the notorious 'Font', a mud duck at the end of the Far East Passage. More recently numerous people have sampled the grandeur of the main chamber as public winch meets have been arranged at Spring and August Bank Holidays during which members of the public could be transported down the massive shaft in a bosun's chair.

A mile away in the wooded valley known as Trough Gill is the large mouth of Ingleborough Cave. Established as a show cave as long ago as 1838, it is a major tourist attraction, drawing many visitors each year. The cave also has much to interest the potholer in the areas beyond the limit of the show cave, these flooded passages being the domain of cave divers using aqualung equipment.

For many years it had been realised that the stream thundering down the 340-foot waterfall into Gaping Gill was the same one which emerged some time later out of the mouth of Ingleborough Cave. The fact that water could find a way through impelled the search for a link between the two caves through which a person could pass.

Later discoveries in Gaping Gill, the Far Country and Far Waters which were first explored during 1970, did appear to come very close to the Radaghast's Revenge area of Ingleborough Cave, discovered by diving in 1976. The way through would almost certainly require

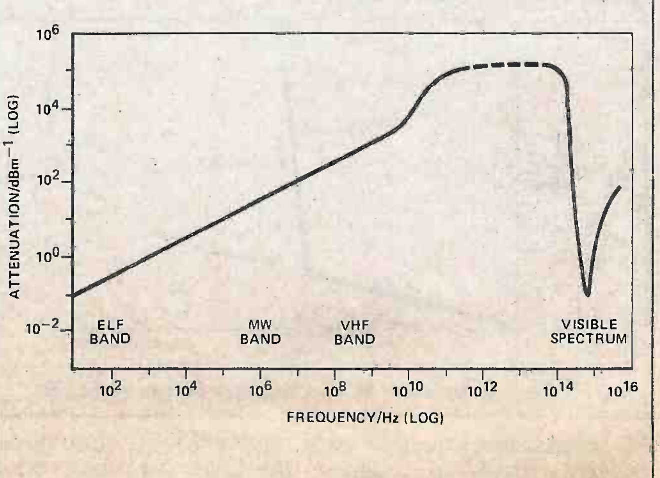


Fig. 1 Attenuation of electromagnetic waves in sea water.

digging and, although both caves were reasonably well surveyed, it was very difficult to tell exactly which points in the two systems were the areas to concentrate on.

Technology To The Rescue

In the early 1980s, the Molephone helped locate a point in Radaghast's Revenge that was found to be so close to the Far Waters of the Gaping Gill system that the surface team found it hard to believe that the link had not been made! The remaining few metres did not give up without a struggle, however.

Numerous digging parties made the long and laborious journey from Gaping Gill to the Far Waters passing through the so called Wallows in which the airspace was sometimes as little as one inch. By early 1983, sufficient progress had been made to start making plans for the through trip.

Planned with the precision of a military operation, the expedition involved a party on the surface, one entering Ingleborough Cave and another party entering Gaping Gill accompanied by a two man BBC film crew making a TV documentary on the link-up. Each party was in communication with the others by use of Molephones, the surface party tracking the Gaping Gill group across the moors and the Ingleborough Cave party being called into the cave once the other team were close to the connection area.

Even this final assault wasn't without its problems. The Gaping Gill party of thirteen took over 1½ hours to move themselves and their equipment through the final 20 feet from where Geoff Yeadon and Geoff Crossley were to dive through the sump pool into Ingleborough Cave.

Geoff's account of the through trip [1] notes that the conditions of the final dig were appalling — extremely wet, mud-logged, cold, tight *and* loose clay (you name it, the connection certainly seems to have it!). All the same, Dr. Mackin's Delivery is now history.[2]

Way Down Low

It will come as no surprise to most people that electromagentic radiation is greatly attenuated by solid rock. In actual fact, due to its greater conductivity, sea water is even more difficult to penetrate than rock, a fact which makes communication with submarines a significant problem. Since submarine communication is of military importance, a great deal of research has been carried out in this area and Fig. 1 shows a graph of attenuation through sea water against frequency.[3]

It will be noticed that the degree of attenuation increases with frequency except for a small band at the high frequency end which corresponds to the visible spectrum (light). To get some idea of the severe limitations imposed at normal radio frequencies, consider a frequency of 1MHz which falls in the medium wave band and accordingly wouldn't normally be considered a particularly high frequency.

The attenuation here is 30dB per metre — in other words, the power level is reduced by a factor of 1024 over this distance. After two metres at this degree of attenuation, the signal remaining from a high power 100kW broadcast station would be only a tenth of a watt. As a result of this situation, submarine communication has to take place in the ELF (30–300Hz) portion of the electromagnetic spectrum.

A concept often used in submarine/subsurface communications is that of skin depth, a measure of how far signals will penetrate below the surface. The skin depth is given by the formula:

$$\delta = (1/\pi f \sigma \mu)^{1/2}$$

where f is the frequency in Hertz, σ is the electrical conductivity of the medium in S/m and μ is the magnetic

Travelling by underground

permeability which is reasonably constant for media such as rock and sea water.

Since the conductivity of rock is generally in the region 10^{-1} to 10^{-3} S/m compared to about 4S/m for sea water it is easy to see that considerably greater ranges can be achieved through rock at the same frequency. Alternatively, acceptable distances can be obtained at a higher frequency than those used for submarines. Since the rate of data transmission is limited by the bandwidth and hence the carrier frequency it is clearly advisable to use the highest frequency possible.

For caving use, where depths of much more than 400 feet are rarely met in Britain and where the rock is limestone (not a particularly conductive substance) a frequency of about 3kHz is quite suitable for CW and direction finding and even an order of magnitude higher could be used if there was a requirement for speech communication.

Nevertheless, 3kHz is a very low frequency (the VLF band is officially designated as 3kHz to 30kHz) with a correspondingly long wavelength. The generally accepted standard aerial, against which the gains of more sophisticated aerials are measured, is the half-wave dipole — such an aerial would be 50kM long for 3kHz and even a quarter wave aerial would be 25kM or 16 miles in length.

Clearly such an aerial is not a feasible proposition in a cave! For submarine communications, aerials many miles in length are used but since even this length is small in terms of wavelengths, extremely high power levels are used to compensate for the inefficiency of the aerial.

Field Strength

Electromagnetic radiation consists of two elements — the electric field and the magnetic field. Normally, when we refer to radio waves, it is the electric field which we really mean and it is these waves which require aerials of the order of a quarter of half wavelength in order to propagate. A magnetic wave, on the other hand, can be radiated from much smaller aerials, a current carrying multi-turn loop being a classic example.

As is the case for electric waves, the magnetic field will also pass through conductive materials if the frequency of the radiation is sufficiently low. The disadvantage of communicating by magnetic waves is that field strength decreases with the cube of distance compared with the electric waves which diminish with the square of distance. This means that long distances are out of the question for magnetic wave communications and is the reason why only the electric waves are usually considered as radio.

For cave communication, long distances are not required and the inverse cube law does not present a great problem. Magnetic field communication is sometimes referred to as inductive communication as its operation can be compared to that of a transformer with a very large separation between the primary and secondary windings.

It will probably have been noticed that the frequencies mentioned are within the band normally referred to as audio. Before going any further, let's clear up any confusion which may be caused by this.

Even though we may use audio frequencies, it is not correct to assume that the communications could be heard by someone close to the aerial. This is because the human ear cannot receive electromagnetic radiation. The ear is sensitive to mechanical vibrations of the air (normally called sound) and audio frequencies occupy just the range over which the ear might respond to air vibrations. ELF and low end VLF communciations could therefore be said to use radio waves at audio frequencies.

Direction Finding

The Gaping Gill link-up made extensive use of the directional properties of magnetic waves to accurately map the appropriate areas of the caves both horizontally and vertically. Figure 2 shows the shape of the magnetic field generated by a current carrying loop.

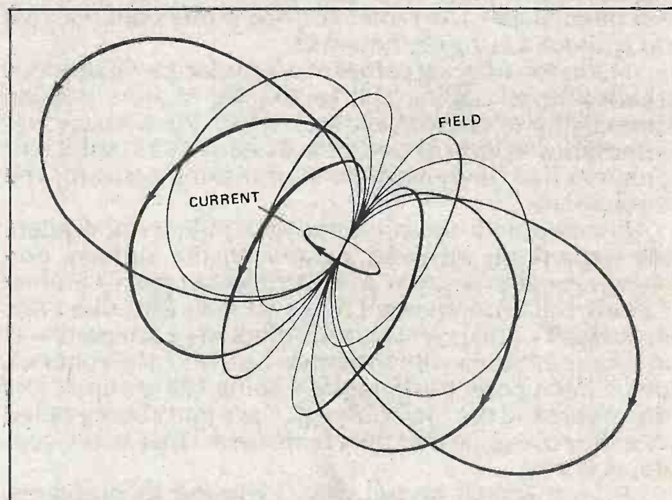
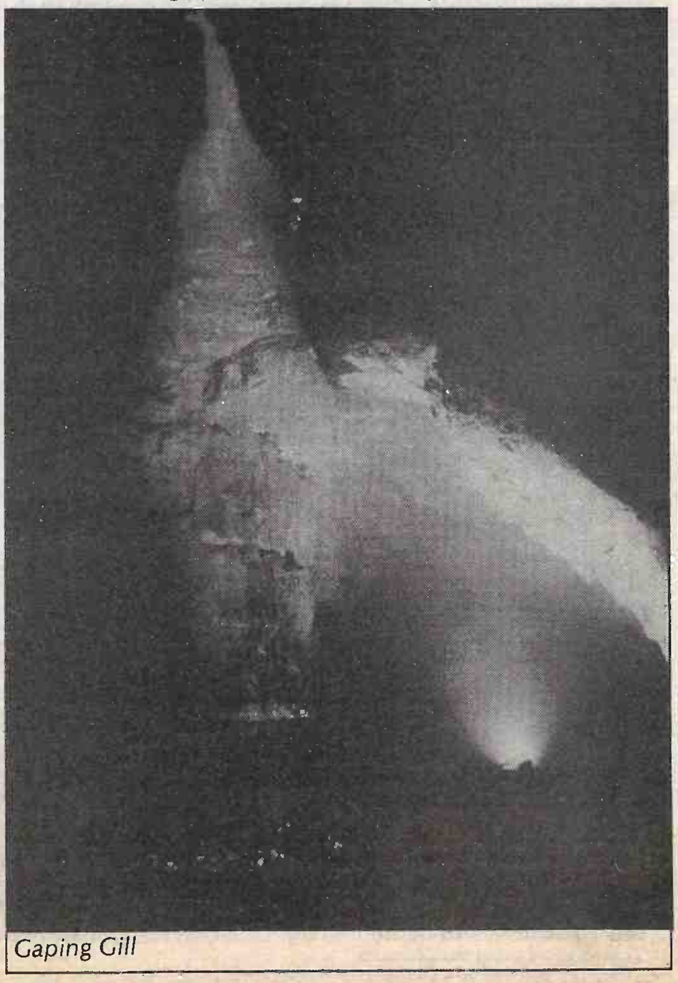


Fig. 2 Magnetic field generated by a current loop.

In contrast to the electric field of normal radio communications, which radiates in straight lines from the aerial, the magnetic field is made up of closed elliptical


Gaping Gill

The author takes the Troglograph for a swim.

loops. As a result, direction finding is not as straightforward as the normal triangulation method used in radio location.

The method used in cave surveying involves taking a transmitter to the point of interest in the cave and switching on at a pre-determined time, having first ensured that the aerial coil is perfectly horizontal. The surface party on first receiving these signals will determine firstly the horizontal location and then the depth. If the field pattern illustrated in Fig. 2 were to be viewed from above (as will be the case with a transmitter in a cave), the lines of flux will appear to be straight lines radiating from the centre of the coil. This means that the point immediately above the transmitter (referred to as ground zero) can readily be found by triangulation.

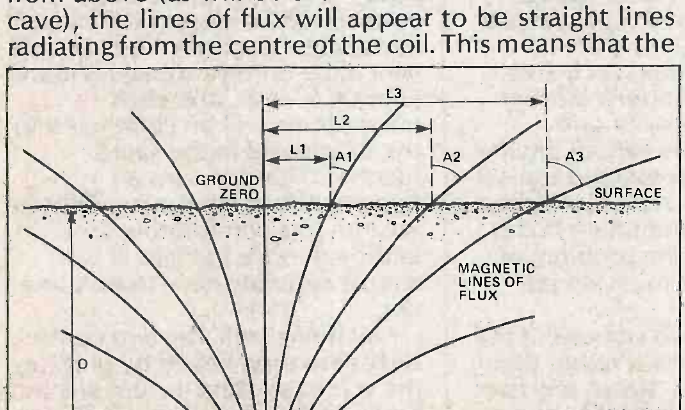


Fig. 3 Location and depth-finding.

Maximum signal strength is received when the lines of flux pass through the plane of the receiving coil, but in practice it will be found to be easier to detect nulls than peaks. By obtaining three nulls, a first approximation of ground zero can be obtained, a more accurate result then being found by repeating the procedure closer to this first point. Having found ground zero, the depth can then be determined.

Figure 3 shows how the force lines from the cave transmitter will break through the surface. In order to calculate depth it is necessary to determine the vertical angle of the field at various known distances from ground zero. It won't be of interest to most people to go into the mathematics; but suffice to say the depth is given by the formula:

$$D = L\,(3/4\ \mathrm{COTAN}(90-A)) + 1/4\ \mathrm{COSEC}(90-A)$$

where L is the distance to ground zero and A is the vertical angle. Clearly it is advantageous to have a programmable calculator in the field, a look or up graph can be used. More practical details on locating can be found in references 4 and 5.

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To Be Continued. **ETI**

MICROLIGHT INTERCOM

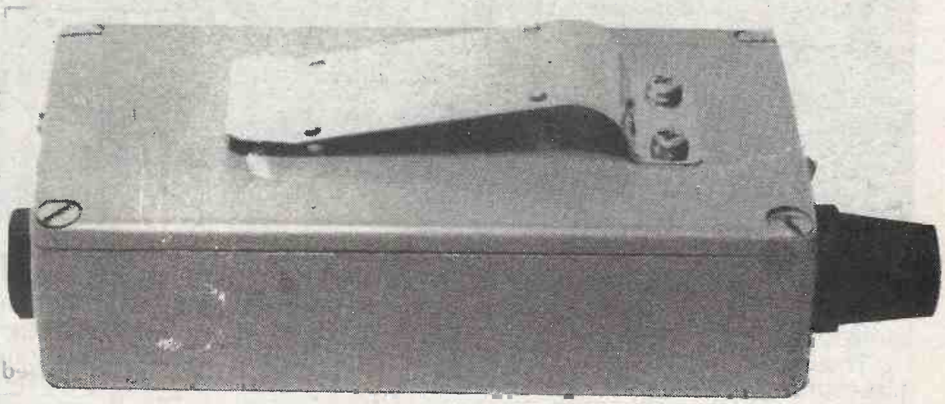
Ian Coughlan describes a high-performance intercom system which is designed for use in microlight aircraft but lends itself to any application which demands short-range, two-way communication in a noisy environment.

The pleasures of microlight flying can be greatly enhanced by taking along a passenger, but, thanks to the noise-level, talking to each other can be a pain in the neck in more ways than one.

This article describes a high-quality intercom system that was designed specifically for microlight aircraft but which has obvious applications in other areas, for example hang-gliding, motorcycling, and rallying. The system may be used either with headsets, or with modified crash-helmets.

The basic requirement of an intercom system is that it should provide a two-way communication link with sufficient audio quality and output to overcome background noise. Furthermore, it should be reliable and of rugged construction.

The system to be described boasts several advantages over commercially available intercoms, not least of which is the high output-power available. Each headset is served by its own 1.5 watt power amplifier, making very high sound pressure levels possible with the minimum of distortion. In addition, each microphone has its own automatic gain control device which reduces the dynamic range over which the headphone amplifiers have to operate, thereby reducing the possibility of the system being driven into overload. The overall performance of the system is excellent, and is certainly better than anything else that the author has tried. The prototype system has been up to 14,000 feet with nary a complaint from the pilot or his passenger!



Of Mikes And Men

The system comprises two identical control-boxes, each of which contains a microphone pre-amplifier with AGC and a headphone amplifier. Each also contains its own battery, battery-check LED, and headphone volume control. The various internal components are protected against vibration by foam rubber padding and the diecast aluminium boxes help to minimise the problem of electrical noise from an aircraft engine.

Because the two stations of the intercom are identical rather than being 'master' and 'slave', any two control boxes made to this design can be interconnected. This might be of value to microlight flying clubs and other groups, where each member could be equipped with one control box. It would then be possible for any two members to establish an intercom link quickly and easily.

In use, each user connects a headset or helmet to their own control-box by means of a latching DIN plug. This switches the control-box on, and provided the send–return link is not also connected the system will be in battery-check mode. The LED will light if the battery voltage is above about 6.5 Volts, and each microphone will be connected to the earphones in the same headset. This provides an opportunity to set the headphone volume to a comfortable level (although once in flight, it will almost certainly have to be turned up).

All being well, the two control-boxes are then linked by plugging the screened send–return link into the ¼-inch jack-sockets. Doing so disconnects the battery-check LED and the circuitry that drives it and also disconnects each microphone from the earphones in the same headset. These actions help to conserve battery power. Each microphone pre-amplifier's output is now sent only to the other user's headphone amplifier by means of the send–return link.

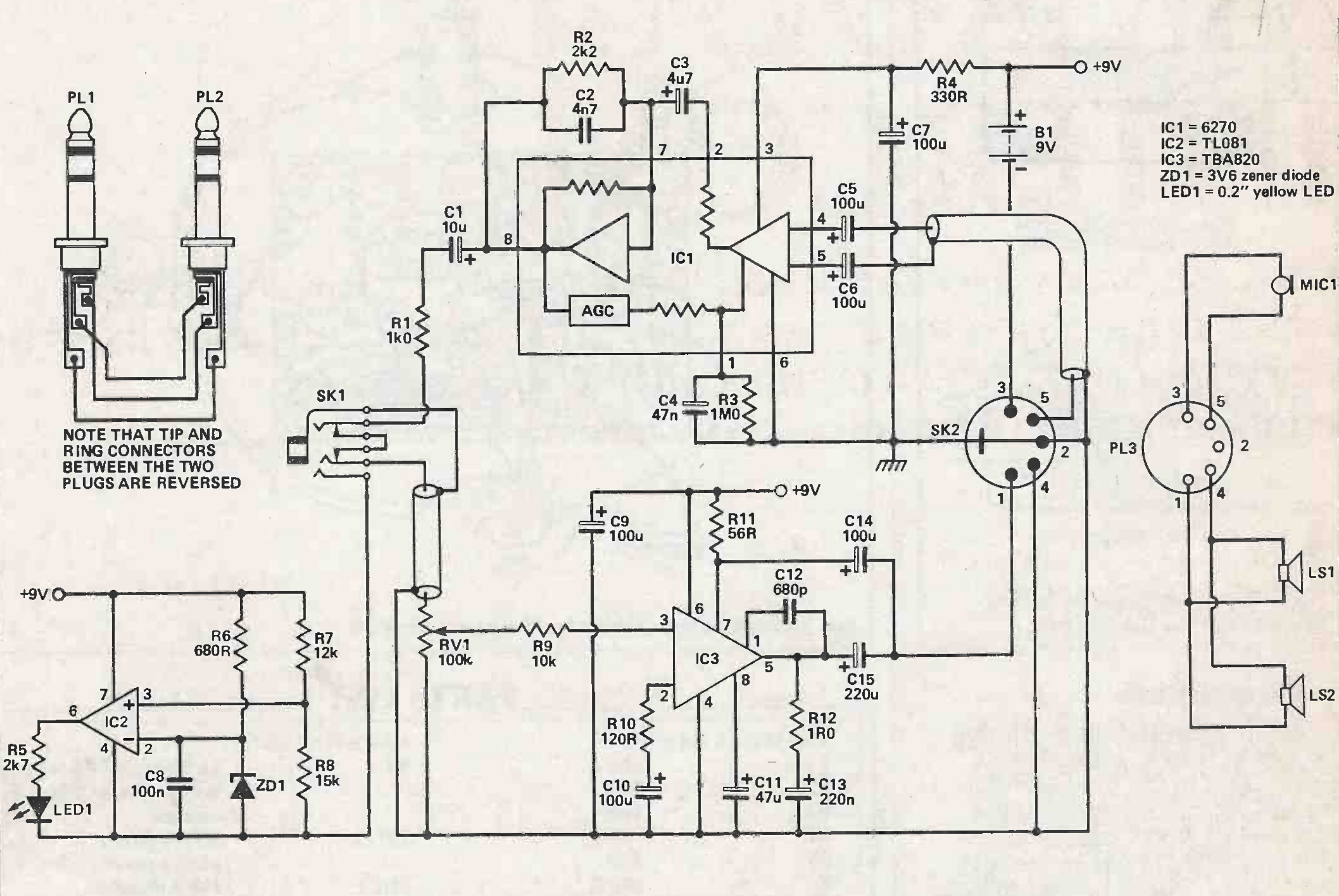


Fig. 1 Circuit diagram of one control box. Two identical control boxes are required for an intercom.

HOW IT WORKS

Each microphone is connected to an SL 6270 VOGAD integrated circuit. VOGAD stands for Voice Operated Gain Adjusting Device, and the device maintains an output of some 100mV RMS over a wide range of microphone levels, allowing either user to shout without overloading the system. The attack and decay times of the VOGAD are set by R3 and C4. With the values shown, the attack time (the time taken for the device to reduce its gain in response to a large input) is somewhat less than 20ms. The decay time, that is, the time taken for the device to return its gain to its former level when the large input is removed, is about 3 seconds.

R4 and C7 serve to decouple the sensitive microphone preamplifier from the supply line, which may be subject to surges caused by the headphone amplifier. It will be noticed that the microphone pre-amplifier and the headphone amplifier have separate 0V returns to the DIN socket; this is because the headphone amplifier is capable of high output currents which would otherwise cause a voltage drop in the microphone pre-amplifier's 0V return, resulting in instability.

The output from the microphone pre-amplifier goes to the 'ring' contact of the send-return jack-socket. When nothing is plugged into this socket, the microphone output is routed to the volume control and hence to the associated headset; when the send-return link is plugged-in, the microphone output is routed to the volume control in the *other* control-box.

The wiper of the volume control goes to the input of the headphone amplifier, a TBA820. This device is capable of producing an output in excess of 1.5 Watts into 4 ohms with a good 9 volt battery, falling to some 750mw at 6 volts. The miniature loudspeakers used in the prototype have an impedance of 8 ohms, and are connected in parallel, giving 4 ohms. The recommended microphone impedance is 300 ohms.

A FET-input op-amp and a 3.6 volt zener diode form the basis of the battery-check circuit. The op-amp is connected as a comparator with its output driving the LED. The inverting-input of the op-amp is connected to the 3.6 volt reference and the non-inverting-input is connected to a potential-divider between +9V and 0V. When the non-inverting-input exceeds 3.6V, as it will for all battery voltages above 6.5 Volts, the output of the op-amp will be high and the LED will light. As the battery voltage drops below 6.5 volts, the voltage on the non-inverting-input will drop below 3.6V and the op-amp output will go low, causing the LED to go out. This section of the circuitry is connected to 0V via one of the contacts on the send-return jack-socket, so it is disconnected when the jack-plug is inserted to reduce the drain on the battery.

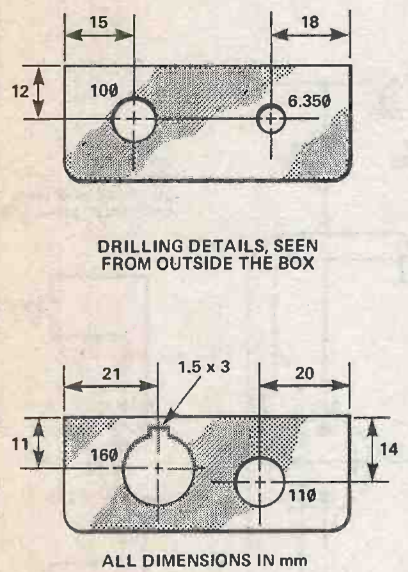


Fig. 2 The holes required in the two ends of the diecast box.

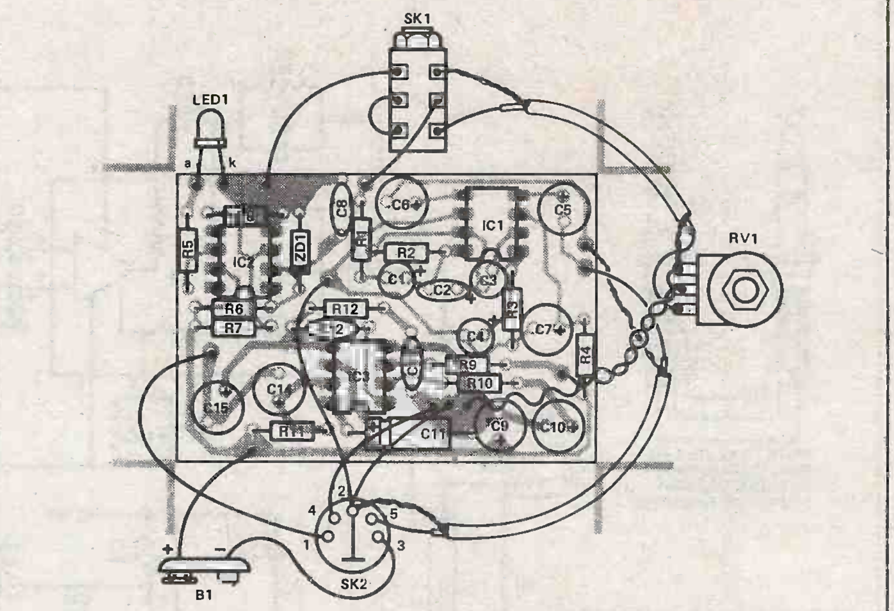


Fig. 3 Component overlay for the intercom PCB.

Construction

Begin construction by drilling the box as shown in Fig. 2, and don't forget to file the notch for the anti-rotation spiggot on the DIN socket. Rub the box down with wet-and-dry paper, clean it, and apply a coat of primer. When this is dry, paint the box in your chosen colour, preferably by spraying (orange was used on the prototypes because it makes them easy to spot on a grass airstrip). Lettering can be applied when the paint is dry, and should be protected by a coat of Let-Fix or Letracote.

Before mounting anything on the PCB, check it for shorts. The Veropins should be gently tapped into position with a (small!) hammer from the underside of the PCB.

Mount the resistors onto the PCB, followed by the capacitors, and the DIL sockets. Crop leads tightly to the board before soldering to reduce the risk of short circuits to the die cast box. Attach 150mm lengths of insulated stranded wire to the Veropins and slide short pieces of 1mm diameter silicone rubber sleeving over them, right down to the PCB. Note that one of the wires comes from the battery connector. Connect the miniature screened cable in the same way.

Cut a piece of thin foam-rubber (56 x 58mm) and glue it to the inside of the box where the PCB

PARTS LIST

RESISTORS (all ±W 5%)

R1	1k0
R2	2k2
R3	1M0
R4	330R
R5	2k7
R6	680R
R7	12k
R8	15k
R9	10k
R10	120R
R11	56R
R12	1R0
RV1	100k miniature logarithmic potentiometer

CAPACITORS

C1	10u 16V radial electrolytic
C2	4n7 polystyrene
C3	4u7 10V radial electrolytic
C4, 11	47u 10V radial electrolytic
C5, 6, 7, 9, 10, 14	100u 16V radial electrolytic
C8	100n miniature layer
C12	680p polystyrene
C13	220n miniature layer
C15	220u 16V radial electrolytic

SEMICONDUCTORS

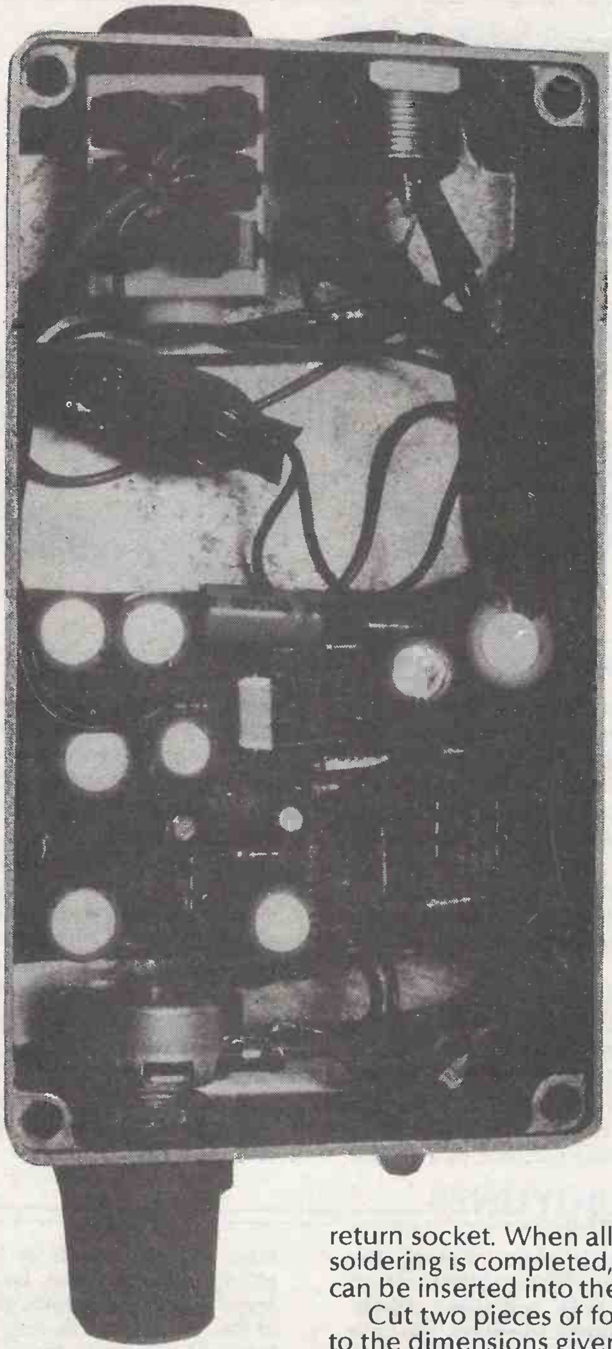
IC1	6270
IC2	TLO81
IC3	TBA820
ZD1	3V6 400mW zener (BZY88C3V6 or equivalent)
LED1	yellow 0.2" LED

MISCELLANEOUS

B1	9V battery, PP3 or similar, preferably alkaline
LS1, 2	8R miniature loudspeakers
MIC1	300R dynamic microphone capsules (see Buylines)
PL1, 2	stereo ¼" jack plugs*
PL3	5-pin 180° latching DIN plug
SK1	stereo ¼" jack socket with three break contacts
SK2	5-pin 180° latching DIN socket

PCB; 8-pin DIL sockets, 3 off; panel-mounting bezel for LED1; diecast box, 113 x 163 x 28mm; PP3-type battery connector; knob; foam rubber; thin screened cable for internal wiring; sleeving; length of twin-core screened microphone cable for link between control boxes*; telephone-type four-core coiled leads for headsets; pocket clip for boxes; connecting wire, nuts, bolts, etc.

*With the exception of PL1, PL2 and the length of cable which joins them, all of the parts listed are for one control box only and two of each will be required for a full system.



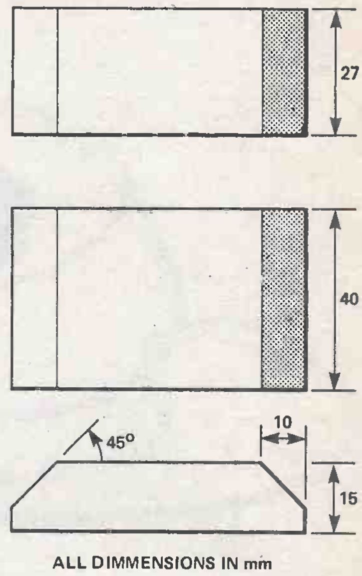


Fig. 4 Details of the foam rubber padding pieces. One of each size is required for each control box.

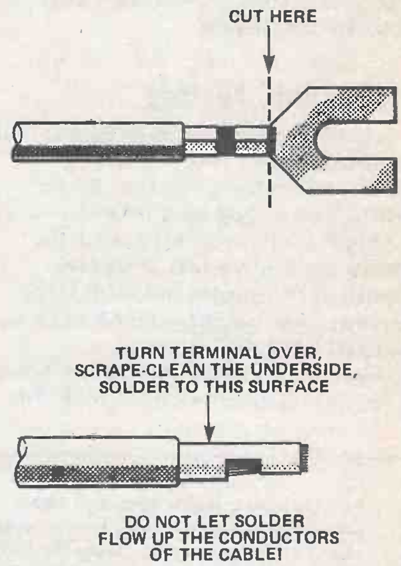


Fig. 5 Modifying the connectors on the telephone-style coiled headset leads.

will sit. Mount the DIN socket, the jack-socket, the volume control pot and the LED clip. Place the PCB in the box on top of the foam-rubber, and connect the flying leads to the case-mounted components as shown in Fig. 3. Use silicone-rubber sleeving wherever possible. Note that the two wires connecting the potentiometer to the PCB should be twisted together and be careful to get the polarity of the LED correct.

The electronics are connected to the case at only one point, and that is at the DIN connector. Also, don't forget the link on the send–return socket. When all the soldering is completed, the ICs can be inserted into their sockets.

Cut two pieces of foam-rubber to the dimensions given in Fig. 4. The narrower of the two mounts under the battery and the other goes over the PCB. These should be glued into place, but not until the unit has been tested.

The DIN plug wiring for the headsets is shown in Fig. 1. Telephone-type curly leads were used on the prototype system, but it is impossible to solder to the very flexible wire in these leads without losing the flexibility. It is recommended that the crimped-connectors on these leads are retained, and cut as shown in Fig. 5. After cleaning with a Stanley knife or similar, these connectors can readily be soldered and none of the lead's flexibility lost.

If the microphones and earphones are to be installed in helmets, bear in mind that helmets are constructed to a very high standard, and, for motorcyclists at least, *must* comply with safety standards laid down by the British Standards Institute. Modifying a helmet in just about any way will probably mean it no longer complies with safety standards. To the best of the author's knowledge, such standards are not applicable to helmets worn while flying microlight aircraft. It is left to

the individual constructor to decide whether such modificiations are morally and legally defensible.

Testing, Testing

Have a quick look over the PCB to make sure there's nothing obviously wrong, such as an IC fitted the wrong way round. Connect a PP3 battery, and, if nothing catches fire, plug the headset or helmet into the DIN socket. The battery-check LED should light. If it doesn't, disconnect the battery and check everything again. Also, check the DIN plug for the wire link. If satisfied that all is as it should be, reconnect the battery. If the LED still does not light, check the voltages around that part of the circuit. If the LED does light, turn the volume up and try speaking to yourself! You should be able to hear your own voice clearly. Check the other control-box in the same way.

When both control-boxes are working individually, they should be tested together. You'll need a partner for this. The send–return link is simply two stereo jack-plugs connected by one metre of twin-core screened cable. Choose the most flexible cable you can get hold of, such as microphone cable. Note that the wires in this lead are reversed so that the 'tip' contact of one jack-plug goes to the 'ring' contact of the other.

With each user wearing a headset or helmet, plug in the send–return link. Both LEDs should go out. Neither user should be able to hear his own voice, but should, of course, be able to hear the other person's voice. If all is well, testing is complete and the pieces of foam mentioned above can be glued into place and the lids put on the boxes. The system is now ready for use.

BUYLINES

The resistors, capacitors and most of the semiconductors are widely available, the only exception being the 6270 which can be obtained from Cirkit or Watford (designated SL6270, SL6270CD, etc). Miniature loudspakers are available from the author, whose address is given below. The low-impedance dynamic microphone capsules used in the prototype were taken from a pair of stick microphones of the type supplied with cheaper music centres and portable cassette machines. These are often sold as 'accessory packs' for a few pounds in radio and electrical shops. It may even be possible to obtain helmets with suitable transducers already in place — have a look through some of the motoring magazines which cover car rallying. If you require a headset rather than separate transducers to mount in a helmet, try the secondhand and surplus stores. Failing that, a glance through the adverts in one of the magazines aimed at amateur radio enthusiasts should yield some useful addresses, but note that many amateur radio headsets use electret microphones (which require a separate power supply) and that they may not block out ambient noise. If all else fails, a DIY microphone boom-arm could be added to a pair of cheap, 'Walkman'-style headphones.

The only components likely to cause any problems are the pocket clips and the coiled leads. The clips used on the prototype came out of the junk-box and we do not know of anyone who supplies new ones. However, early pocket bleepers appear frequently on the second-hand and suplus market and usually have a metal pocket clip attached by two rivets. These can be drilled out and the clip then attached to the intercom control box using nuts and bolts of a suitable size. The coiled leads are not available as a new part either, but again can be found in second-hand and surplus shops. One of the companies who may be able to help with the above items is Henry's Audio Electronics, 301 Edgware Road, London W2, tel 01-724 3564.

One point to note is that Alkaline batteries (Duracell, Ever Ready Gold Seal etc) are recommended for use in the intercom. The battery drain can be quite considerable, especially if high volumes are being used to overcome wind noise in microlight flying, and ordinary zinc-carbon batteries may not last very long.

The PCB will be available from our PCB Service, but see the note in News Digest. The miniature loudspeakers cost £2.50 inclusive per pair and can be obtained from 17d Stuart House, Burns Road, Cumbernauld, Glasgow G67 2AP.

ETI

BAUD RATE CONVERTER

Norwegian correspondent Ola Borrebaek provides a project designed to make the most out of data communications. If you're pining for the bauds, start here ...

There are two basic ways in which personal computers and peripherals communicate with each other. The first, parallel communication, is the simpler of the two because data is transmitted as it is stored — in byte-wide chunks. Speed of transfer is controlled by the peripheral device, which acknowledges reception of each data word by pulsing a control line running parallel to the data. The main drawback is that multiway or ribbon cable is very expensive if you need enough of it to transfer data over a long distance. If you intend to use a telephone line for parallel data, you would need some very complex circuitry.

For computer-to-terminal applications, synchronous serial transmission is often used. The data is sent serially (one bit after another) but parallel to a clock signal on another line. Asynchronous serial transmission does away with the clock signal altogether. In these cases, the peripheral device does not control the rate of data transfer. Instead, computer and peripheral must operate at the same speed and the start and finish of a block of data is usually signalled by particular bits bracketing the block. Although serial transmission is increasing in popularity — especially through growing use of modems (modulators-demodulators) — many computers on the market have only limited capabilities, especially when it comes to bi-directional serial communications with different transmission rates in each direction.

Problems

PC serial ports are often far from flexible. Some require re-soldering to allow for a change in baud rate (measured as the average number of bits transmitted per second), although most are software programmable. In some cases, programmable baud rates won't themselves be sufficient. For example, the Sinclair QL has two serial communication ports, configured in such a way that the computer can act as an originating device (DTE or Data Terminal Equipment) and an answering device (DCE or Data Circuit-terminating Equipment) at the same time. Both ports operate in full-duplex mode — that is, both can transmit and receive simultaneously — but all operations on both ports are restricted to the same, albeit programmable, baud rate. You will have problems using a split rate modem — 1200/75 or 75/1200, for example — or using a modem on one port and a printer on the other operating at different bit transmission rates.

Principles

The kind of serial data dealt with in this article is called asynchronous because the transfer of a character does not need to occur in synchrony with a clock signal or, indeed, simultanously with any particular event or events in time. The receiving part of an asynchronous serial connection will need to know when a character is being sent, so a start — low level — bit always precedes the data bits which comprise the transmitted character (Fig. 1).

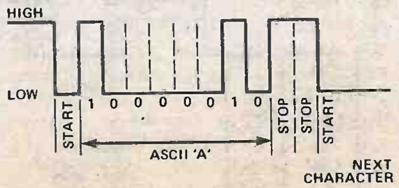


Fig. 1 The character 'A' as 8-bit asynchronous ASCII data (note the two stop bits).

There are typically between five and eight of these data bits, each one being a high or low state of equal duration to that of the start bit. The least significant bit is transmitted first.

One or two stop bits (high) signal the end of a character transfer. Note that with RS-232, the actual levels are inverted: a high being between −3V and −12V and a low being between 3V and 12V. The RS-232 protocol is quite old now — RS-423 describing a more recent but largely compatible system.

In European literature, the equivalent specification is referred to as V.24. V.24 is actually a list of definitions for interfacing DTE with DCE. Commonly, these will be a computer and a modem, respectively. V.28 gives electrical characteristics, while plugs are defined by an international standard (ISO 2110). All these aspects are covered by the American RS-232 standard (current revision level, C). RS-232 is the closest we have to an internationally agreed data transmission standard. Despite a wide variety of practical implementations and the fact that it and V.24/V.28 were originally restricted to telephonic data transmission, it is the commonest serial communications specification in use today.

The number of stop bits specified for a particular port is the minimum number required. With asynchronous transmission, it is possible to insert as many high-level bits as you like between data words, but this would decrease the baud rate, whose definition takes no account of any distinction between start, data and stop bits.

Error Detection

ASCII (The American Standard Code for Information Interchange)

HOW IT WORKS

One UART (IC1) is used for converting data from your PC to the peripheral device while the other (IC2) converts from the device to the PC (Fig. 4b). A high-level on either the PARITY ERROR or FRAMING ERROR outputs of IC2 will charge C1 and provide the ERROR LED with current via Q1 and Q2. The PARITY ERROR Output of IC1 is used to toggle a D flip-flop (IC3a). The state of this flip-flop determines the type of parity used by both UARTs (of course, only when parity is enabled — parity may be enabled at one UART only if desired).

The following applies for both UARTS:

When a character has been received and transferred to the RECEIVER HOLDING REGISTER the DATA RECEIVER Output (pin 19) will go high and force the TRANSMITTER HOLDING REGISTER LOAD input (pin 23) low. After a slight delay in IC4b and c, the DATA RECEIVER RESET input (pin 18) is forced low to reset pin 19 to a low state. Since the received-data outputs are directly connected to the transmit-data inputs, the character has now been transferred from the transmitter to the receiver section of the UART. The conversion of bit durations is accomplished by using different receive and transmit clocks. The above process will repeat itself for every received character.

The TRANSMITTER HOLDING REGISTER EMPTY output from IC1 is used as a CTS output (it is ANDed with the CTS output from the peripheral device to provide CTS for the PC). When the THR is empty, the character previously occupying this space has been transferred to the TRANSMITTER SHIFT REGISTER and while it is being shifted out a new character may be shifted in at the RECEIVER SHIFT REGISTER. But as long as a character is waiting to be transferred to the TSR, no character should be sent by the PC. In such case THRE is low and CTS is kept inactive.

The 4060 oscillator and binary counter (IC7, Fig. 4a) has several clock outputs which are derived from the quarts crystal, XTL1. They are given by 2.4576MHz divided by 2^n, where n is the number of IC7's Q output. The divider circuit consists of a programmable down-counter (IC8). It will count down from a value set by SW1. After each countdown a pulse is output on TC (ripple carry output, IC8 pin 7) and the countdown is repeated when this pulse triggers the parallel load enable input, IC8 pin 1, which in turn reloads the value set by SW1. Before being fed to one of the UARTs, the pulse is squared (to achieve a 50% duty cycle) by IC3b which divides by two.

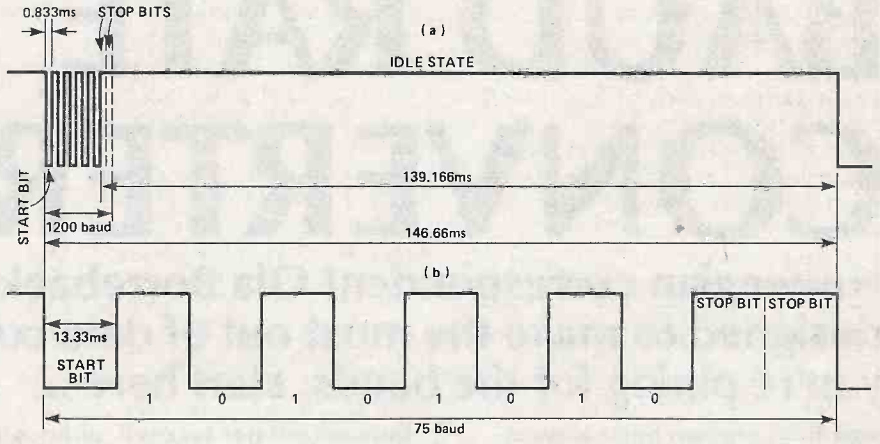


Fig. 2 How 1200 baud plus an idle state makes 75 baud.

uses seven bits of character information. Following these bits can be an eighth bit called the parity bit. This bit is set high or low by the transmitter so that there are always an even number of high levels (in even parity) or always an odd number of high levels (in odd parity), excluding the start and stop bits transmitted (Table 1).

If the received parity doesn't match the transmitted parity, at least one bit has altered during the transfer. This comparison provides a basic error checking mechanism, which is only guaranteed to detect single-bit errors.

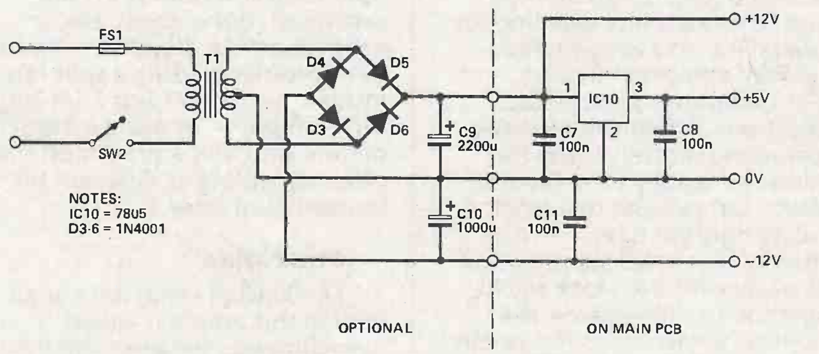
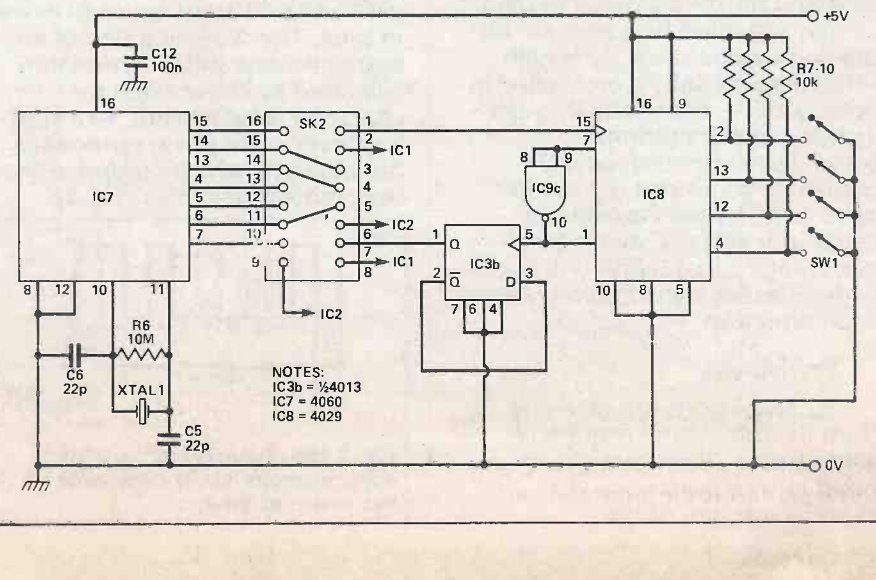


Fig. 3 Optional PSU — components to right of dotted line are on main board.



Serial Conversion

Figure 2 shows two ways in which a single byte could be transmitted at 75 baud. Clearly, the maximum allowable duration for one bit at 75 baud is 13.33 ms (the reciprocal of 75), but most modems will report a framing error if bit duration is even a few percent short of this. This is because stop bits are not received when expected. The serial converter avoids any problems arising from such irregularities by stretching pulses where required. It will, in fact, convert Fig. 2a into Fig. 2b.

Character	7-bit ASCII	As transmitted with even parity
A	100 0001	s100 00010ss
B	100 0010	s100 00100ss
C	100 0011	s100 00111ss

Table 1 How even parity works.

This facility is exploited in converting, say, a 1200 baud transmission to a 75 baud one. Stripped of its idle state, the data word of Fig. 2a would be transmitted at 1200 baud. Conversion to 75 baud (a down conversion) demands the insertion of idle states between the stop bits of one 1200 baud data word and the start bit of the next. This can be done simply by deactivating the CTS line to the computer after the computer has transmitted each character. CTS will remain deactivated until the whole character has been transmitted down the line at the lower rate. Up conversion — say, from Fig. 2b to Fig. 2a — is simpler since, in this case, the transmitter does not have to wait for the receiver to catch up with it. If the transmitter is operating slowly (at 75 baud, for example) you can't actually speed it up (to 1200 baud, for example). What you can do it make sure that each 75 baud character is retransmitted at 1200 baud. Each character is then sent out at a much higher speed than it was received from the computer, but there will be long pauses between characters while the original transmitter (the computer, that is) catches up.

UART For Art's Sake

The Universal Asynchronous Receiver and Transmitter is a chip normally used to provide a serial I/O port connected to a computer data bus. The device specified in this circuit is a TR1863 by Western Digital, but it is actually pin-compatible with the industry standard UART, the 6402 (see Buylines).

The receiver and transmitter circuits of the UART are independent and will convert data from serial to parallel and vice versa. Both the receiver and the transmitter contain two registers — one for shifting data in or out bit by bit and one for holding the data. Some of the UART pins are used to indicate when to load or

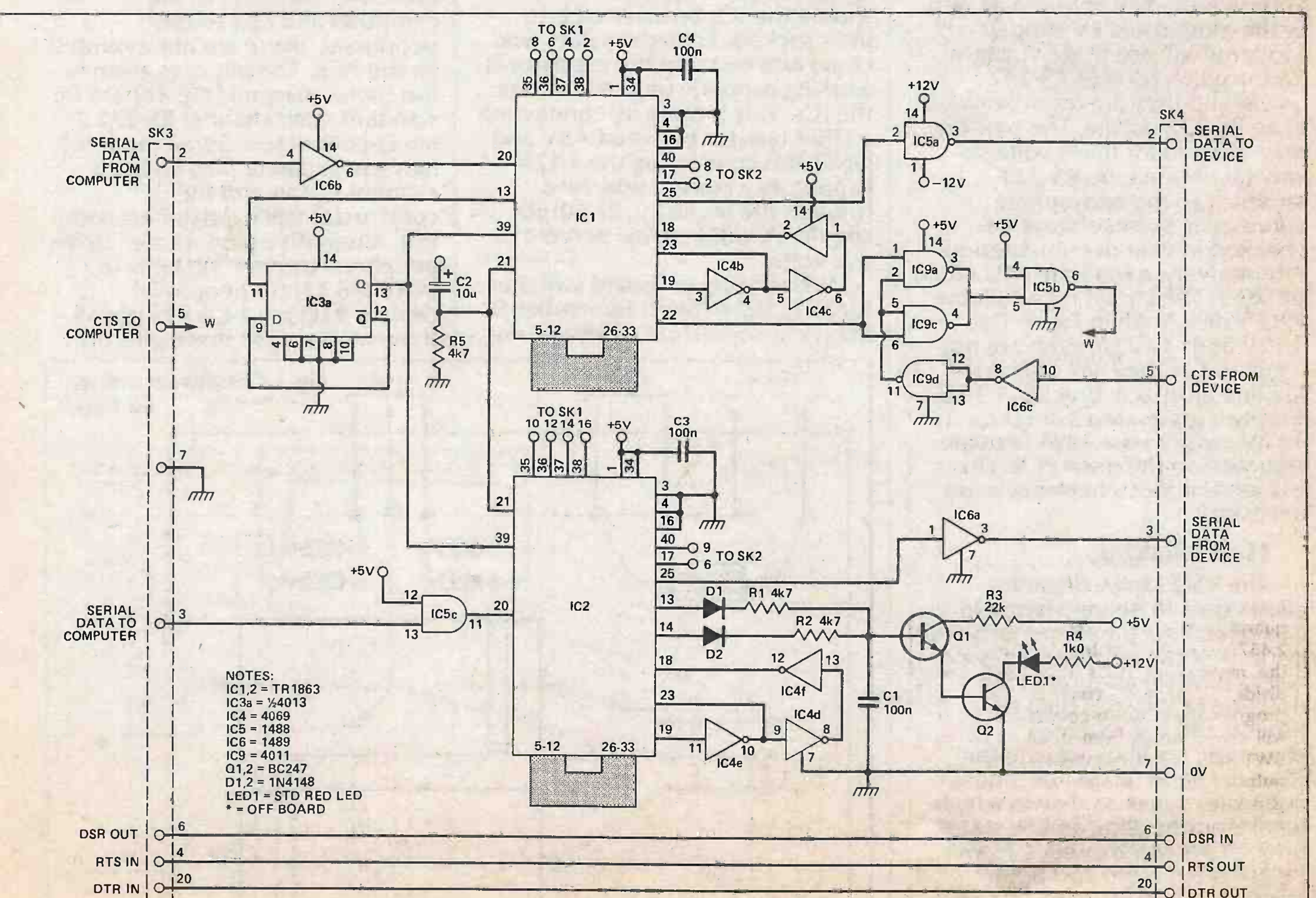


Fig. 4 The circuit of the baud rate converter in two parts: (a), left, shows the clock generator and rate-programming socket, (b), right, shows the input and output section.

read the parallel holding registers, but this circuit makes no use of the parallel data-handling features of the UART. The rates for shifting data in and out of the UART are controlled by receive and transmit clocks.

The converter actually contains two UARTS — one to convert data going from the computer to the peripheral and one to handle data flowing in the reverse direction. An LED indicates if this latter UART issues a framing or parity error. Both UARTs automatically adjust to the same parity as that received by the first UART. Parity may be enabled or disabled and the UARTs can be programmed for the number of data and stop bits. The in-circuit clock may be configured for a large number of baud rates and all programming is undertaken by setting links on two 16-pin IC sockets and positions on a 4-way DIL switch.

Supply Demanded

The converter requires +12V at 200mA and −12V at 50mA as well as the more usual 5V supply. Modems will use these voltages for the generation of RS-232 levels, and they are often available at an RS-232 socket. The pins that may be used for these voltages vary (as, indeed, do RS-232 sockets), so the appropriate connecting points should be checked in your documentation. Alternatively, a separate PSU could be used. The circuit for a suitable PSU is described in Fig. 3. The +12V and −12V supplies are not regulated — they will only drive the line interface directly. A +5V supply is generated from the +12V supply via a 7805 regulator mounted on the main PCB. This will get hot, but a heatsink is not necessary.

Handshaking

The RS-232 specification allows data to be transferred in two directions simultaneously (full duplex). If the peripheral device needs time (in addtion to the duration of the stop bits) to process the last received character, it will deactivate the Clear To Send (CTS) line. The computer will then deliver a high-level (commencing an idle state) until CTS is reactivated. CTS will be activated if the computer requests permission to send by activating the Request To Send (RTS) line.

The RTS output from the computer is often held active. If the computer has no RTS output but an RTS input exists at the peripheral device, this input would have to be held active. Note that CTS and RTS have no effect on the data going from the peripheral device to the computer.

Common implementations of RS-232 use a Data Terminal Ready (DTR) line to enable the peripheral device. It is often held active inside the computer. A Data Set Ready (DSR) line may also be provided to inform the computer that data has been received by the modem and is ready to be transferred to the computer's serial port. This line is sometimes equal to the Carrier Detect (CDC) output from a modem. 'Data Set', incidentally, is American for 'modem'.

Construction

Before mounting the IC sockets (not used for IC10) be sure to solder the links, some of which run beneath the sockets. Not until all other components are mounted should the ICs be inserted into their sockets. For extra safety, you could also test that the regulator is working properly before inserting the ICs. This is done by connecting a 100R resistor between +5V and GND and connecting the +12V supply. As a current now runs through the regulator, its output should be within a few percent of five volts.

When using off-board switches for SK1, SK2 or SW1, remember to keep the wires short. They will not require screening, but do not twist them together as this may result in cross-talk and noisy clock-signals. To avoid glitching, good quality switches should be used. If you want easy selection between several RTTY baud rates, off-board switches will have to be used for SW1 as well as SK2.

The link between pin 21 of ICs 2 and 1 should be made with insulated wire as it is rather long. When soldering in the crystal do not over-heat as this may destroy the quartz.

Normal precautions against static electricity should be taken when handling ICs. Inserting the ICs the wrong way round will probably destroy them, so note that IC7 is mounted the same way as SK2 — the opposite way to most of the ICs (Fig. 6).

The choice of cabinet is entirely up to the constructor but keep in mind that it may need to be large enough for both the main and the PSU PCBs (Figs. 5 and 6).

Two RS-232 connectors are used. SK3 connects to the computer and SK4 to the peripheral. These are not mounted on the PCB. The pin-outs given in the circuit diagram (Fig. 4b) are for standard main channel RS-232 25-pin D-connectors. Some modems may use separate pins for back channel signals and the constructor will have to deal with this. Alternative pinouts are : (from peripheral device) BRD pin 16, BCTS pin 13; (to peripheral device) BTD pin 14, BRTS pin 19. If the modem use these pins they

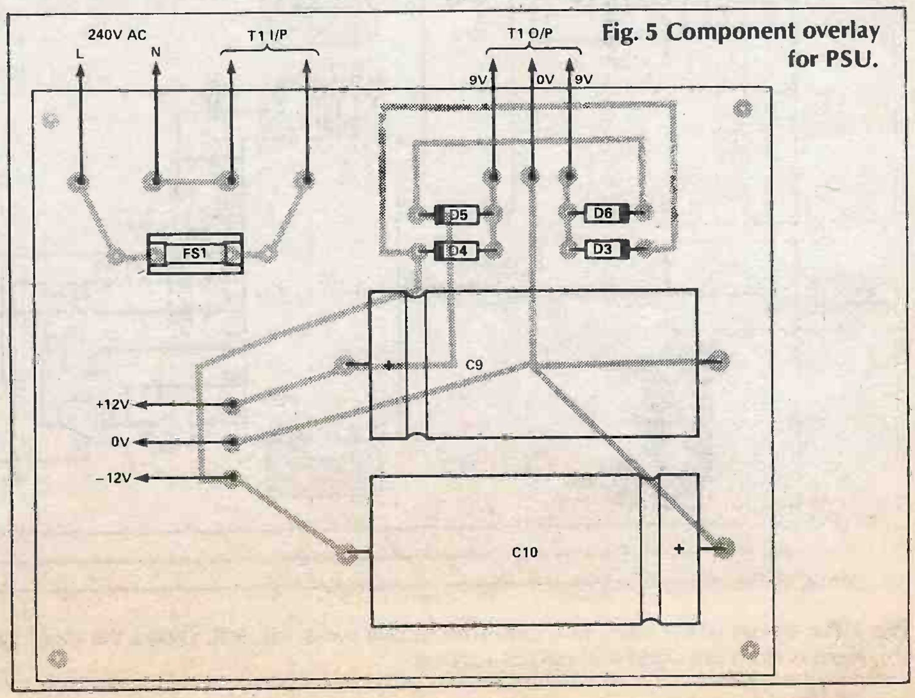
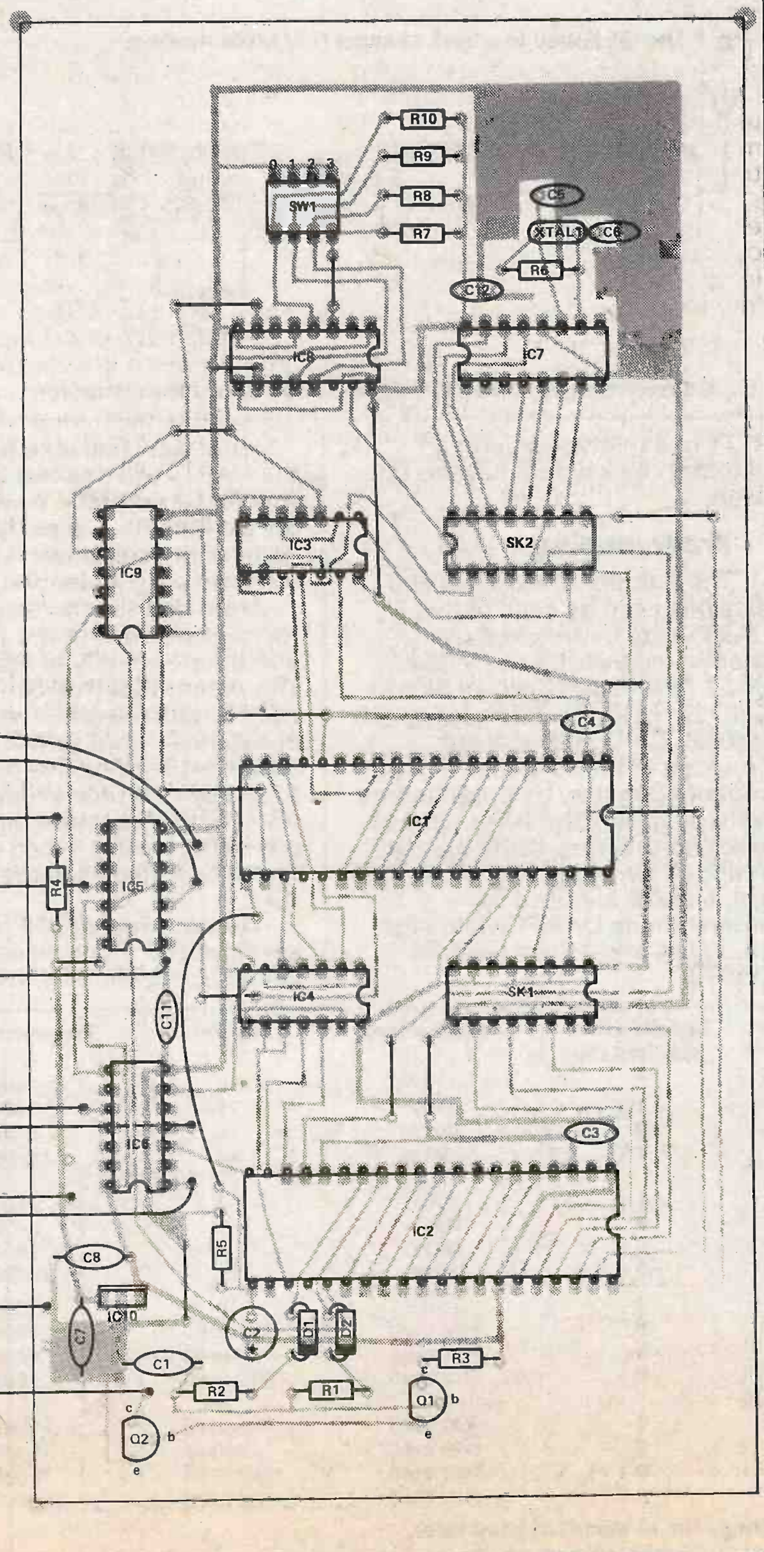


Fig. 5 Component overlay for PSU.

will have to be connected instead of pins 3, 5, 2 and 4 respectively. Pins 4, 6 and 20 of SK3 should be connected to the equipment pins on SK4. If a back channel configuration is used, connect pin 4 of SK3 to pin 19 of SK4 instead. Many devices use simpler, non-standard connectors with only four or five pins. Appropriate connections should be obvious from a comparison of Fig. 4a and the wiring diagrams of these connectors to be found in the device documentation.

Fig. 6 Component overlay for main board.



PARTS LIST

RESISTORS (all ¼W, 5%)

R1	4k7
R2	4k7
R3	22k
R4	1k0
R5	4k7
R6	10M
R7, 8, 9, 10	10k

CAPACITORS

C1	100n polyester
C2	10µ elect.
C3	100n ceramic
C4	100n ceramic
C5	22p ceramic
C6	22p ceramic
C7	100n ceramic
C8	100n ceramic
C9	2200 µ25V* elect.
C10	100 µ25V* elect.
C11	100n ceramic
C12	100n ceramic

SEMICONDUCTORS

IC1, IC2	TR1863
IC3	CD4013
IC4	CD4069
IC5	MC1488
IC6	MC1489A
IC7	CD4060
IC8	CD4029
IC9	CD4011
IC10	78MO5
Q1, 2	BC247
D1, 2	1N4148
D3, 4, 5, 6	1N4001*
LED1	Red LED

MISCELLANEOUS

SW1	4-way DIL-switch
SW2	Mains switch*
FS1	50mA fuse*
T1	9V-0-9V 200mA mains
SK1, 2	16-pin IC sockets with headers as required
SK3, 4	25-way female D-sockets
IC sockets	3 x 14 pin, 4 x 16 pin, 2 x 40 pin

XTAL1 2.4576 MHz parallel resonance crystal; PBC; case (*optional — PSU components).

BUYLINES

None of the components should provide particular problems. As mentioned in the text, Western Digital's TR1863 can be happily replaced by the CDP6402 (RCA), or General Instruments' AY3-1015. To be on the safe side, make sure you get a fast version, if different speed versions are available. The 78M05 is not absolutely necessary, an ordinary 7805 will do. Modems themselves are widely available, but particularly suitable models may be obtained (cheaply) from Cirkit, Maplin and Computer Warehouse — all of whom advertise regularly in ETI.

Use

The converter was originally intended for connection of a back channel modem to the Sinclair QL. The setup in Fig. 7 not only allows separate rates to be used, it also makes sure that all data received by the QL are of correct parity and thereby prevents the QL from issuing a 'Xmit Error'. The Xmit Error interrupts any BASIC programme and is a real nuisance when trying to receive continuous text.

Switches could be connected to the serial converter so that the modem could operate on either 1200/75 or 300/300 without having to disconnect the converter and reprogram the computer. Some PCs require re-soldering to change baud rates and here a switchable converter would add new prospects of multi-baud operation if the PC did support separate transmit and receive rates in the first place.

There are many other applications. Converting RTTY from an amateur receiver to a PC is an interesting possibility. Converting 50/300 is shown in Fig. 8. Here only UART2 is used and UART1 need not be mounted. For RTTY operation, every baud rate is available (Table 2). For modem operation, even a Bell (US) 5-band back channel is obtainable.

A useful application could be to interface your PC to an old 110 baud teletype printer. The serial converter could also be used as a clock generator for other circuitry — just don't mount the UARTS.

Since there is only one programmable divider on board, 50 and 110 baud cannot be used at the same time. For interfacing RTTY to a teletype printer an external clock would have to be used.

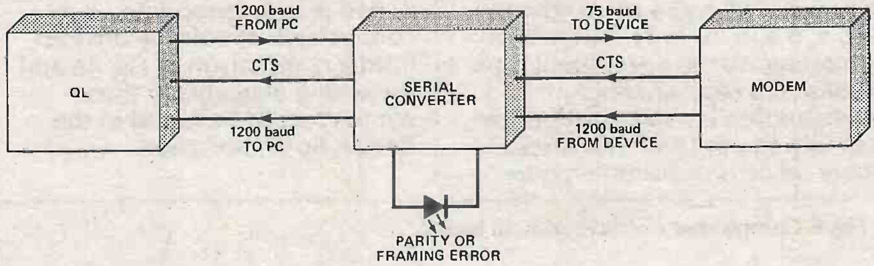


Fig. 7 The QL linked to a back channel (75/1200) modem.

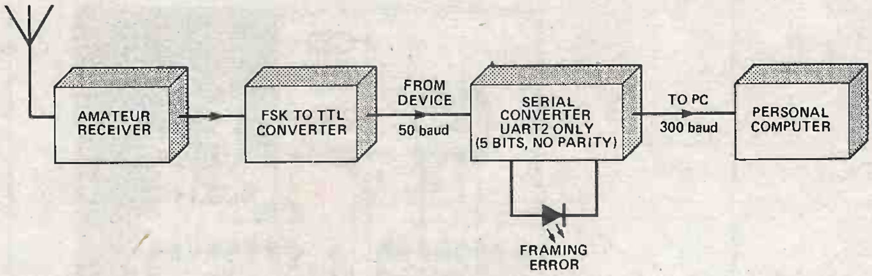


Fig. 8 Converting 50 baud RTTY signal to 300 baud for a computer.

Programming

The number of stop bits and data bits used by each of the UARTS may be selected by connecting the SBS and WLS1/WLS2 pins respectively of SK1 to GND or +5V (see Table 3, Figs. 4b and 9a). GND and +5V are provided at the socket so that any combination may be programmed without getting the wires crossed when hard-wiring. Parity may be inhibited by wiring PI to +5V. Pins 2, 4, 6 and 8 are used for programming UART1 while pins 10, 12, 14 and 16 are used for UART2.

How you choose to programme the UARTs will depend on the specifications of the computer and the peripheral — especially the latter as the computer is usually software programmable.

Note that the transmitter and receiver sections of the UARTS are not independently programmable. This means that true conversion of word length (altering the number of databits) is not possible. However, sending five bits of data to an eight bit receiving-port will result in the four most significant bits being set to 1 when up-converting, thanks to the idle state.

The alert reader will probably have noticed that true conversion could be achieved by using the

Standard baudrate	Used by converter	Deviation from standard (%)	Divider setting	Divisor	Frequency (Hz)
5.000	5.000	0	1111	30	2400
45.45	46.15	+1.5	1101	26	19200
50.00	50.00	0	0011	6	4800
56.92	54.55	−4.2	1011	22	19200
74.20	75.00	+1.1	0001	2	2400
75.00	75.00	0	0001	2	2400
100.0	100.0	0	0011	6	9600
110.0	109.1	−0.8	1011	22	38400
120.0	120.0	0	0101	10	19200
150.0	150.0	0	Not used	Not used	2400
300.0	300.0	0	Not used	Not used	4800
600.0	600.0	0	Not used	Not used	9600
1200	1200	0	Not used	Not used	19200
2400	2400	0	Not used	Not used	38400
4800	4800	0	Not used	Not used	76800
9600	9600	0	Not used	Not used	153600

Table 2 Source frequencies and divider settings for 16 standard baud rates.

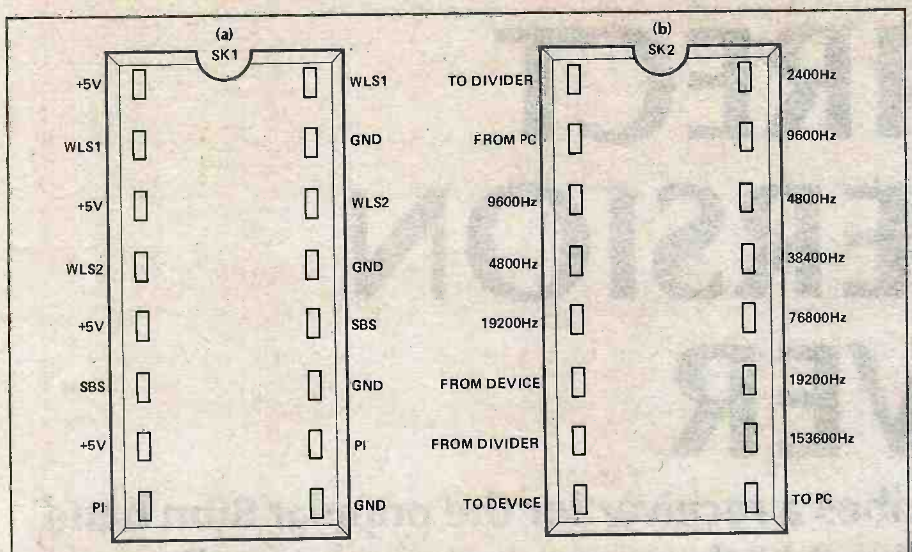


Fig. 9 Pin-outs for the programming sockets.

receiving section of one UART together with the transmitter of the other. This would introduce the need for a more expensive double-sided PCB and it would no longer be possible to use a different number of data bits in each direction. User-designed software is probably used when receiving RTTY (Baudot) code (with five bit data words) and including a mask instruction to clear the four ones should be easy.

SK2 and SW1 are used for programming the clock generator. Clock signals of 2^n multiples of 2400Hz are available at SK2 (Figs. 4a and 9b). These may be fed directly to the clock inputs of the UARTs, also available at SK2, or they may be fed through an on-board divider first.

Specifying number of stop bits:

SBS	No. of bits
0	1
1	2 (1.5 when using 5 databits)

Selecting number of databits:

WLS2	WLS1	No. of bits
0	0	5
0	1	6
1	0	7
1	1	8

+5V on PI inhibits parity generation and checking.

0 is GND
1 is +5V

Table 3 Programming the UARTS for number of stop bits (SBS) and word length (WLS).

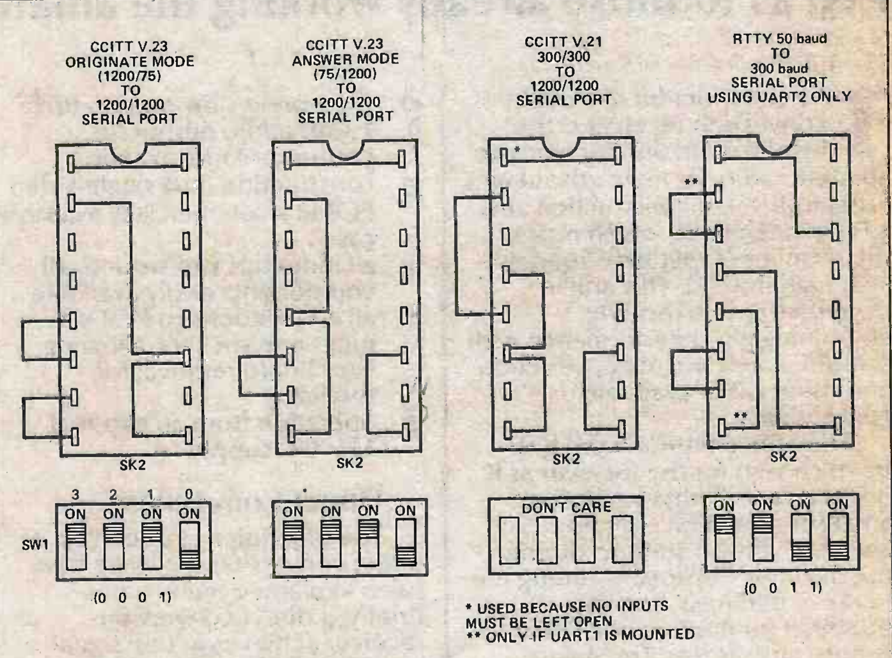


Fig. 10 Programming configurations — a sample.

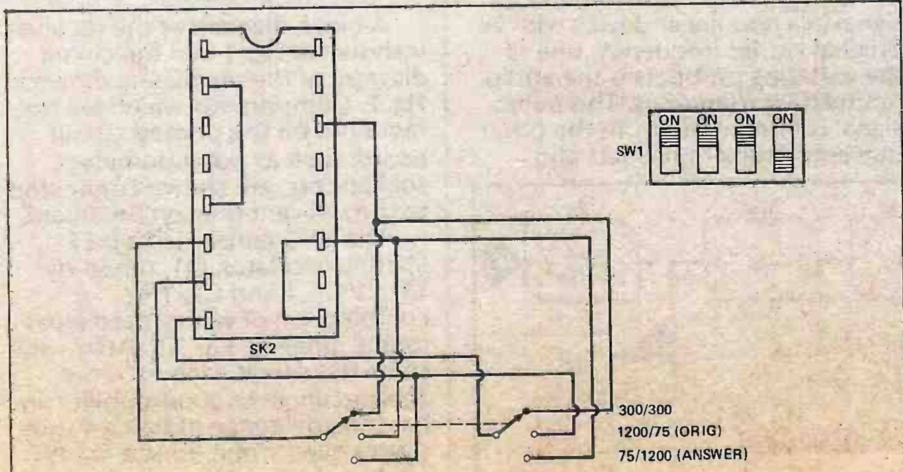


Fig. 11 Switch set-up to handle common baud rates.

The divider divides by two times the binary value set by SW1. Be careful not to connect any of the clock outputs together as this may destroy IC7. Note that the baud rate (maximum baud rate, to be precise) used by the UARTs is 1/16 of the clock frequency. The frequencies and the divider settings used for some standard baud rates are shown in Table 2. Some examples of hard-wiring the sockets are shown in Fig. 10. When connecting off-board switches, some ingenuity will be demanded from the constructor as to how to achieve the switch-action required. A set-up for use with a 1200/75+300/300 modem is also shown in Fig. 11. **ETI**

80m DIRECT CONVERSION RECEIVER

S. Niewiadomski describes a receiver for the popular 80m band which should be of interest to those new to amateur radio as well as to those already working the amateur bands.

The construction of a direct conversion receiver is the first introduction for many to amateur radio. Its main advantages are simplicity of construction and ease of alignment, which makes the chances of first time success very high indeed. This article describes such a receiver, combining good performance with printed circuit board construction and using easily available components.

The 80m amateur band has been chosen for the receiver as it offers a varied cross-section of amateur operation — "rag-chewing" British stations during the daytime, Europeans during the hours of darkness, and the potential for more exotic DX at sunrise and sunset. The main features of the receiver can be summarised as:

a) operation on the 80m amateur band
b) audio AGC System
c) high quality passive audio bandpass filter
d) high stability VFO design
e) two-speed slow motion drive
f) 1 watt audio output for phones or loudspeaker
g) construction on a single-sided PCB in a commercially available case
h) all inductors pre-wound, all components easily available
i) all connections to PCB via plugs and sockets, allowing easy board removal for servicing
g) operation from an external 12V DC supply.

Direct Conversion

The principles of operation of direct conversion receivers have been explained many times. Briefly, a direct conversion receiver achieves in one signal conversion operation what a superhet achieves in two or more. By mixing a single side band (SSB) signal in a non-linear device with its original carrier frequency, one of the resulting products is the audio modulating frequency. This audio signal is filtered out from the other unwanted mixer products and amplified, forming the audio output of the receiver. Since most amplification and filtering take place at audio frequencies, the performance of a direct conversion receiver depends on high audio amplification and a selective audio filter.

To recover the modulating frequency exactly, the oscillator used for detection must be at precisely the original carrier frequency. If not, the received audio will be shifted in frequency, and may be completely unintelligible. Shifts of a few tens of Hz for SSB are unimportant and when receiving a CW signal, the audio frequency can be set to whatever the listener finds easiest to read.

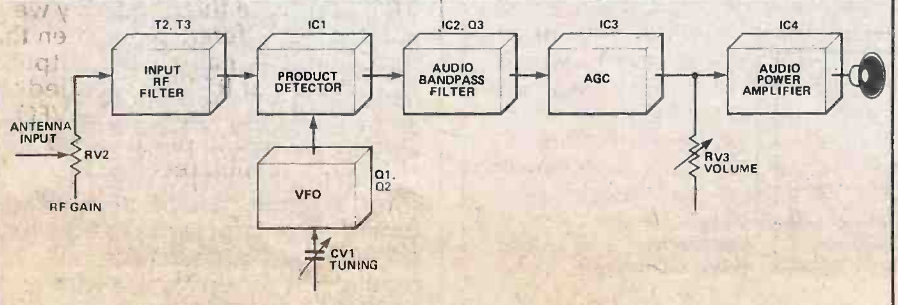


Fig. 1 Block diagram of the 80m receiver.

The RF Circuitry

A block diagram of the receiver is shown in Fig. 1 and the circuit diagram of the receiver is shown in Fig. 2. Components which are not mounted on the printed circuit board, such as potentiometers, sockets, etc, are shown connected to the relevant plug on the board.

The VFO consists of a JFET Hartley oscillator, Q1, tuned by T1, CV1, C1 and C2. The combination of values used gives a tuning range of 3.5–3.8 MHz, with some overlap at each extreme. This circuit gives good stability and has the advantage of being a sure-starter even when using a ready-made inductor. The use of a dual-speed slow motion drive gives both a slow tuning rate so that no

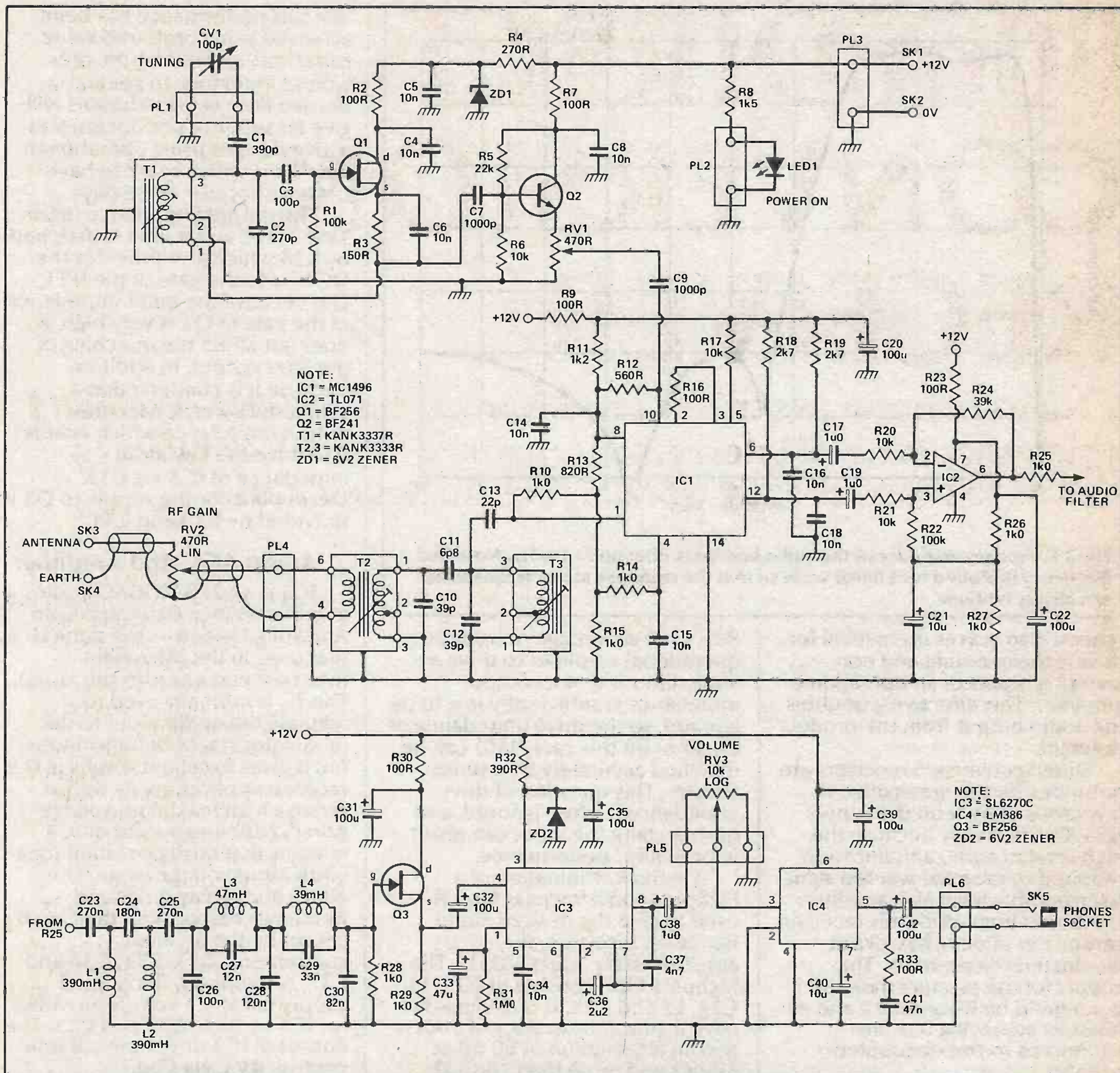


Fig. 2 Complete circuit diagram of the receiver. It is intended that an external 12V supply is used, so no power supply circuitry is shown here.

fine tuning control is needed and a faster rate for rapid frequency changes.

A stabilised 6.2 volt supply for the VFO JFET is derived from the 12 volt rail by R4 and ZD1, and decoupled by C5, R2 and C4. Q2 is configured as an emitter follower to give high input and low output impedance, and its output can be varied by adjusting the pre-set potentiometer RV1. A maximum output of 500mv peak-to-peak was available from RV1 on the prototype.

Although direct conversion receivers do not suffer from image reception problems in the same way as superhets, an input RF filter is required to reduce the amount of unwanted RF energy reaching the product detector if intermodulation problems are to be avoided. The filter is formed by T2, C10, C11, C12 and T3 which can be set to cover the entire 80m band without the need for any tuning during operation. The amount of signal from the antenna reaching the input filter can be varied by RV2 and this prevents the product detector from being overloaded on strong signals.

IC1 (an MC or LM 496) is a double-balanced mixer biased for operation from a single 12 volt supply rail. This IC produces the sums and differences of various multiples of the two input frequencies applied to pins 1 and 10. In this case the frequency we want is the difference between the fundamentals, namely the output from the input RF filter (applied to pin 1) and the output of the VFO buffer (applied to pin 10). In a direct conversion receiver the required output of the detector stage is at audio frequencies, so the outputs of IC1 (pins 6 and 12) are decoupled to RF by C16 and C18. Both outputs of IC1 are used in this application because the voltages are in anti-phase to each

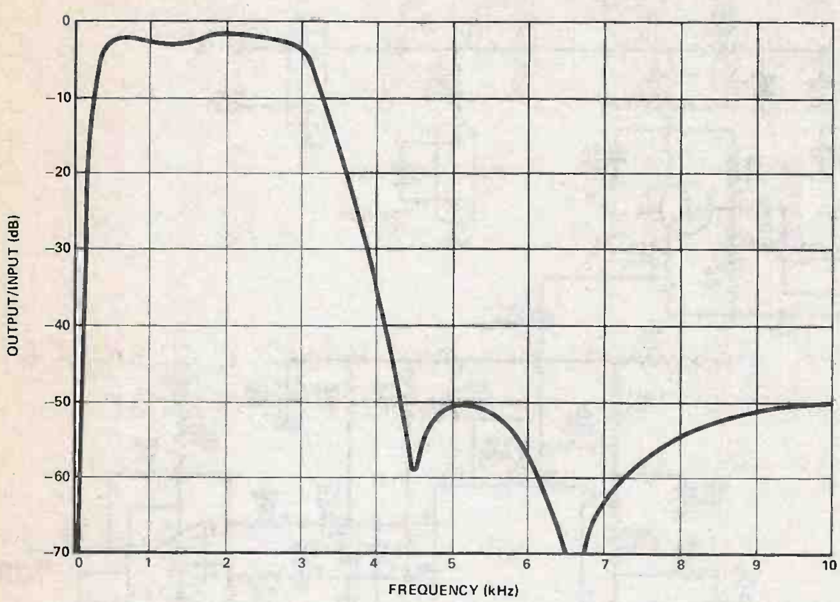


Fig. 3 Frequency response of the audio bandpass filter up to 10kHz. Note that frequency is plotted on a linear scale so that the response at low frequencies can clearly be seen.

other which makes them ideal for driving the inverting and non-inverting inputs of an operational amplifier. This effectively doubles the audio output from the product detector.

Direct conversion receivers are notorious for being sensitive to low levels of hum on the supply rails. This is mainly because the high level of audio amplification required to raise the wanted signal to an audible level also amplifies unwanted hum. With this receiver, careful decoupling has all but eliminated the problem. The supply for the product detector is decoupeld by R9 and C20 and all resistors supplying IC1 are connected to this decoupled supply.

Audio Filter

IC2 is an operational amplifier whose gain is set at 3.9 by its input and feedback resistors. Because IC2 is operated from a single supply rail, its inputs (and therefore its output) are baised to mid-rail by R22 from potential divider network R26 and R27. A low noise amplifier, a TLO71, was used for IC2, but it is debatable whether it is really merited. Other ICs with the same pinout (such as the 741) can be substituted without much degradation in performance. A decoupled supply for IC2 is provided by R23 and C22.

The output of IC2 drives the audio filter via the 1k0 resistor, R25. One advantage of using an operational amplifier to drive an audio filter is that its output impedance is sufficiently low to be ignored, so the drive impedance of the filter (in this case, 1k0) can be matched accurately by a series resistor. This question of drive impedance is often ignored, and mismatching the input can result in poor filter performance.

A series combination of a highpass and a lowpass filter is used to give the desired audio bandpass response of approximately 300Hz-3kHz. The highpass filter consists of C23, L1, C24, L2 and C25. It is designed to have a cut-off frequency of 300Hz and an attenuation of 60 dB at 100Hz and more than 70dB at 50Hz. An elliptic design was chosen for the lowpass section which consists of C26, L3, C27, C28, L4, C29 and C30. You can see that it is an elliptic filter by the tuned circuits (L3/C27 and L4/C29) which it contains. Elliptic filters give a very fast initial roll-off but the attenuation does not continue to rise in the stopband. It settles down to a more or less constant value, in this case approximately 50 dB.

Figure 3 shows the response of the complete filter. This is an excellent response for a direct conversion receiver whose main selectivity depends on the audio filter (and the ability of the human brain to concentrate on the desired signal, of course). Note that this performance has been achieved using preferred value capacitors and miniature, pre-wound inductors. In general, a passive filter using inductors will give far superior performance to active designs using operational amplifiers which seem to have become popular these days.

The output impedance (again 1k0) of the audio filter is matched by R28 which also provides the DC bias to the gate of the JFET, Q3. Because the input impedance of the gate of Q3 is very high, it does not affect the matching of the filter output. In addition, because it is connected as a source-follower, it has a low output impedance which enables it to drive the low input impedance of IC3 via C32. Decoupling for the supply to Q3 is provided by R30 and C31.

Audio AGC And Amplifier

IC3 is a 6270 VOGAD audio amplifier (Voice Operated Gain Adjusting Device — the same IC as that used in the Microlight Intercom elsewhere in this issue). This IC is normally used to regulate the audio input to the modulator stages of transmitters, but it gives excellent results in this receiver application. As well as giving a high maximum voltage gain (52dB), the output of IC3 remains essentially constant for a 60dB input voltage range. The attack and decay times and frequency response of the circuit are set by the external components C33, R31, C36 and C37. A stabilised, decoupled supply rail at 6.2 volts is provided for IC3 by R32, ZD2 and C25. The output of IC3 drives the volume control, RV3, via C38.

IC4 is an LM386 audio power amplifier which in this configuration has a gain of approximately 20. This IC produces less output noise than the popular LM380, and is housed in a more compact 8 pin DIL package. A standard output-stabilising Zobel network is fitted, consisting of R33 and C41. IC4 drives the phones socket SK5 via capacitor C42. The supply to IC4 is decoupeld by C39.

Details of the construction, testing and alignment of the receiver will appear next month, along with some notes on reception for those unfamiliar with SSB operation.

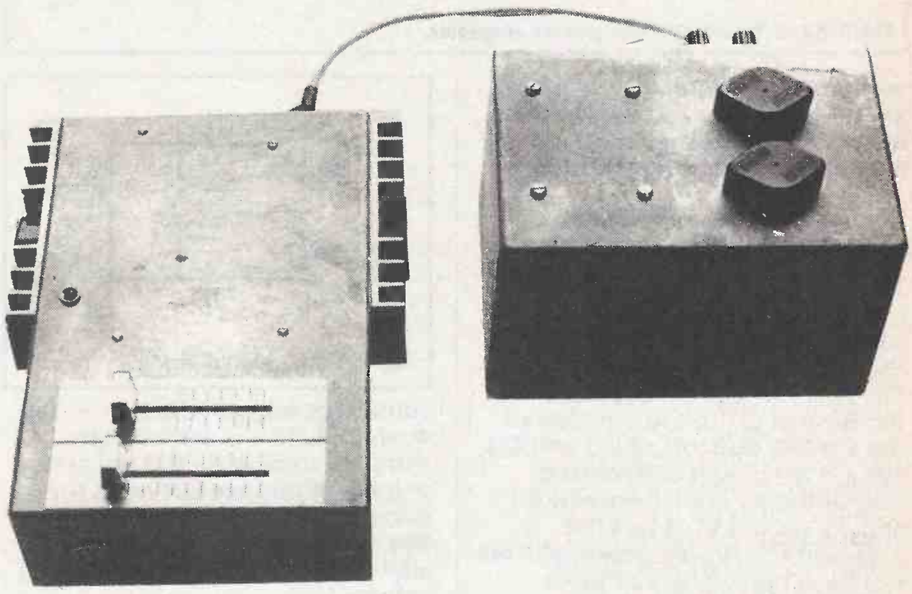
ETI

PORTABLE PA AMPLIFIER

John Linsley Hood describes a fifty watt amplifier which is designed for public address applications and can be powered from a car battery using last month's DC-DC converter.

As those who saw the article in last month's ETI will know, this design was evolved to meet the need for a cheap, fully-portable amplifier system which requires the minimum of ancillary equipment and can be operated out-of-doors and in other locations where a mains supply is not readily available.

To meet these requirements, it was decided that the amplifier should be able to oeprate from a 12V DC car battery supply. Rather than supply the amplifier directly at this low voltage, a DC-DC converter is employed which steps the 12V up to 55V. This simplifies the design of the amplifier stages considerably and reduces the need for compromises, allowing near 'hi-fi' levels of performance to be achieved at reasonable cost. This converter formed the subject of last month's article.



Amplifier Design Requirements

An output level of 50 watts was chosen as being a good compromise, providing reasonably high power without excessive battery drain. It was also decided that basic mixing facilities should be included so as to remove the need for an external mixer. The result is that a complete sound reinforcement system can be produced by adding a loudspeaker, a microphone and a car battery to the piece of equipment described here.

I decided that the target THD value at 50W into 4 ohms should be 0.1% — not a very low distortion level by today's hi-fi standards, but entirely adequate for this purpose. In fact, if many of the PA systems I hear could get down below 10% they would be much more pleasant to listen to. I also chose a fairly conventional bandwidth of 40Hz–20kHz. This allows the design of the amplifier to be both conventional and simple, which makes it easier to design and cheaper to build.

I used a single supply line system in the converter so that 12V of the 55V DC output could be provided directly by the battery, and also to simplify the DC output voltage regulation circuitry. This means that the amplifier cannot be directly coupled, although this has advantages since a capacitor coupling the output to the loudspeaker will help protect both the 'speaker and the amplifier from inadvertent misuse.

A design feature which I feel is an absolute essential in such a PA system is an amplifier overload indicator. This is necessary because the operator and/or the person behind the microphone are, invariably, behind the loudspeakers and therefore have no idea of the sort of sounds reaching the audience. One of the more unpleasant of these is the sound of the PA amplifier being driven hard into clipping. A bit of forethought at the design stage allows this condition to be indicated, so that the operator can make remedial adjustments to the

OOPS!

In the parts list which accompanied last month's DC-DC converter article, SK3 was listed as a two or three way connector. Please note that, for use with the amplifier described here, SK3 will need to have three or more ways since it must carry a +12V supply as well as +55V and ground.

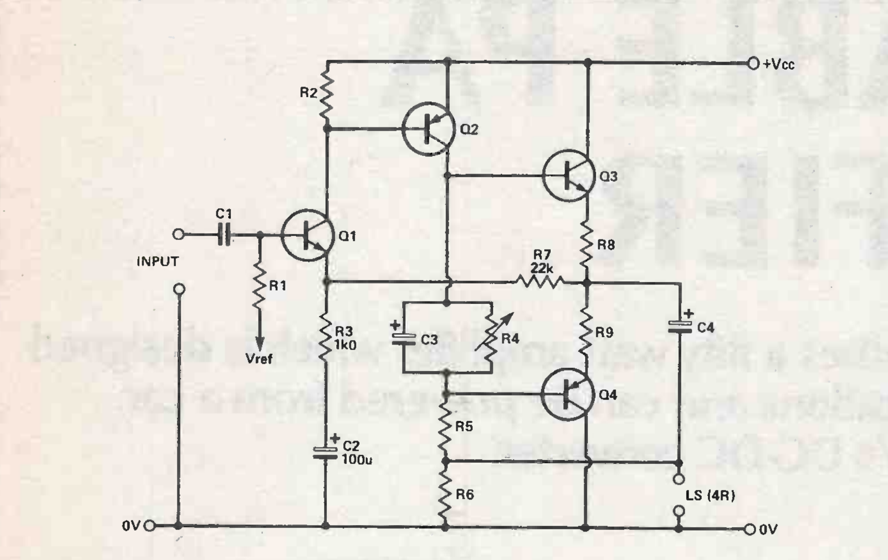


Fig. 1 Basic four-transistor power amplifier.

volume levels. After all, once an amplifier reaches its clipping level, no more volume can be obtained, only more noise and distortion.

The Power Amplifier Design

A simple audio power amplifier which is well suited to this sort of application is the four transistor design shown in Fig. 1. This is direct coupled from the base of Q1 to the junction of the emitter resistors of Q3 and Q4, and for maximum undistorted output the junction between R8 and R9 should sit at half the available DC supply potential. This can be achieved by a suitable choice of the reference DC potential to which Q1 base resistor is returned.

If the output transistors are power Darlington devices, quite high output power levels are possible. Also, because of the way it is laid out, the output capacitor, C4, can serve as a 'bootstrap' coupling capacitor to the bottom end of R5. This allows a high AC voltage swing to be obtained from Q2, which is the final class A voltage amplifier stage.

The overall AC gain of the amplifier is determined by the negative feedback resistors R7 and R3. With the values shown, the overall gain would be 23x. Since the output voltage swing for 50 watts into 4 ohms will be 14.14V RMS, the required input signal level for maximum output will be 615mV RMS.

To avoid excessive crossover-type distortion, the output transistors need to be biased

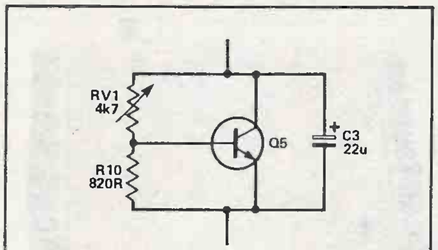


Fig. 2 An 'amplified diode'.

somewhat into conduction — say 40–60mA. This is achieved by using R4 to provide the necessary voltage difference between the two output transistor bases, and this could be made variable to allow for setting up to the desired value.

Circuit Improvements

One of the problems of this simple type of circuit is that the quiescent current through the output transistors is determined by the forward voltage drop of the base-emitter junctions of the output transistors, and the potential drop across R4. These are affected by operating temperature (the hotter the output devices become, the lower the Vb-e potential), and the supply voltage, which affects the current flow through the chain Q2, R4, R5 and R6//LS.

A considerable improvement to the output quiescent current stability is given if R4 is replaced by an 'amplified diode' layout of the kind shown in Fig. 2, particularly if Q5 is physically mounted on the heat sink of the output transistors.

The HF stability of the circuit is also improved if an output Zobel network, typically 100n in series with 8.2 ohms, is connected from the output to the 0V line, effectively in parallel with the loudspeaker. This ensures also that the amplifier will still be stable with the loudspeaker disconnected.

The main HF stabilisation component is an internal HF roll-off capacitor, which can either be connected between the collector of Q2 and Q2 base, or, preferably, from the point of avoiding slew-rate limiting effects, between Q2 collector and Q1 emitter. I have always preferred the latter method.

Overload Indication

If a 'DC bootstrap' circuit (consisting of Q6 and R11 in Fig. 3) is interposed between Q1 and Q2, several advantages follow. The major one is that the gain of both Q1 and Q2 is substantially increased. This happens because the input impedance of the emitter follower in Fig. 1 (Q6) is higher than that provided by Q2, and this greatly increases the stage gain of Q1. In addition, the fact that Q2 is now driven from a very low impedance also increases its stage gain.

I originally introduced this circuit dodge in my '75 watt' amplifier of 1972, and it contributed greatly to the low distortion given by that design. However, a small phase-correcting capacitor, C5, is necessary to prevent the HF stability of the amplifier from being impaired. A further advantage offered by this circuit addition is that the collector current of Q6 (in Fig. 3) increases substantially if the amplifier is

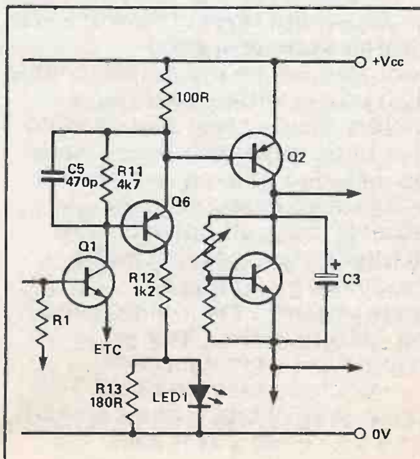


Fig. 3 Using a 'DC bootstrap' to increase the gain of Q1 and Q2.

driven into clipping, and this can be employed to give an indication, by way of LED1, that the amplifier is being over-driven.

The only other point requiring attention concerns the output stage. As it stands, the amplifier circuit of Fig. 1 suffers from a brief 'hang-up' when driven into clipping, which makes the audible effects even worse. This defect can be removed simply by putting a couple of resistors, R14 and R15, in the base leads of the output devices, as shown in Fig. 4. This leads to the final power amplifier circuit shown in Fig. 5.

Circuit Component Value Calculations

Most of these are either not very critical or very straightforward. For example, R1, R2 and R3 are chosen simply to give a base potential at Q1, which will

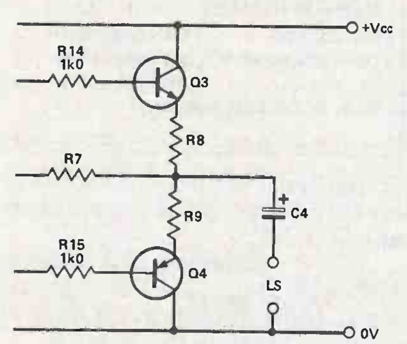


Fig. 4 Modification to remove the risk of 'hang-up' when driven into clipping.

give half the supply voltage at the top end of C7 after allowing for the voltage drops along R4 and R14. R12 is present to allow C7 to charge or discharge if the loudspeaker is not connected, and will prevent a bang sounding if this is connected up after the amplifier is switched on. It also allows the amplifier to work normally even without the LS load.

The value of R11 is chosen to give a DC current through Q3 which is a good bit greater than the likely 2mA peak base currents demanded by Q5 and Q6 at maximum output. The value chosen puts Q3 collector current at about 10mA, which is also high enough to ensure that the charging and discharging of the HF compensation capacitor C5 will not significantly affect the possible rate of change of voltage at Q3 collector, within the audio band.

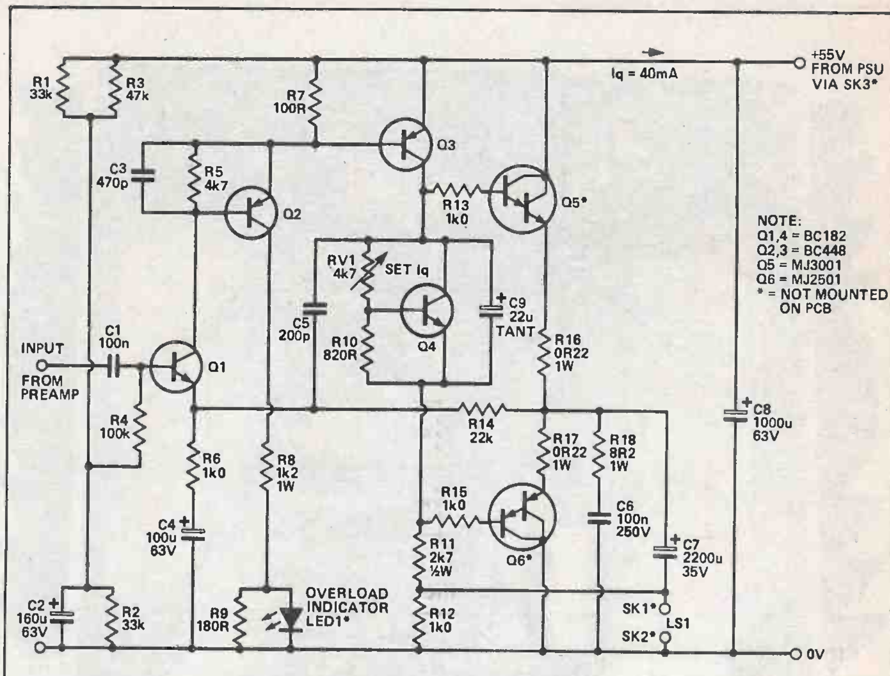


Fig. 5 Complete circuit diagram of the power amplifier.

This helps give a good sound quality. The transistor used for Q3 should be capable of supporting some 80V collector–emitter potential and have a permitted dissipation in excess of 550mW. Apart from this, the type used isn't particularly critical.

R8 and R9 are chosen so that the 5–6mA collector current which flows in Q2 under normal drive conditions will not light up to the LED. THis current level would provide about 1V drop across R9. If, however, the amplifier is driven into clipping, Q2 will provide a progressively increased drive current to Q3 and the voltage drop across R9 will increase rapidly and light the LED. R8 is included to limit the worst case current flow to a peak value of 40mA, and also to prevent excessive dissipation in Q2.

At maximum output the amplifier THD is about 0.1% at 1kHz. This is mainly second harmonic, and decreases rapidly at levels below peak power output.

BUYLINES

We understand that some or all of the parts for this project will be available from Hart Electronic Kits Ltd, but we didn't have the time to sort out the details before going to press. We suggest contacting them directly at Penylan Mill, Oswestry, Shropshire SY10 9AF or on 0691-652 894. The boards will also be available from our PCB Service, but see the note in News Digest.

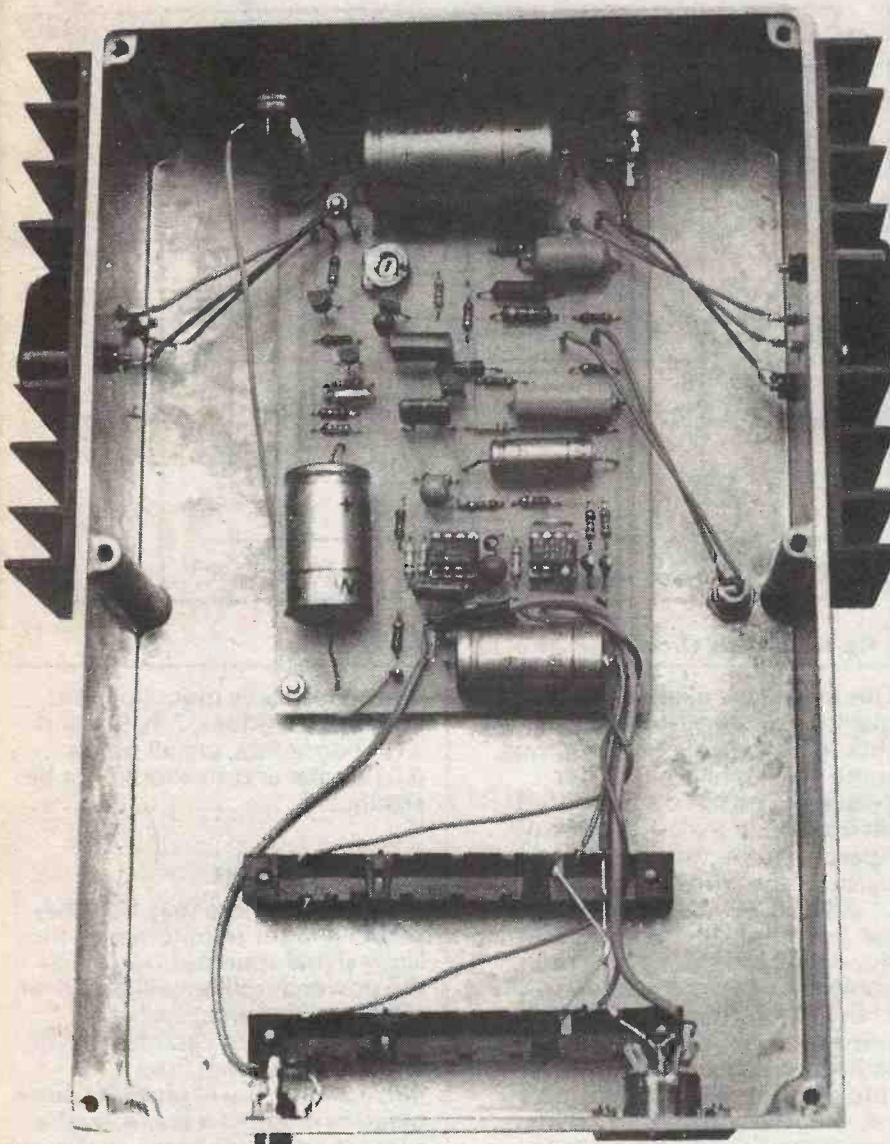
The acoustically objectionable crossover residues, 7th, 9th and 11th harmonics, are all below 0.01% total and so should not be significant.

The Preamp

Although there may be other possible input requirements, the likely signal sources from which the power amplifier will be driven are a music source, such as a battery operated cassette player, and a voice source from a microphone. It will often be more pleasing in effect if these can be present simultaneously, so that the background music can be faded down when the microphone is used, giving a 'voice over' effect.

This suggests that a simple mixer circuit with a couple of volume controls will be preferable to a simple selector switch. This is easy to arrange.

The power amplifier requires an input drive of some 620mV RMS for full output. A typical battery operated cassette recorder output into a high impedance load will be about 250–300mV. If the cassette recorder input circuit in the preamp is simply a unity gain impedance converter stage, included so that the volume control potentiometer doesn't directly load the cassette recorder output, a gain of 2.5x will be necessary between the input buffer and the power amplifier input. This can be given by a



PARTS LIST — PREAMPLIFIER

RESISTORS (all ¼W 5%)

R101-3	100k
R104	1k0
R105, 106	47k
R107	120k
R108	5k6
R109, 110	10k
R111	100R
RV101, 102	10k logarithmic slide potentiometer

CAPACITORS

C101, 102	100n
C103	47u 16V tantalum
C104-107	1u0 16V tantalum
C108	100u 16V tantalum
C109	470u 16V axial electrolytic

SEMICONDUCTORS

IC101	TL072
IC102	TL071

MISCELLANEOUS

SK101, 102 DIN, phono or ¼"	DIN, pho or ¼" jack socket as desired
PCB; IC sockets if desired	

virtual earth connected inverting op-amp stage, of the type shown as IC3 in Fig. 6.

IC2 is connected as a straight 100x gain stage for a microphone input. Most microphones have an output voltage in the range 2–10mV, and this will allow adequate gain without the likelihood of overloading IC2. The preamplifier is operated from a 12V DC supply obtained directly from the battery input, with some additional smoothing provided by R11 and C9 to remove any HF generator noise should the unit be operated from a car battery while the engine is running.

No voltage regulation is necesssary since the ICs can accept up to 30V DC supply, and it is not possible for a 12V car battery to get much higher than 15.5V even under the worst conditions of overcharge.

On 12V DC, the op-amps can deliver some 3.5–4V RMS, which allows an adequate overload margin to the power amplifier. In practice, if the gain controls are used sensibly, the only op–amp which could overload is IC2, for which the maximum input signal is 40mV RMS.

Although I have only shown two input connections, the circuit

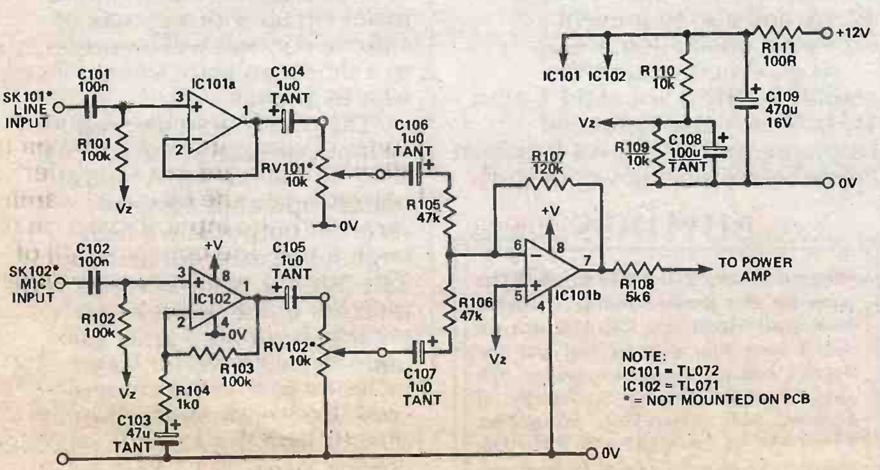


Fig. 6 Circuit diagram of the preamplifier. Note that component numbers beginning with 100 have been used to avoid confusion on the overlay.

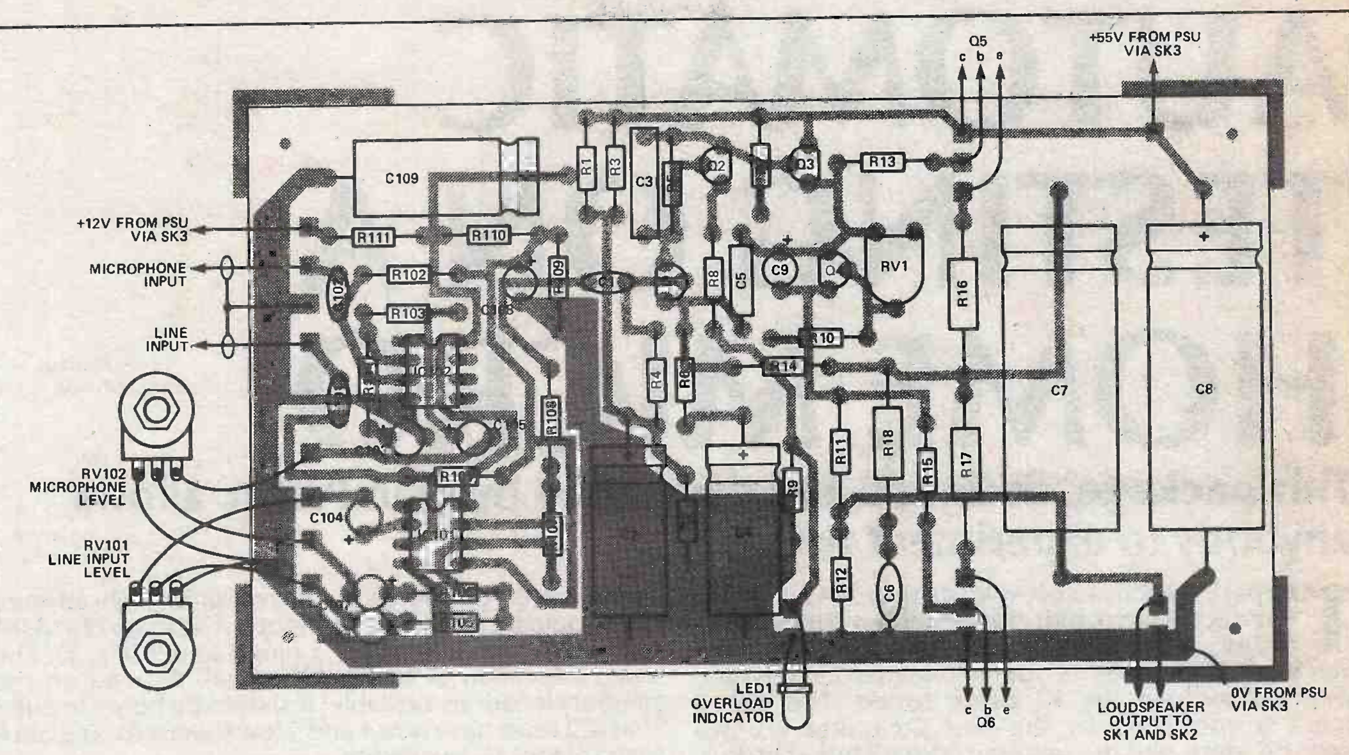


Fig. 7 Printed circuit board component overlay for the combined preamplifier and power amplifier.

PARTS LIST — POWER AMPLIFIER

RESISTORS (all ¼W 5% unless otherwise stated)

R1, 2	33k
R3	47k
R4	100k
R5	4k7
R6, 12, 13, 15	1k0
R7	100R
R8	1k2 1W
R9	180R
R10	820R
R11	2k7 ½W
R14	22k
R16, 17	OR22 1W
R18	8R2 1W
RV1	4k7 horizontal skeleton preset

CAPACITORS

C1, 6	100n
C2	150u 63V axial electrolytic
C3	470p
C4	100u 63V axial electrolytic
C5	200p
C7	2200u 35V axial electrolytic
C8	1000u 63V axial electrolytic
C9	22u 16V axial electrolytic

SEMICONDUCTORS

Q1, 4	BC182
Q2, 3	BC448
Q5	MJ3001
Q6	MJ2501
LED1	red LED

MISCELLANEOUS

SK1	red 4mm terminal
SK2	black 4mm terminal
SK3	3 pole chassis-mounting plug (Eg., Bulgin P429 and P646 or P430SE plug to suit)

PCB; heatskinks and insulating sets for Q5 and Q6; diecast metal box; panel-mounting bush for LED1; nuts, bolts, PCB-pillars, etc.

of IC1, RV1 and R7 can be replicated as many times as the user wishes to give additional inputs, the additional feed resistors (as R5 and R6) being taken to the inverting ('virtual earth') input of IC3.

Construction

The pre-amp/power amp combination is built in a 222 x 146mm diecast box. The two output transistors are separately mounted on either side of the box, as shown in the photograph. Individual heat sinks are used since calculations have shown that, at full power, a dissipation of 50 watts (total) will occur.

Two 10k slider pots are mounted through the top of the box at the opposite end to the power transistor connections and are wired to the PCB using screened cable, as are the input phono/DIN connectors.

Due care should be taken in the layout of the input and output wiring to avoid possible feedback problems, bearing in mind that 2mV at the microphone input will become 14V at the output transistors and loudspeaker terminals at full gain.

No on-off switch is provided on the PA since there is a power switch on the DC-DC converter unit. The only items present on the PA top panel are the two slider controls and the overload warning LED, with the input sockets on the side wall at the opposite end of the box to the LS output terminals and the power supply input socket.

The quiescent current in the output stage is adjusted by RV1, and this will be correct (although the actual value is not particularly critical) when the total HT current drain from the PA unit is about 40–50mA.

ETI

AUTOMATIC TESTING ON A HOME MICRO

This package, designed and developed by Alan Paton, allows anybody to experiment with ATE.

The package consists of two parts, the software and an interface which holds the integrated circuit being tested. The test interface consists of a circuit board which contains three or four integrated circuits and a socket to hold the IC being tested. The circuit board is controlled by the host computer via two eight-bit ports, plus the required address bus, data bus, and control lines.

Several circuits were considered when designing this interface, the main problem being that the two eight-bit ports had to be able to configure any of their bits for input or output in any combination. The data being sent to the IC under test had also to be latched while incoming data was read.

The final circuit, shown as a schematic diagram in Fig. 1, uses a Peripheral Interface adaptor (PIA) to do most of the work. The PIA provides all the facilities required and the chip count for the circuit is minimal.

Properly Addressed

Figure 2 shows the circuit for a Z80 system (in this case, a Spectrum), while a 6502 system configuration is shown in Fig. 3.

For Z80 systems thè allocation of ports is decided by the output pin used at IC2. Each pin will select a group of four ports as shown in Table 1.

The port values are assigned at line 60 in the program (Listing 1) and the values are the first and third in the group. For example, if the program uses ports 90–95 (HEX) set A=90H and B=92H.

For 6502 systems, the PIA will have to be memory-mapped which means decoding all 16 address lines instead of just the first eight. The remaining eight address lines could be taken to an 8-input NAND gate (74LS30) and the output taken to IC3 pins 4 and 5 (Fig. 3). The exact allocation of address lines will depend on the memory lcoations available. It should be borne in mind that IC2 must have pins 4 and 5 low (binary 0), and pin 6 high (binary 1), to operate.

Alternatively, the circuit of Fig. 3 could be used. Fourteen address lines (A2 to A15) are connected to the inputs of IC4 and IC5. The PIA (IC1) will be selected when all inputs to IC4 are at logic 1 and all inputs to IC5 are at logic 0.

Depending on the system or individual requirements the four consecutive addresses are decoded as follows.

From the combinations of the six 1s and eight 0s the lowest address block possible is 252 to 255 (or 00FCH to 00FFH) which is 0000 0000 111111XX in binary where A15 is the leftmost bit and A0 is the rightmost bit. The two Xs can be either 0 or 1 depending on which of the four locations are selected.

In this example address lines A15 to A8 would be connected to the inputs of IC5 and address lines A7 to A2 would be connected to the inputs of IC4. A0 and A1 are connected directly to the PIA at pins 35 and 36.

The highest address therefore is 64512 to 64515 which is 11111100000000XX in binary. Any location between these extremes may be used, which should cater for any computer system.

For example, a more useful location may be 25000; this converts to 01100001110010XX binary or 61A8H. Connect each address line to a 1 or 0 and the interface can be used at memory locations 25000 to 25003.

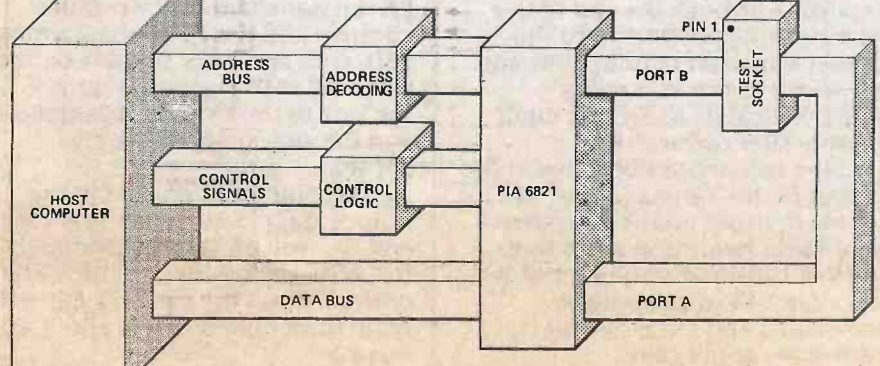


Fig. 1 Block diagram of the test rig.

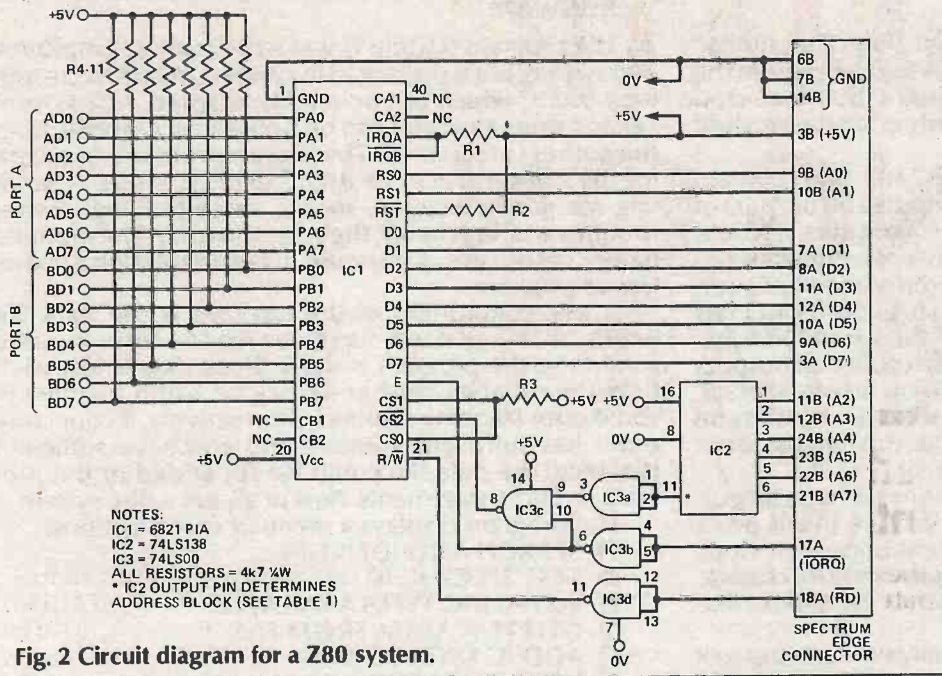


Fig. 2 Circuit diagram for a Z80 system.

IC2 pin no:	Hex Address	Decimal
15	80 – 83	128 – 131
14	84 – 87	132 – 135
13	88 – 8B	136 – 139
12	8C – 8F	140 – 143
11	90 – 93	144 – 147
10	94 – 97	148 – 151
9	98 – 9B	152 – 155
7	9C – 9F	156 – 159

Table 1 Allocating port addresses by means of a 74138 decoder.

Method Of Testing

In order to test a logic gate for correct function, all possible combinations of logic level could be applied to its inputs while its output is monitored. This, in effect, produces a truth table for the particular function whose states are well known.

The rules of logic prove that the number of tests required to validate one gate is 2 to the power of the number of inputs. To completely test an 8-input NAND gate, for example, would require 256 tests. In practice, a far smaller number is sufficient to identify the device and to prove that it will function correctly. Of course, multiple gate chips can have their gates tested simultaneously.

Provided the tests are carefully considered, four tests for each IC should be sufficient to identify the device and to assess its function. This means that any device with a number of 2-pin input gates will be completely tested while almost all other devices will be tested with reasonable accuracy.

Power Supply

As it stands, the project is designed to test TTL and TTL-compatible combinational logic chips only. This means that 74, 74LS, 74S, 74F, 74ALS, 74L, 74C, 74HC and 74HCT types are all catered for. The common J and N packages (that is, most of them in everyday use) have supply voltages on the highest number pin and the one diametrically opposite (5V on 14, 16 or 20 and 0V on 7, 8 or 10). Some TTL packages don't obey this convention, so be warned. Some chips are anomalous, the commonest being the 7473 and 7490, 92 and 93. These latter involve sequential logic and are not catered for by the project at present. Testing a chip with unconventional power supply pins will have no damaging effect on the chip or on the interface. The test results will, however, be meaningless.

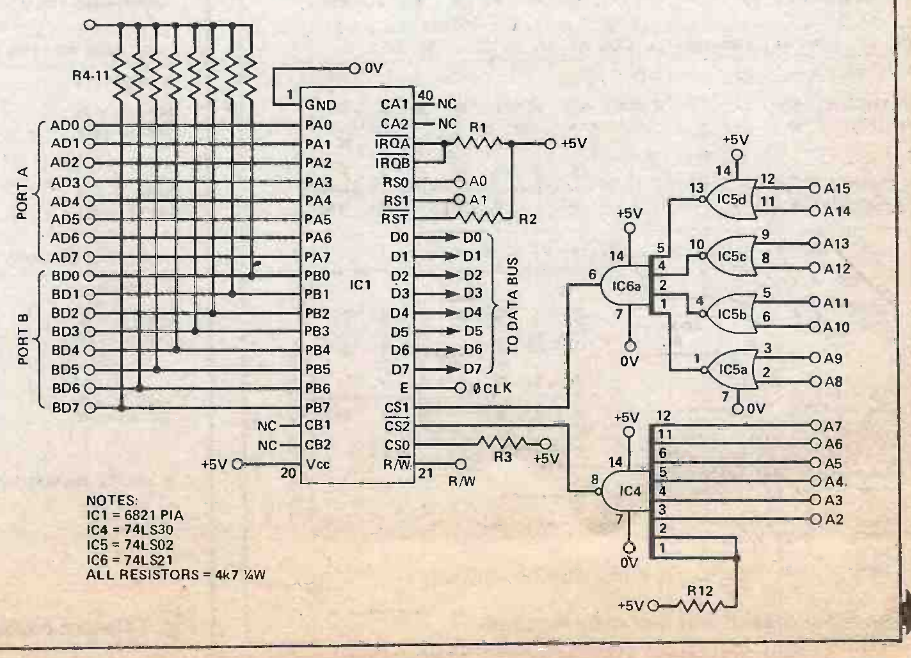


Fig. 3 Circuit diagram for a 6502 system.

Logically Alike

Certain ICs, as mentioned, are 'logically similar' although electrically different. This is the case where the code number is the same — 7400 and 74LS00, for example. Some devices may have different code numbers and yet still be logically similar.

For example, the 7400 and the 7403 both contain four 2-input NAND gates with the inputs and outputs of each gate using equivalent pins. In some cases, it would be possible to interchange these devices without affecting the operation of a circuit. The difference between them is that the 7400 is standard TTL, but the 7403 has open collector outputs which allow the wired-OR function, achieved by connecting the open collector outputs together and adding an external pull-up resistor. In fact, the quad 2-input NAND gate is one of the most useful ICs available and for this reason it has the longest list of logically equivalent types.

Because of all this, it is sometimes extremely difficult precisely to identify a device. In practice this is not a problem — when a logic IC fails, it fails because it stops working, not because its electrical characteristics change. This does not always apply to other IC types, like amplifiers.

With this test package, any logically similar types will be printed with the result of the test, and since the vast majority of ICs have legible number codes on them, this can be checked against the test identification. The IC is first tested for correct function, then checked with test identification (one or more types) for characteristics.

Software

The program (Listing 1) was written for a home-brew Z80 system, but is presented in a fairly standard Microsoft-type BASIC which can be readily adapted. A Spectrum version does exist and can be bought, on cassette, from the author (see below). The biggest problems in adapting the software for other BASIC dialects will be in handling memory allocation, strings, cassette filing, printer routines and, inevitably, the screen display. The modular nature of the program should make adaptation as painless as possible.

A key component of the package is the data file which, as things stand, has to be loaded from cassette each time the program is used. Since data is lost each time the program crashes, it may be worth building in some error trapping routines. Alternatively, if your computer has sufficient memory and you have sufficient patience, the data file could be appended to the program as DATA statements. Best of all, get a disc system.

The program displays a menu of seven options:

1) SEARCH AND IDENTIFY
2) TEST SPECIFIC IC
3) LIST ALL IC TYPES AVAILABLE
4) DELETE IC DATA FROM FILE
5) ADD IC DATA TO FILE
6) LOAD DATA FILE
7) SAVE DATA FILE

Initially, there is no data present and only Options 5 or 6 will be accepted. Option 5 enables the user to build up a data file from scratch as well as add to an existing one,

```
I.C. PINS SET FOR INPUT....12, 11, 9, 8, 2, 3, 5, 6,
-------------------------------------------------------------
[ TEST 1 ]

DATA A = 54                   +5V  0   1   1   0   1   1
INP(A)=246                    ---------------------------
                               14  13  12  11  10  9   8
                              )       [ 7402 ]
                               1   2   3   4   5   6   7
DATA B = 54                   ---------------------------
INP(B)=246                     0   1   1   0   1   1   GND

I.C. PINS SET FOR INPUT....12, 11, 9, 8, 2, 3, 5, 6,
-------------------------------------------------------------
[ TEST 2 ]

DATA A = 36                   +5V  0   0   1   0   0   1
INP(A)=228                    ---------------------------
                               14  13  12  11  10  9   8
                              )       [ 7402 ]
                               1   2   3   4   5   6   7
DATA B = 36                   ---------------------------
INP(B)=228                     0   0   1   0   0   1   GND

I.C. PINS SET FOR INPUT....12, 11, 9, 8, 2, 3, 5, 6,
-------------------------------------------------------------
[ TEST 3 ]

DATA A = 18                   +5V  0   1   0   0   1   0
INP(A)=210                    ---------------------------
                               14  13  12  11  10  9   8
                              )       [ 7402 ]
                               1   2   3   4   5   6   7
DATA B = 18                   ---------------------------
INP(B)=210                     0   1   0   0   1   0   GND

I.C. PINS SET FOR INPUT....12, 11, 9, 8, 2, 3, 5, 6,
-------------------------------------------------------------
[ TEST 4 ]

DATA A = 0                    +5V  1   0   0   1   0   0
INP(A)=201                    ---------------------------
                               14  13  12  11  10  9   8
                              )       [ 7402 ]
                               1   2   3   4   5   6   7
DATA B = 0                    ---------------------------
INP(B)=201                     1   0   0   1   0   0   GND


Device is 100% Functional
Identified as... Quad 2-Input NOR

Logically similar to....
7402    Quad 2-Input NOR Gate
7428    Quad 2-Input NOR Buffer
7433    Quad 2-Input NOR Gate ( Open Collector )
```

Fig. 4 Successful test and identification.

```
I.C. PINS SET FOR INPUT....13, 12, 10, 9, 1, 2, 4, 5,
-------------------------------------------------------------
[ TEST 1 ]

DATA A = 27                   +5V  1   1   1   1   1   1
INP(A)=255                    ---------------------------
                               14  13  12  11  10  9   8
                              )       [ 7403 ]
                               1   2   3   4   5   6   7
DATA B = 27                   ---------------------------
INP(B)=255                     1   1   1   1   1   1   GND

I.C. PINS SET FOR INPUT....13, 12, 10, 9, 1, 2, 4, 5,
-------------------------------------------------------------
[ TEST 2 ]

DATA A = 18                   +5V  0   1   1   0   1   1
INP(A)=246                    ---------------------------
                               14  13  12  11  10  9   8
                              )       [ 7403 ]
                               1   2   3   4   5   6   7
DATA B = 18                   ---------------------------
INP(B)=246                     0   1   1   0   1   1   GND

I.C. PINS SET FOR INPUT....13, 12, 10, 9, 1, 2, 4, 5,
-------------------------------------------------------------
[ TEST 3 ]

DATA A = 9                    +5V  1   0   1   1   0   1
INP(A)=237                    ---------------------------
                               14  13  12  11  10  9   8
                              )       [ 7403 ]
                               1   2   3   4   5   6   7
DATA B = 9                    ---------------------------
INP(B)=237                     1   0   1   1   0   1   GND

I.C. PINS SET FOR INPUT....13, 12, 10, 9, 1, 2, 4, 5,
-------------------------------------------------------------
[ TEST 4 ]

DATA A = 0                    +5V  0   0   1   0   0   1
INP(A)=228                    ---------------------------
                               14  13  12  11  10  9   8
                              )       [ 7403 ]
                               1   2   3   4   5   6   7
DATA B = 0                    ---------------------------
INP(B)=228                     0   0   1   0   0   1   GND


( DEVICE MALFUNCTION )
```

Fig. 5 Device malfunction — output pins stuck at one.

1)	27	219	27	219	18	246	18	246	9	237	9	237	0	228	0	228	1
2)	54	246	54	246	36	228	36	228	18	210	18	210	0	201	0	201	3
3)	21	213	21	213	5	229	5	229	1	233	1	233	0	234	0	234	5
4)	27	255	27	255	18	210	18	210	9	201	9	201	0	192	0	192	9
5)	29	221	31	223	13	239	13	237	5	231	4	228	0	226	0	224	11
6)	27	223	27	223	18	246	18	246	9	237	9	237	0	228	0	228	19
7)	6	223	63	255	4	249	15	207	2	251	3	195	0	249	0	192	25
8)	27	255	27	255	18	246	18	246	9	237	9	237	0	192	0	192	26
9)	54	246	54	246	36	237	36	237	18	219	18	219	0	201	0	201	2
10)	29	255	29	255	17	209	17	209	21	213	21	213	1	1	1	1	–1
11)	29	255	31	255	17	209	4	196	21	213	22	214	0	192	0	192	12
12)	27	255	27	255	18	214	18	214	9	205	9	205	0	196	0	196	20
13)	27	219	27	219	18	246	18	246	9	237	9	237	0	192	0	192	31
14)	51	243	51	243	34	238	34	238	17	221	17	221	0	192	0	192	34
15)	29	221	31	223	21	213	22	214	8	198	9	199	0	226	0	224	23
16)	–1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2 Contents of sub-file A.

while Option 6 loads a file from cassette.

Once loaded, you can select any of the seven options, returning to the Menu if you want by pressing 'M' on the keyboard.

Option 1 will, if possible, identify an IC, printing out its code number, function and logically equivalent types. Option 2 tests a specified IC, checking whether it is present in the data file or not, printing out the appropriate identity if it is and the result of the tests (Figs. 4 and 5). Option 3 lists all devices held on file. Option 4 deletes specified devices. Option 5 asks for a device code-number, a functional specification, additional information such as 'open-collector outputs' and the appropriate test data in order to add the device to the file. If the device is already on file, its details will be displayed and the user will be given the chance to change all or some of them.

	Device Code	Pointers			
1)	7400	1	1	0	1
2)	7402	1	1	3	9
3)	7402	2	1	0	2
4)	7403	1	1	3	1
5)	7404	3	0	0	3
6)	7405	3	3	0	3
7)	7406	9	3	4	3
8)	7407	9	3	4	3
9)	7408	4	1	0	4
10)	7409	4	1	3	4
11)	7410	5	1	0	5
12)	7411	10	1	0	11
13)	7412	5	1	3	5
14)	7413	6	5	0	6
15)	7414	11	5	0	3
16)	7415	10	1	3	11
17)	7416	9	3	4	3
18)	7417	9	3	4	3
19)	7420	6	1	0	6
20)	7421	12	1	0	12
21)	7422	6	1	3	6
22)	7426	1	1	4	1
23)	7427	13	1	0	15
24)	7428	2	2	0	2
25)	7430	7	1	0	7
26)	7432	8	1	0	8
27)	7433	2	3	0	2
28)	7437	1	2	0	1
29)	7438	1	2	3	1
30)	7440	6	2	0	6
31)	7486	14	1	0	13
32)	74132	1	5	0	1
33)	74136	14	1	3	13
34)	74266	14	1	3	14
35)	74386	14	1	0	14
36)	–1	–1	–1	–1	–1
37)	0	0	0	0	0
38)	0	0	0	0	0
39)	0	0	0	0	0
40)	0	0	0	0	0

Table 3 Contents of sub-file B.

Option 6 loads the data file from tape. It comprises three 'sub-files' designated A, B and C which are loaded in that order — A containing numerical test data for each IC, B containing numerical device codes and pointers to other information and C containing alphanumerical information on logic functions (see Tables 2, 3 and 4). Option 7 will save a new or amended data file to tape.

Formulation Of Test Data

The IC being tested is held in a socket in the test interface. The connections to these sockets (14, 16 or 20 pins) are shown in Fig6. Port A of the test interface's 6821 PIA controls the high number pins and Port B controls the low number pins. Each IC requires 16 numbers as test data since there are four tests and each test uses four data numbers. Each group of four numbers (one test) consists of two codes to be sent to Ports A and B and two codes to be compared with the data received from Ports A and B.

		Array T$	
1)	Quad 2-Input NAND	1)	Gate
2)	Quad 2-Input NOR	2)	Buffer
3)	Hex Inverter	3)	(Open Collector)
4)	Quad 2-Input AND	4)	(High voltage)
5)	Triple 3-Input NAND	5)	Schmitt Trigger
6)	Dual 4-Input NAND	6)	EOF
7)	8-Input NAND	6)	
9)	Quad 2-Input OR	7)	
9)	Hex Buffer	8)	
10)	Triple 3-Input AND	9)	
11)	Hex	10)	
12)	Dual 4-Input AND		
13)	Triple 3-Input NOR		
14)	Quad 2-Input EX-OR		
15)	EOF		
16			
17			
18			
19			
20			

Table 4 Contents of sub-file C and of array T$.

Consider the 7400 (Fig. 7). The inputs to the four NAND gates are pins 1, 2, 4, 5, 9, 10, 12 and 13. It should be clear that to send a high to each of these pins involves taking PA0, PA1, PA3, PA4, PB0, PB1, PB3 and PB4 high. Taking binary weighting into account (PAn and PBn each correspond to 2^n), this means sending a 27 to Port A and a 27 to Port B. This is done on the 6821 in a fairly roundabout manner.

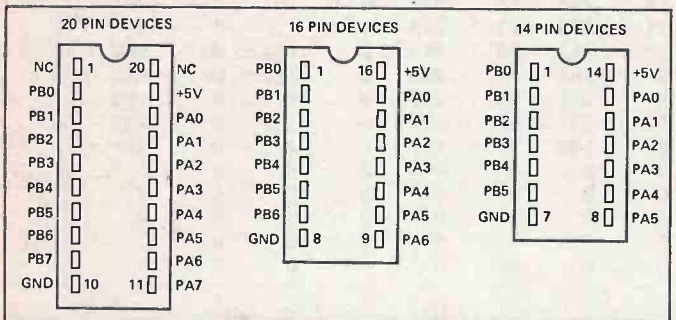


Fig. 6 Connections to test sockets.

First, the data direction registers for Ports A and B must be set to receive data. This is achieved by setting bit 2 of the *control* registers for Ports A and B to 0. If Port A's address is 144 (as here) then its control register will be located at address 145. To write to Port A, bit 2 of location 145 must be set to zero. This is done in the program by the command OUT A+1,0 (line 680), where A equals 144 or 90H (line 60). Then the inputs to the chip under test must be set up by configuring them as *outputs* from the two ports. As far as Port A is concerned, this is done by means of the command OUT A,A(J,K) (line 690), where A is 144 again and A(J,K) is the test data — the number 27 we discussed above. This ensures that the right pins on the IC under test are connected to outputs from the 6821. All the port lines on the 6821 *not* configured as outputs will be treated as inputs and will be ignored by the 6821 when data is sent to the IC under test.

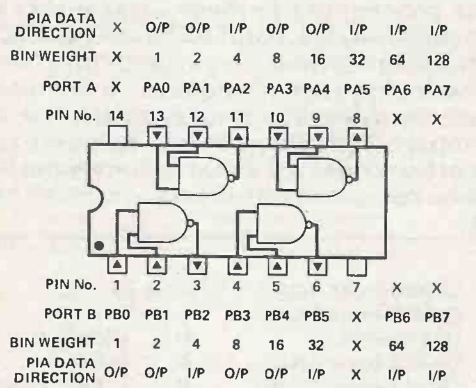


Fig. 7 The 7400, ins and outs and port connections.

Line 700 in the program then resets bit 2 of the control registers by actually setting all bits high (OUT A+1,255). Now the program has access to the peripheral hanging off the ports and all the right lines have been set to outputs and inputs. In line 830 (and in line 390, for that matter), we find the command OUT A,A(J,K) again. Having sent 27, in the first instance, to Port A we now seem to be doing it again. The difference is that this time the command actually writes logical highs to the port lines which were defined as outputs the first time 27 was sent to Port A. In line 804, inputs from Port A and Port B appear in the guise of the functions INP(A) and INP(B). These read their respective ports and return numbers composed of values from every line or bit of the ports. The value read from input lines will be determined by whatever is connected to those lines. The values read from the output lines will normally be whatever value was last written to those lines. (The only problem arising when Port A — and only Port A — is so heavily loaded that voltages on the data lines fall below 2V for a high or rise above 0.8V for a low).

Thus, if we send 27 to Port A and the 7400 is working properly, pins 11 and 8 and hence lines PA2 and PA5 will be low. The remaining data lines, PA6 and PA7, are held high by internal pull-up resistors (the Port B lines all have external pull-ups). The result will be that a read operation on Port A will return 27+64+128 — or binary 11011011 — or decimal 219. This number appears as the second (and fourth) item in data file A's entry for the 7400 and is, therefore, the value ascribed to A(J,K+1) (and A(J,K+3)). Line 840 (and line 400) of the program test that the value returned from read operations on Ports A and B does correspond to the proper data file entry. If there is any error, a device malfunction can be assumed under Option 2 of the program menu, or under Option 1, non-equivalence of the device under test and a library device follows.

The complete test data (held on sub-file A) for a 7400 quad 2-input NAND gate is:
27 219 27 219 18 246 18 246 9 237 9 237 0 228 0 228.
The format being 1) data out to Port A, 2) comparison data for Port A read operation, 3) data out to Port B, 4) comparison data for Port B read operation. The next group of four numbers form the second test, then come the third and fourth tests. Between them, they exhaust all possible input conditions for this IC.

A complete set of test data can be simply built-up by reference to a pin-out diagram and a functional specification of any device, bearing in mind the connections from the PIA ports to the test sockets. After entering a new device, the data can be verified by an actual test using a known functioning IC. Test data can be displayed and printed in order to help locate any mistakes in the test data or any malfunction of a device under test. The new data file should be saved to tape using Option 7. As it stands, the program includes too little in the way of error-checking and can crash quite easily. Each time it does, your data will be lost.

Program Structure And Operation

The program can be split into seventeen sections. It is menu driven with seven of the sections being the options already listed. These, in turn, call subroutines as required before returning to the menu.

The program was designed to be easily expandable and adaptable to other types of IC. For this reason, fixed length files are not used. During program execution, frequent checks are made when accessing files to ensure that the end of file has not been reached. This slows down the speed of execution but, in practice, the devices tested with the current data files appear to be identified immediately when data is available.

The arrays are dimensioned in line 50 of the program; this is a requirement of BASIC and if larger files were required for future use these dimensions would have to be changed and the new program copy saved. This also applies to array T$ which is loaded from data at line 2740. If different data were required, items would have to be added or changed at this line.

The structure of the arrays has been designed to make as efficient use of memory as possible, and where data could be duplicated the use of pointers has avoided this.

Only 14 different sets of test data are used, but the package can test and identify 35 different IC types. Table 3 shows most clearly how pointers are used to maximize memory use.

Array Structure

Array A, which has been described during the formulation of test data, is two-dimensional with each row holding the 16 test numbers plus a pointer to an IC identified by this data. There may be more than one IC which could be identified from this data and, because of the design of the program, it does not matter which of the logically similar ones it is.

If the first element of a row, A(n,1), contains –1 this is the 'end of file' marker. The last element, A(n,17), of a row is –1 when test data has been erased.

Array B is two-dimensional with each row holding data as follows:

- B(n,1) Numerical device code. A –1 is the 'end of file' marker;
- B(n,2) Pointer to an element of array C$ which describes the function of the device;
- B(n,3) Pointer to an element of array T$ which describes the type of device;
- B(n,4) Also pointer to array T$ if there is any further information (zero if none);
- B(n,5) Pointer to array A which contains the test data for device B(n,1). If this element contains –1 then the data has been erased.

C$ is a one-dimensional alphanumeric array containing all the IC functions. It is referenced by B above during program execution. EOF is the 'end of file' marker.

Table 5 Program variables.

Variable	Function
C	Temporary counter
Q	Holds value of option chosen (1-7).
LD	Data file flag. If LD=0 file is empty. If LD=2 file contains data.
J, K, O	Temporary counters.
C1	Used to reference array B, as in B(C1,1).
L$	String containing a row of dashes half of screen width.
Q$	Holds single character from keyboard scan
A, B	Address of ports used for testing, 90H and 92H in this case.
T	Counts number of tests made for display of test process.
D	Decimal number to be converted to binary.
A$	Binary number to be displayed alongside IC being tested, to show logic levels.
S$	Holds single character from keyboard scan.
PN$	Holds pin numbers used for input during display of test process.
P9	Temporary count, used when translating pin numbers from binary string A$.
DN, DT	Holds device number and device type number.
A1	Temporary count, used in loop to display test data.
X	Free element of array B. Used when adding IC to data file.
CR	Change Record flag. If CR=0 then IC data already on file is being amended.
DF$	Holds device function
D1	Temporary store for pointer. Used when deleting IC from file.
A (X,Y)	Two dimensional array, holds test data for all ICs on file, also the last element in each row holds a pointer to array B.
B (X,Y)	Two dimensional array, holds device codes and pointers to arrays A, C$ and T$.
C$ (X)	One dimensional array, holds IC functions.
T$ (X)	One dimensional array, holds further device information.

T$ is a one-dimensional alphanumeric array containing further device information. It also is referenced by B above during program execution. EOF is the 'end of file' marker.

Doing it Yourself

The hardware requires very little effort to modify for your own system or to build. The author's original circuit was built on strip-board, looks fine and works well.

The program as it stands requires very little modification to work on an Amstrad, BBC or Commodore 64 computer, once you have sorted out the hardware addressing. The circuit given in Fig. 2 works with a Spectrum and Spectrum+ and the author will provide suitable software on cassette. The price is £2 inclusive of p&p from Alan Paton, 67 Bradford Road, Trowbridge, Wiltshire BA14 9AN. Please make cheques payable to Alan Paton.

Listing 1 The IC Functional Test Program.

```
10 REM ******************************************************
20 REM  FUNCTIONAL TEST OF INTEGRATED CIRCUITS    A.D.Paton.
30 REM ******************************************************
40 REM  .....INITIALISATION
50 CLEAR 500:DIM A(20,17),B(40,5),C$(20),T$(10)
60 A=$90:B=$92:L$="--------------------------------":
70 C=0
80 C=C+1:READ T$(C)
90 IF T$(C)<>"EOF" THEN 80
100 A(1,1)=-1:B(1,1)=-1:C$(1)="EOF"
110 REM ******************************************************
120 REM ============        TITLE AND OPTIONS      ============
130 REM ******************************************************
140 CLS :PRINT STRING$(64,42):PT=0:P=0:CR=0:Q$=""
150 PRINT TAB(11)"INTEGRATED CIRCUIT FUNCTIONAL TEST PACKAGE"
160 PRINT :PRINT STRING$(64,42)
170 PRINT :PRINT TAB(14)"1) SEARCH AND IDENTIFY"
180 PRINT TAB(14)"2) TEST SPECIFIC I.C."
190 PRINT TAB(14)"3) LIST ALL I.C. TYPES AVAILABLE"
200 PRINT TAB(14)"4) DELETE I.C. DATA FROM FILE"
210 PRINT TAB(14)"5) ADD I.C. DATA TO FILE"
220 PRINT TAB(14)"6) LOAD DATA FILE"
230 PRINT TAB(14)"7) SAVE DATA FILE"
240 PRINT :PRINT TAB(18)"Select option (1 to 7)....";
250 GET Q:IF Q<1 OR Q>7 THEN 250
260 CLS :IF LD=2 OR Q=5 OR Q=6 THEN 280
270 GOSUB 1250:GOTO 110
280 ON Q GOSUB 330,750,970,2350,1540,2610,2680
290 GOTO 110
300 REM ******************************************************
310 REM ============  FUNCTIONAL TEST ROUTINE  =============
320 REM ******************************************************
330 J=0
340 J=J+1
350 IF A(J,1)<0 THEN GOSUB 630:RETURN
360 IF A(J,17)<0 THEN 340
370 FOR K=1 TO 13 STEP 4
380 IF K=1 THEN GOSUB 680
390 OUT A,A(J,K):OUT B,A(J,K+2)
400 IF A(J,K+1)<>INP(A) OR A(J,K+3)<>INP(B) THEN 340
410 NEXT K
420 C1=A(J,17)
430 REM ******************************************************
440 REM ============        TEST O.K. ROUTINE      ============
450 REM ******************************************************
460 PRINT :PRINT "Device is 100% Functional"
470 PRINT "Identified as... ";:J=0
480 PRINT C$(B(C1,2)):PRINT :PRINT "Logically similar to...."
490 J=J+1:IF B(J,1)<0 THEN 520
500 IF B(J,5)=B(C1,5) THEN PRINT B(J,1),C$(B(J,2));T$(B(J,3));T$
(B(J,4))
510 GOTO 490
520 GOSUB 2780
530 PRINT L$L$:PRINT " D...Display Test Process   P...Print Test
 Process   M...MENU"
540 PRINT TAB(20)"Select Option (D,P or M)...":J=B(C1,5):PRINT L
$L$
550 GET Q$:IF Q$="" THEN 550
560 IF Q$="D" THEN CLS :GOSUB 1050:RETURN
570 IF Q$="P" THEN CLS :GOSUB 1040:RETURN
580 IF Q$="M" THEN RETURN
590 GOTO 550
600 REM ******************************************************
610 REM ============        TEST FAIL ROUTINE      ============
620 REM ******************************************************
630 PRINT "Device malfunction or insufficient data."
640 GOSUB 1260:RETURN
650 REM ******************************************************
660 REM ======== Set up PIA for required input bits. ========
670 REM ******************************************************
680 OUT A+1,0:OUT B+1,0
690 OUT A,A(J,K):OUT B,A(J,K+2)
700 OUT A+1,255:OUT B+1,255
710 RETURN
```

```
720 REM ****************************************************
730 REM ============    TEST SPECIFIC TYPE    =============
740 REM ****************************************************
750 PRINT "Enter No. of device to be tested (omit any letters)"
760 INPUT "...";DT:C=0:PRINT
770 C=C+1:IF B(C,1)<0 THEN 880
780 IF B(C,5)=-1 THEN 770
790 IF B(C,1)=DT THEN J=B(C,5) ELSE 770
800 C1=C:GOSUB 920
810 FOR K=1 TO 13 STEP 4
820 IF K=1 THEN GOSUB 680
830 OUT A,A(J,K):OUT B,A(J,K+2)
840 IF A(J,K+1)<>INP(A) OR A(J,K+3)<>INP(B) THEN 870
850 NEXT K
860 GOSUB 460:RETURN
870 PRINT :PRINT "( DEVICE MALFUNCTION )":GOSUB 520:RETURN
880 PRINT "No record of I.C. type "DT" on file.":PRINT :GOSUB 12
60:RETURN
890 REM ****************************************************
900 REM ============    PRINT I.C. No. and TYPE    ============
910 REM ****************************************************
920 PRINT "Number .........  "B(C1,1)
930 PRINT "Type ............ "C$(B(C1,2));T$(B(C1,3));T$(B(C1,4))
:RETURN
940 REM ****************************************************
950 REM ==============    LIST ALL I.C. TYPES    ==============
960 REM ****************************************************
970 C=0:PRINT
980 C=C+1:IF B(C,1)<0 THEN GOSUB 1260:RETURN
990 IF B(C,5)=-1 THEN 980
1000 PRINT B(C,1),C$(B(C,2));T$(B(C,3));T$(B(C,4)):GOTO 980
1010 REM ****************************************************
1020 REM ===========    DISPLAY OR PRINT PROCESS    ===========
1030 REM ****************************************************
1040 GOSUB 2760
1050 T=0:FOR K=1 TO 13 STEP 4
1060 IF K=1 THEN GOSUB 680:GOSUB 1320
1070 OUT A,A(J,K):OUT B,A(J,K+2)
1080 PRINT "I.C. PINS SET FOR INPUT...."PN$:PRINT L$L$
1090 A9=INP(A):B9=INP(B)
1100 T=T+1:PRINT "[ TEST "T" ]":PRINT
1110 D=A9:GOSUB 1440:PRINT "DATA A =";A(J,K)TAB(31)"+5V  "A$
1120 PRINT "INP(A)="A9TAB(30)L$
1130 PRINT TAB(32)"14  13  12  11  10  9   8":PRINT TAB(30)")
   [ "B(C1,1)" ]"
1140 PRINT TAB(32)"1   2   3   4   5   6   7"
1150 PRINT "DATA B =";A(J,K+2)TAB(30)L$
1160 D=B9:GOSUB 1440:PRINT "INP(B)="B9;TAB(32)A$"GND"
1170 PRINT :PRINT :IF Q$="P" THEN NEXT K:GOSUB 810:RETURN
1180 PRINT :PRINT "Press M for MENU - any key to continue test"
1190 GET S$:IF S$="" THEN 1190
1200 IF S$<>"M" THEN NEXT K
1210 RETURN
1220 REM ****************************************************
1230 REM ==============    KEYBOARD SCAN    =================
1240 REM ****************************************************
1250 PRINT "No data available ......Please LOAD DATA FILE"
1260 PRINT :PRINT "Press M to return to MENU";
1270 GET Q$:IF Q$<>"M" THEN 1270
1280 RETURN
1290 REM ****************************************************
1300 REM =============    LOCATE PIN NUMBERS    ============
1310 REM ****************************************************
1320 PN$="":D=A(J,K):GOSUB 1440:P9=13
1330 FOR O=1 TO 24 STEP 4
1340 IF MID$(A$,O,1)="1" THEN PN$=PN$+STR$(P9)+", "
1350 P9=P9-1:NEXT O
1360 D=A(J,K+2):GOSUB 1440:P9=1
1370 P9=1:FOR O=1 TO 24 STEP 4
1380 IF MID$(A$,O,1)="1" THEN PN$=PN$+STR$(P9)+", "
1390 P9=P9+1:NEXT O
1400 RETURN
1410 REM ****************************************************
1420 REM ==========    DECIMAL TO BINARY ROUTINE    =========
1430 REM ****************************************************
1440 A$=""
1450 IF D=0 THEN A$="0   0   0   0   0   0   ":RETURN
1460 IF INT(D/2)=D/2 THEN A$=A$+"0   ":D=D/2:GOTO 1460
1470 A$=A$+"1   ":D=D-1:IF D>0 THEN D=D/2:GOTO 1460
1480 IF LEN(A$)<24 THEN A$=A$+"0   ":GOTO 1480
1490 IF LEN(A$)>24 THEN A$=LEFT$(A$,24)
1500 RETURN
1510 REM ****************************************************
1520 REM ============== ADD I.C. DATA TO FILE ==============
1530 REM ****************************************************
1540 PRINT "* ADD I.C. DATA TO FILE"
1550 PRINT :INPUT "Enter Device No. (or -1 to return to MENU)...
";DN
1560 IF DN<0 THEN RETURN
1570 REM ...Is device on file ?
1580 J=0
1590 J=J+1:IF B(J,1)=-1 THEN 1680
1600 IF B(J,5)=-1 THEN 1590
1610 IF B(J,1)<>DN THEN 1590
1620 PRINT :PRINT "Device "DN" is on file with the following dat
a...":C1=J:GOSUB 920
1630 A1=B(J,5):PRINT :FOR K=1 TO 16:PRINT A(A1,K)" ";:NEXT K
1640 GOSUB 1980
1650 IF Q$="N" THEN RETURN
1660 IF Q$="Y" THEN X=J:CR=1:GOTO 1740
1670 REM ...Device not found   -    find free location in File B
result into X
1680 J=0
1690 J=J+1:IF B(J,1)=-1 THEN B(J+1,1)=-1:GOTO 1720
1700 IF B(J,5)=-1 THEN 1720
1710 GOTO 1690
1720 X=J:B(X,1)=DN
1730 REM ...Get device details for data file
1740 IF CR=1 THEN PRINT "Current Function..."C$(B(X,2)):GOSUB 19
80
1750 IF Q$="N" THEN 1800
1760 PRINT "Enter Device Function"
1770 INPUT " (or L to list Functions on file)...";DF$
1780 IF DF$="L" THEN GOSUB 2290:PRINT :GOTO 1740
1790 IF CR=0 THEN GOSUB 2230 ELSE C$(B(X,2))=DF$
1800 IF CR=0 THEN 1830
1810 PRINT "Current further details are..."B(X,3);T$(B(X,3)),B(X
,4);T$(B(X,4))
1820 GOSUB 1980:IF Q$="N" THEN 1860
1830 PRINT "Enter further device details (No.1,No.2)"
1840 INPUT " (or 0,0 to list details available)...";B(X,3),B(X,4
)
1850 IF B(X,3)=0 AND B(X,4)=0 THEN GOSUB 2190:PRINT :GOTO 1800
1860 GOSUB 2030:IF CR=0 THEN 1880
1870 GOSUB 2150:GOSUB 1980:IF Q$="N" THEN 1960
1880 PRINT :PRINT "Enter test data (16 integer numbers)..."
1890 FOR K=1 TO 16:PRINT K"...";
1900 IF CR=1 THEN PRINT "Current test data..."A(B(X,5),K);
1910 INPUT "...";A(A1,K)
1920 IF A(A1,K)<0 OR A(A1,K)<>INT(A(A1,K)) THEN PRINT "INCORRECT
 DATA":K=K-1
1930 NEXT K
1940 A(A1,17)=X:B(X,5)=A1
1950 GOSUB 2080:GOTO 1580
1960 RETURN
1970 REM ...Get YES or NO response
1980 PRINT :PRINT "* Change data ? (Y or N) "
1990 GET Q$:IF Q$="" THEN 1990
2000 IF Q$<>"Y" AND Q$<>"N" THEN 1980
2010 RETURN
2020 REM ...Find free location in array A (result into A1)
2030 J=0
2040 J=J+1:IF A(J,1)<0 THEN A1=J:A(J+1,1)=-1:RETURN
2050 IF A(J,17)<0 THEN A1=J:RETURN
2060 GOTO 2040
2070 REM ...Is same test data already in use ?
2080 J=0
2090 J=J+1:IF A(J,1)<0 THEN RETURN
2100 IF J=A1 THEN 2090
2110 FOR K=1 TO 16:IF A(J,K)<>A(A1,K) THEN 2090
2120 NEXT K
2130 B(X,5)=J:A(A1,17)=-1:RETURN
2140 REM ...Print test data from array A
2150 PRINT "Current test data is..."
2160 FOR K=1 TO 16:PRINT A(B(X,5),K)" ";:NEXT K
2170 RETURN
2180 REM ...Print contents of array T$
2190 J=0
2200 J=J+1:IF T$(J)="EOF" THEN RETURN
2210 PRINT J,T$(J):GOTO 2200
2220 REM  ...Is Device Function (DF$) already in array C$ ?
2230 J=0
2240 J=J+1:IF C$(J)="EOF" THEN 2260
2250 IF C$(J)=DF$ THEN 2270 ELSE 2240
2260 C$(J)=DF$:C$(J+1)="EOF"
2270 B(X,2)=J:RETURN
2280 REM ...Print contents of array C$
2290 J=0
2300 J=J+1:IF C$(J)="EOF" THEN RETURN
2310 PRINT J,C$(J):GOTO 2300
2320 REM ****************************************************
2330 REM ============= DELETE I.C. FROM FILE ================
2340 REM ****************************************************
2350 PRINT "* DELETE I.C. FROM FILE"
2360 PRINT :INPUT "Enter Device No. (or -1 to return to MENU)...
";DN
2370 IF DN<0 THEN RETURN
2380 J=0
2390 J=J+1:IF B(J,1)=-1 THEN PRINT "Device No."DN" not on file."
:GOTO 2360
2400 IF B(J,5)=-1 THEN 2390
2410 IF B(J,1)<>DN THEN 2390
2420 C1=J:PRINT "The following device to be deleted from file :-
":GOSUB 920
2430 PRINT :PRINT TAB(22)"Confirm or Reject ? (C or R)"
2440 GET Q$:IF Q$="" THEN 2440
2450 IF Q$="R" THEN RETURN
2460 IF Q$<>"C" THEN 2360
2470 D1=B(C1,5)
2480 IF C1<>A(D1,17) THEN B(C1,5)=-1:RETURN
2490 B(C1,5)=-1:J=0
2500 J=J+1:IF B(J,1)<0 THEN GOSUB 2540:RETURN
2510 IF B(J,5)=D1 THEN A(D1,17)=J:RETURN
2520 GOTO 2500
2530 REM ....Delete test data from FILE A
2540 K=0
2550 K=K+1:IF A(K,1)<0 THEN RETURN
2560 IF A(K,17)=C1 THEN A(K,17)=-1
2570 GOTO 2550
2580 REM ****************************************************
2590 REM =============    LOAD DATA FILES    ================
2600 REM ****************************************************
2610 PRINT "* LOAD DATA FILES"
2620 INPUT "Start TAPE and press RETURN";Q$
2630 LOAD ("FILE A")@A:LOAD ("FILE B")@B:LOAD ("FILE C")@C$
2640 LD=2:RETURN
2650 REM ****************************************************
2660 REM =============    SAVE DATA FILES    ================
2670 REM ****************************************************
2680 PRINT "* SAVE DATA FILES"
2690 INPUT "Start TAPE and press RETURN";Q$
2700 PRINT "FILE A":SAVE ("FILE A")@A
2710 PRINT "FILE B":SAVE ("FILE B")@B
2720 PRINT "FILE C":SAVE ("FILE C")@C$
2730 RETURN
2740 DATA "Gate","Buffer","( Open Collector )","( High Voltage )
","Schmitt Trigger","EOF"
2750 REM ....Switch on printer
2760 POKE $1401,$55:PRINT :RETURN
2770 REM ....Switch off printer
2780 POKE $1401,$AA:RETURN
```

ETI

NEXT MONTH

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COMING TO THESE PAGES SOON

Etienne Scrooge yawned, scratched himself and got up from his chair. 'June,' he said to himself, 'is busting out all over.' With that out of the way, he found himself with a little time on his hands. It was half an hour. He rushed to the window, seized with a sudden irrational fear. Luckily, the window was open and Etienne immediately proceeded to shake his hands vigorously in the air. The half an hour soared up and away. 'Time flies', Etienne muttered. He breathed a sigh of relief, for the time had been weighing heavily.

Turning from the open window, Etienne was aghast to notice the other half of the hour on the floor by the chair he had only recently been occupying. It was very still and Etienne wondered whether it had been standing that way for long. It certainly didn't look longer than a few minutes, which — in fact — it wasn't. Etienne picked it up gingerly and with something more like auburn he tip-toed out of the room. 'I suppose you could call this "taking my time",' Etienne thought.

No sooner had he stepped outside into the hall when the first half of the hour burst through the front door and raced by. It was musical time, and it had the right key. The second half sprang into action and pursued its one-time partner all the way down the road to the shops. 'Time,' thought Etienne, 'waits for no man.' On his way to work, Etienne found a few minutes in the newsagents to pick up the latest copy of ETI. Curiously, there was almost nothing about time in it. 'That sounds like the cue for a song,' Etienne thought. But it wasn't.

The Upgradeable Amp

Easy for the beginner to build, yet equally easy to upgrade into a quality amp, this design represents one school of audio thought in practice. Designer Graham Nalty will explain exactly why each critical component has been used and how each stage of upgrading can be accomplished. The result is an amplifier which at the most basic level provides outstanding quality for the cost of building it and, when fully upgraded, quite simply provides outstanding quality.

RF Oscillators

In this general feature on radio frequency oscillators, design considerations and actual circuits are examined. These circuits are not only vital to communications devices, but can also be the basis of valuable test equipment and clock-controlled digital circuits.

MIDI to CV Converter

Music to the ears of all those readers with pre-digital synthesizers. This project by Robert Penfold will allow full digital control of these instruments using the MIDI protocol as an input and a 1V per octave control signal as an output.

PLUS

All our usual features. Tech Tips, News Digest, Read/Write, Circuit Solutions, Reviews, Open Channel, and much, much more.

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Articles described here are at an advanced stage of prepartion but circumstances beyond our control may dictate changes to the final list of contents.

TECH TIPS

Courtesy Light Delay/Lights Minder

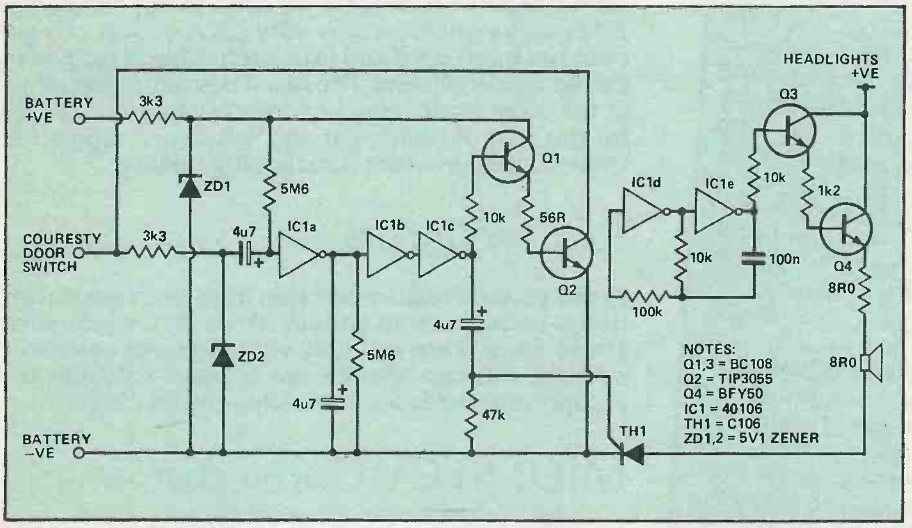
G. S. Howe
Durham

This circuit was developed to provide a switch-off delay for a car courtesy light and will also provide a reminder should you leave the car with its lights on.

Zener diodes ZD1 and ZD2 are included to prevent false triggering of the unit due to electrical noise on the positive supply. IC1a and b provide a simple 30s monostable, the inverted ouput from IC1c being normally low. When a car door is opened, the monostable is triggered and transistors Q1 and Q2 turn on.

After approximately 30s the output of IC1c will go low turning transistors Q1 and Q2 off and with them the courtesy light.

IC1d and e are configured as an astable multivaibrator. If the headlights have been left on, the output of IC1e will be amplified by transistors Q3 and Q4. When a door is opened, the monostable is triggered which will cause thyristor SCR1 to conduct. This produces an audible alarm which will cease when the lights are turned off. The lights may be left on by simply switching off then on again, after the alarm has triggered.



Repairing Personal Hi-fi Systems

Ian Pitt

Miniature stereo tape players of the 'Walkman' type are now in widespread use, and many of our readers must have been presented with an ailing example of the species at some time or another and asked to repair it.

The most common fault, it seems, is a poor connection at the headphone socket, resulting from repeated insertion and removal of the jack plug and sideways pressure on the plug whilst in place. The obvious solution is to replace the jack socket, which is usually a PCB-mounted component. In practice, this may not be necessary in many cases.

What appears to happen in an awful lot of these tape machines is that the stressing on the jack socket eventually causes one of the solder pins to become stripped of its plating. The plating remains attached to the (apparently intact) solder blob while the pin is free to move in and out as the jack socket moves. The result is a faulty connection which only 'makes' when the headphone plug is held in a particular position.

The solution is simply to try cooking each of the jack socket solder joints in turn with a soldering iron for a few seconds. With any luck this will cure the problem completely and you will have saved yourself the cost of a new jack socket and the work involved in gaining access to both sides of the PCB (gaining access to the solder side of the board alone is usually quite straightforward).

Simple Percussion Noise Gate

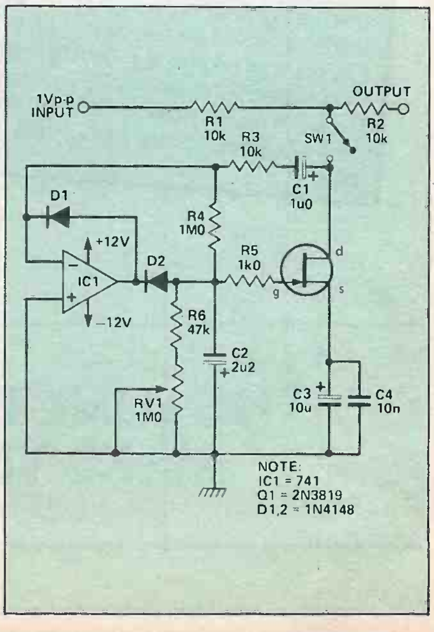
Robin Foxland
Sheffield

This circuit can be fitted to the output of a compressor/limiter or installed on a mixer channel to give excellent noise gating on percussive sounds. It does this without losing any of the punchy attack as so often happens with VCA-based noise gates.

With no signal present Q1 acts as a low resistance to C3, C4 which filter off any noise from the signal path. Applying a signal produces a negative voltage at the output of IC1 and across D2, driving the gate of Q1 and increasing the N-channel resistance. This will cut off C3, C4, leaving the signal unaffected.

RV1 is fitted to allow the decay of the circuit to be matched to that of the signal. R1 and R2 may be omitted and replaced by the input and output resistance between stages. R3 controls the sensitivity and may be varied according to requirements, although obviously the circuit should not be made so sensitive that it is activated by its own noise level!

The results are very good, with hum and hiss virtually disappearing yet allowing a sharp crisp sound to remain. SW1 is used to disengage the circuit when signals with a slow attack are present.



Switching Regulator

P. Cuthbertson
Inverurie

This circuit was originally intended to generate 5V from a car battery, to power a BBC micro. There are no ICs in it, and all the semiconductors are readily available as I had to knock it up from bits and pieces that were lying around at the time.

Efficiencies of over 60% are possible with this circuit. A linear regulator would attain an efficiency of between 33% to 42% maximum.

Q1 and Q2 form an astable multivibrator which provides a narrow positive going pulse at the base of Q3 every 50µs, discharging the capacitor C4 which recharges via the 2k7 resistor, providing a ramped voltage to the base of Q6.

Q9 and Q10 compare the reference voltage from the ZN423 with a portion fo the regulator's output voltage, derived from a potentiometer. This potentiometer is the output voltage adjustment. It is inadvisable to use a zener instead of the ZN423 as its slope resistance will react badly to changing battery voltages.

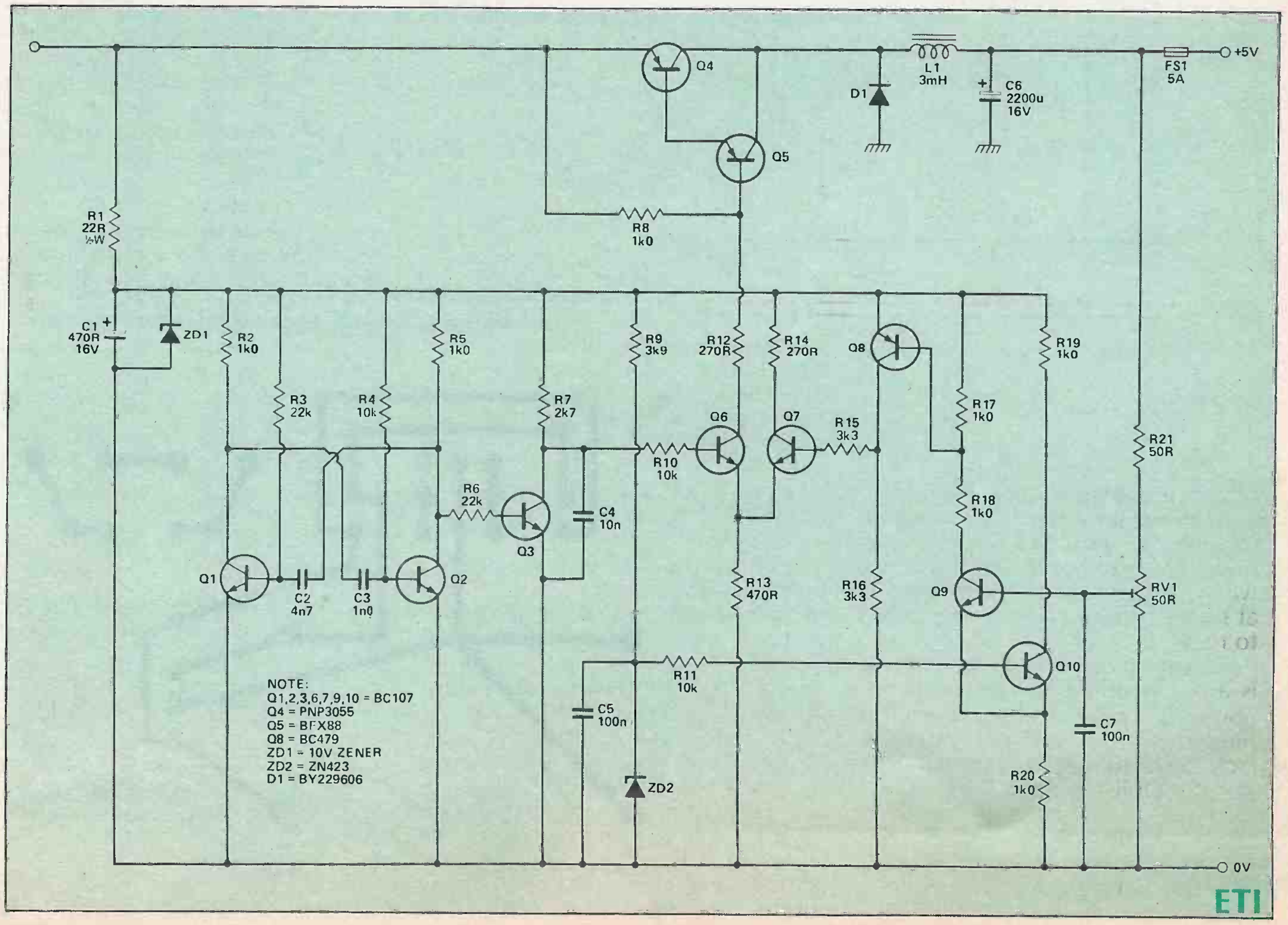
As the potentiometer wiper voltage tends to rise above the reference voltage, Q8 turns on, and the ramp at the base of Q6 has to rise further to match the voltage on the base of Q7. This delays the turning on of the Darlington pair, Q4 and Q5, resulting in a narrower power output pulse to the choke. This in turns lowers the output voltage (a process known, of course, as pulse width modulation). The frequency of operation is nominally 20kHz but can vary quite a bit with drifting or falling battery voltages.

Although I have specified a BY229-600 for the catch diode, in the prototype I used an ordinary high current rectifier which seemed to be all right. Perhaps 20kHz is not too much for these devices. Most of the wasted energy goes into heating up Q4, which should have a heat sink to suit.

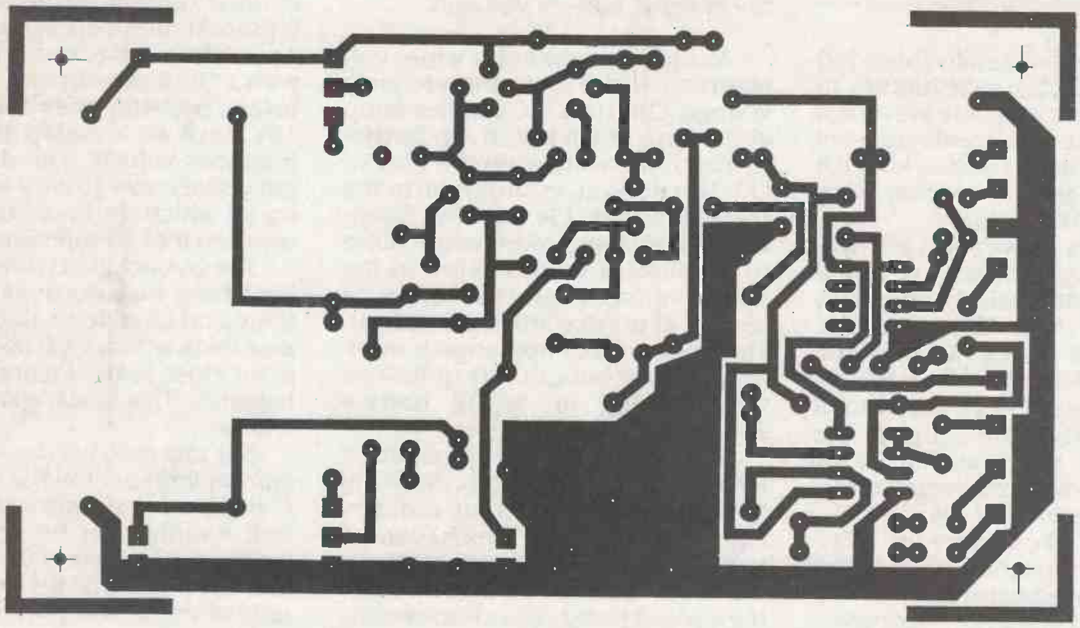
The output voltage feedback attenuator uses 50R resistors in order to draw 50mA from the output. This is the minimum to maintain stability. As an alternative, shunt the output with a 100R resistor and use a resistor and potentiometer of up to about 10k each to develop the correct feedback voltage. The drop in output voltage was 200mV when drawing 5A which works out to an output resistance of 40 milliohms

The ground points shown in heavy lines have high currents flowing to them and need to be tied back with nice thick wiring, PCB track, etc, to a point close to the incoming battery negative. This is standard practice, really.

No attempt has been made to current limit or crowbar the output. Crowbars are simple to rig and current limiting can be achieved by pulling up the base of Q9 somehow, thereby lowering the mark space ratio of the power pulses.

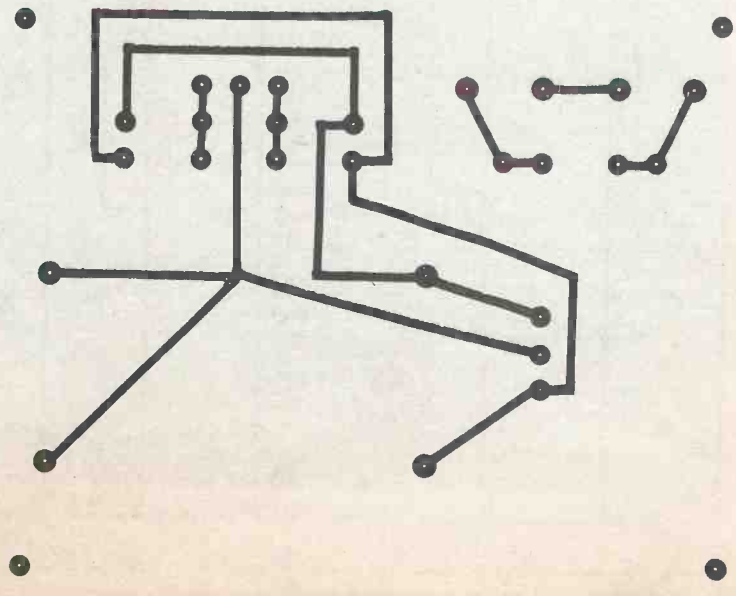


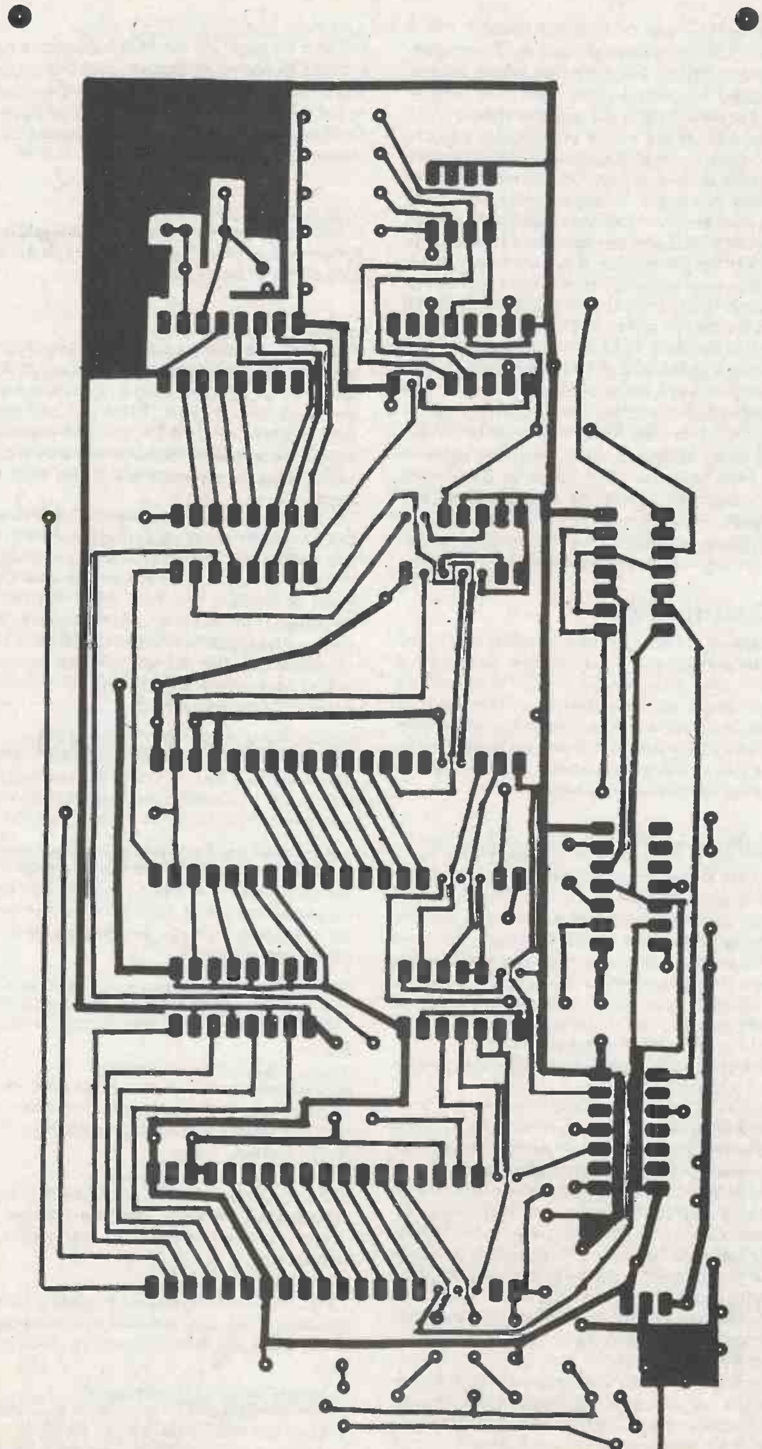
PCB FOIL PATTERNS

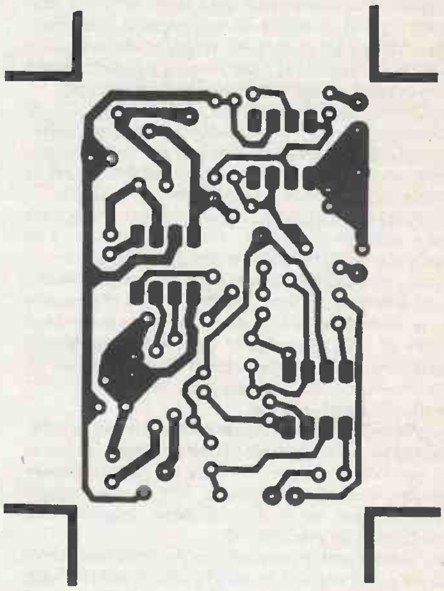


The foil pattern for the JLLH PA amplifier board.

The foil patterns for the Baud Rate Convertor main board (opposite) and the optional PSU board (below).







The pattern for the Microlight Intercom board.

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- We undertake to do our best to answer enquiries relating to difficulties with ETI projects, in particular non-working projects, difficulties in obtaining components, and errors that you think we may have made. We do not have the resources to adapt or design projects for readers (other than for publication), nor can we predict the outcome if our projects are used beyond their specifications;
- Where a project has apparently been constructed correctly but does not work, we will need a description of its behaviour and some sensible test readings and drawings of oscillograms if appropriate. With a bit of luck, by taking these measurements you'll discover what's wrong yourself. Please do not send us any hardware (except as a gift!);
- Other than through our letters page, Read/Write, we will not reply to enquiries relating to other types of article in ETI. We *may* make some exceptions where the enquiry is very straightforward or where it is important to electronics as a whole;
- We receive a large number of letters asking if we have published projects for particular items of equipment. Whilst some of these can be answered simply and quickly, others would seem to demand the compiling of a long and detailed list of past projects. To help both you and us, we have made a full index of past ETI projects and features available (see under Backnumbers, below) and we trust that, wherever possible, readers will refer to this before getting in touch with us.
- **We will not reply to queries that are not accompanied by a stamped addressed envelope** (or international reply coupon). **We are not able to answer queries over the telephone.** We try to answer promptly, but we receive so many enquiries that this cannot be guaranteed.
- Be brief and to the point in your enquiries. Much as we enjoy reading your opinions on world affairs, the state of the electronics industry, and so on, it doesn't help our already overloaded enquiries service to have to plough through several pages to find exactly what information you want.

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Write For ETI

We are always looking for new contributors to the magazine, and we pay a competitive page rate. If you have built a project or you would like to write a feature on a topic that would interest ETI readers, let us have a description of your proposal, and we'll get back to you to say whether or not we're interested and give you all the boring details. (Don't forget to give us your telephone number).

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OOPS!

Corrections to projects are listed below and normally appear for several months. Large corrections are published just once, after which a note will be inserted to say that a correction exists and that copies can be obtained by sending in an SAE.

Low Cost Audio Mixer (June 1985)

In Fig. 6 on page 39, the PCB foil pattern has been incorrectly shown as though from the copper side. The board is shown correctly from the copper side in the foil pattern pages. In Fig. 10 on page 40, the positive power rail at lower left should be shown connected to pin 8 of the TL072s, IC1-5).

Noise About Noise (July 1985)

In Fig. 5 on page 24, no connection should be shown between the cathode of the diode and the negative side of the 470u capacitor.

Printer Buffer (July 1985)

The case specified is actually larger than the one used for the prototype. It will, of course, work perfectly well, but if you want to a compact unit use a Verocase 202-21038H (180 x 120 x 65mm) rather than a Verocase 202-21035. The regulator IC17 should be bolted to the back of the case to provide heatsinking or, alternatively, fitted with a TO220 heatsink.

Please note that the designer, Nick Sawyer, has been in touch to inform us that the refresh problem we mentioned in September ETI is dealt with in the printer buffer software. In this case there is no need to replace the TMS 4416 dynamic RAMs, although as far as we know the replacement parts mentioned (Hitachi HM48416 DRAMs) will cause no problems. The full text of Nick Sawyer's letter will appear next month. Meanwhile, our apologies for any confusion caused.

Cortex Parallel I/O (September 1985)

Pins 1 and 2 of IC2 have been swopped over on both the circuit diagram (Fig. 1) and the Veroboard overlay (Fig. 2). Pin 1 should connect to pin 16 on the header and pin 2 should connect to pin 2 on the header.

Intel 8294 Data Encryption Unit (September 1985)

It should be apparent from the text, page 35, that an actual program has been omitted. This program is for use with the SDK 8085 kit only, and copies may be obtained from us on receipt of a stamped addressed envelope.

Tech Tips — Novel Input Stage (October 1985)

The caption against the lower figure should read "Low noise output at *minimum* gain", not maximum gain.

Chorus Unit (November 1985)

IC3 is shown on the circuit diagram on page 49 connected to the 9V supply. It should be connected to the 5V supply. The foil pattern connections to this IC are correct.

Foil Patterns (November 1985)

The foil patterns for the Modular Test Equipment Waveform Generator and the Chorus Unit are shown from the component side rather than the copper side.

The Rhyth-ROM (November 1985)

R2 has been omitted from the parts list on page 35. It's value is 39k, as given on the circuit diagram. Also in the parts list, R821 should, of course, read R8-21.

Cymbal Synth (November 1985)

R18 is labelled as R20 on the circuit diagram (page 59) and the real R20 is missing altogether. It should be shown connected between the base of Q3 and the +ve rail. The overlay diagram is correct in both cases.

Digibaro (February 1986)

Capacitors C1, C3, C5 and C7 should be 470u 25V types as shown on the circuit diagram, not 47u 25V types as stated in the parts list. We have also been told that one of the companies mentioned in Buylines, Hawke Electronics, no longer supply the MPX100a pressure transducer. The other company recommended, Macro Marketing, should still be able to help.

REVIEWS — BOOKS

68000 User Guide
Lionel Fleetwood. Price: £8.95
Sigma Press, 5 Alton Road, Wilmslow, Cheshire.

The Sinclair QDOS Companion
Andrew Pennell. Price: £6.95

Inside The Sinclair QL
Jeff Naylor and Diane Rogers Price: £6.95

Sunshine Books, 12-13 Little Newport St., London WC2H 7PP.

68000 Machine Code Programming
David Barrow. Price: £12.95
Collins, 8 Grafton Street, London W1X 3LA.

Having looked at some basic books for the QL (pun intended), we now move on to the heart of the matter — the 68008 and Sinclair's own operating system, coyly titled QDOS.

The growth in the number of relatively low cost computers using the 68000-series processors (not least, the QL) means that there will be a corresponding growth in the number of books to support the series. Most of them will pursue comprehensiveness, while some will hope to prepare new and established programmers for the '68000 Revolution'.

68000 Machine Code Programming

This is quite a large book by paperback standards and the price is correpondingly large. As the title suggests, the book is concerned with the 68000, the 68008, the 68010, and it also contains a large amount of information on the immensely powerful 68020.

It is a very comprehensive reference work, comprising all the essential information on the processors, and a whole lot more. Among other things, the book contains details of the internal architecture and data organisation of the chips, a summary of the addresing modes, exception handling, supervisor mode, assembler directives and 68020 emulation on the other 68000s.

Other interesting features of this family of ICs are discussed, for example, concurrent bus and CPU activitiy, pipelined decoding and cache memory.

Around 60% of the book is given over to appendices, which are dominated by two very large sections describing the 68000/8/10 and the 68020 instruction sets respectively.

If you have experience of machine code on other processors and want to move to the Motorolas then you will probably need to read another book before tackling this one. However, as a reference manual for a 68000 programmer or for someone moving from the smaller 68000 chips to the 68020, the book may prove invaluable.

68000 User Guide

Which can't be said for this one.

This book contains a 68000 overview and programming model, a brief look at some of the more universal assembler directives and conventions, a reasonable explanation of only the more frequently used op-codes and some general programming advice with unusual examples.

For a newcomer to machine code, the op-code chapter describes a subset of the instruction set quite well. Unfortunately, the examples given are usually in 'structured idea' form rather than ready for typing into an assembler.

In fact, the author has tried to include too many topics in this short book and, in doing so, has sacrificed useful detail. No one topic is covered very thoroughly and most seem, at times, confusing.

The style is generally lighthearted, with some very strange programming examples. The book is certainly not a complete 68000 user guide, treating some of the more powerful features of the processor all too briefly and some not all all, and is neither a proper user guide nor a preparatory tome for the coming revolution.

The 68000 may be old-hat to some, in the shape of the QL's 68008, a cut-down version of the full machine featuring an 8-bit data bus for downward compatibility and an internal architecture like that of its big sister for upward compatability. So let's prise open the QL box and take a look inside.

Inside The Sinclair QL

This book — another in Sunshine's growing QL library — purports to be our guide beneath the keyboard. It is divided into two parts.

The first deals with the fundamental principles of digital electronics, at a level suitable for people with very little or no knowledge of computer or any other sort of hardware. The text begins by attempting to describe the very nature of electricity, as we currently (!) theorise it. It then moves through logic gates (!) to show how TV pictures and sound are generated, ending up with a description of microprocessors and their associated systems.

The second section deals specifically with QL, and is more to do with software than hardware, or to be more precise, 68000 assembly language. With this switch, the book also changes for a considerable time from 'educational' to reference format. Actually, some useful hardware information about the QL is included.

The text keeps our interest while explaining various aspects of computer operation. This is a simplified description of a very complex piece of equipment and is suitable only as an introductory text for someone who would like to learn about the basics of computing electronics.

The Sinclair QDOS Companion

The professional programmer will be more interested in this — especially since it aims to give real help.

One of the problems of writing commercial software for Sir Clive's micros is that he too often decides to release a slightly revised computer. As like as not, your machine code, instead of proving the ultimate in cheque book reconciliation, merely crashes. One way around this, of course, is to rewrite the whole program, making slight changes here and there.

A far better way — on the QL, at least — is to write your machine code in the first place using QDOS.

The aim of 'The QDOS Companion' is to enable you to do just that. Of course, using QDOS has other advantages. Why write a program to print a character to the screen for example, when such a routine already exists in the ROM and is easily accessible through QDOS?

The book is basically a list of all the QDOS calls that can be made, explaining the parameters needed to enter, the parameters returned from the routine, the function of the routine and so on. This comprehensive list can be divided into a number of sections: multitasking; the 8049 second processor (used for sound production and reading the keyboard); input and output (including microdrives); device drivers; exceptions; interrupts and the job scheduler; and QDOS ultilities

Other useful information includes how to add procedures to SuperBASIC, a complete list of the system variables and memory and microdrive maps.

This reference book will certainly be of value to anyone tho owns a QL and understands 68000 assembly language.

Leigh Chappell

OPEN CHANNEL

As reported last month, big blue IBM declined to join the Corporation for Open Systems, the group set up by a number of American computer manufacturers to define and implement standards which would conform to open systems interconnection (OSI). The idea of OSI is that any computer conforming to it will be able to talk to any other similarly conforming computer.

Now, in a distinctly embarrassing about-face, IBM have decided that a unified opposition to their own systems network architecture (SNA) would be too much too compete with and have joined COS.

In a similarly eye-opening move here in the UK, IBM have managed to weasel their way into a Department of Trade and Industry sponsored project to develop software which will test whether computers conform to the OSI standard.

I'm sorry to be cynical but I'm sure the only reason why IBM have conducted such turnarounds is that there's gold in them thar hills. If IBM had thought for one minute that their SNA standard could win the day, they would have had no hesitation in maintaining it and making full use of patents, copyrights, royalties etc, in leasing the system to competitors. As the situation now stands, IBM will probably still be able to maintain their piece of the pie with SNA by using delaying tactics within the organisations they have decided to join — it will be many years before OSI finally takes off, remember. Oh well, if you can't beat 'em ...

Just Another Socket In The Wall

It looked, for a time, as if Oftel was getting to grips with British Telecom and was managing to gently persuade it to liberalise everything for the benefit of the customer. In a recent document, however, Oftel has suggested that, although domestic telephone extension wiring could be done by BI's competitors, wiring of the master socket (the first socket on the user's premises) would still be in BT's hands.

At first sight, this seems logical — it's BT's line and obviously they don't want any old Tom, Dick or Harry sticking an unauthorised connector on the end of it, wilfully or negligently committing damage. After all, BT will willingly come and install master and extension sockets for the user.

On the other hand, you have to consider what happens when you ask BT to do the job for you. First, it often takes a while for them to get their act together and send an engineer out to your house (the time span is better than it used to be, but we're still talking of up to a week or so). Second, you get a whopping great bill for a job that shouldn't cost even one fifth of the amount!

If BT maintains a monopoly on this condition, only BT benefits (that's what a monopoly is all about, isn't it?). The customer is overcharged and BT's competition is forced out of some essentially worthwhile work. After all, there is no reason why qualified private engineers couldn't do the conversions, and there is no reason why master sockets which the private engineers fit shouldn't be of a sufficiently high standard not to do damage (the other sockets which private contractors *would* be allowed to fit presumably are).

Come on, Oftel. Do the work you're supposed to do.

DBS

Finally, the Home Office has decreed that a non-British satellite may be used to broadcast British DBS television channels. This may seem like a small concession, but the previous insistence on all British systems is the main reason why we haven't already got the originally proposed DBS service. As it happens, the British satellite manufacturers up to now haven't been able to provide a satellite which will make an economic proposition of DBS television. Perhaps this change of heart by the Government will make them see the folly of their ways. If they can't reduce costs, then the programme providers will go elsewhere.

About the time you read this, an advertisement will probably appear in the national press requesting potential operators of the DBS service. Later this year the operator who gets the job will be announced. Then, in only another three years (yawn, yawn) we may, just may, have DBS.

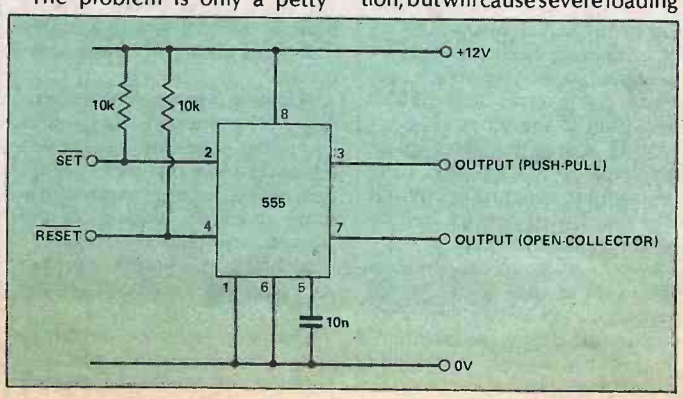
Keith Brindley

TRAINS OF THOUGHT

Watch television in the same house as an operating model railway and you will soon be well aware of the amount of electrical noise they generate. Turn the light off in the railway room leaving the trains running and you will see the multitude of spark-gap transmitters responsible, aided by their direct coupling to a most effective antenna system, the track! Some proprietary model locomotives incorporate so-called 'suppressors' — in practice just small capacitors in parallel with the motor — but they do little to alleviate the problem.

The problem is only a petty irritation until you try to operate certain kinds of logic circuit close to the layout. Circuits using TTL flip-flops may prove so susceptible to spurious sets and resets as to be useless. The trouble is that TTL flip-flops can be tripped by pulses as low as 1V, and with 12V motors whizzing around on circuits all too prone to interruption, transients of 1V occur quite frequently.

So what can we do? Keeping the track, the locomotive wheels and power pick-ups scrupulously clean undoubtedly helps to reduce the amount of sparking but is most unlikely to eliminate all of it. Connecting 47R resistors in series with 100R capacitors between the rails at intervals of 2 ft (600 mm) will reduce the amount of electromagnetic radiation, but will cause severe loading



PLAYBACK

Question: *What sort of a noise annoys an oyster?* An up-dated version of this old chestnut could be: *what sort of a noise annoys an audiophile?* Noise has been one of the principal annoyances associated with sound reproduction from the earliest days. This is why noise specifications figure prominently in the specifications quoted for various items of equipment.

One of the chief sources of noise has been recording tape. Early examples had high noise levels, and wide tracks travelling at high speed were the only means of reducing noise at source whilst maintaining a reasonable high frequency response. The compact cassette would have been impossible with the tape then in use.

To 'B' Or . . .

To reduce tape noise various noise-reduction systems were introduced. The best-known of these is Dolby B which is found on the majority of tape decks. This functions by increasing the recording gain of sounds below a certain level and within a particular frequency range, then reducing the same ones at playback. That restores the original proportion, but reduces anything that appeared between recording and playback, such as tape noise.

Though apparently an ideal solution, there are, as always, snags. Identical levels must be presented to the recording and playback processors or variations of frequency repsonse will result. Level differences can result from various causes including using another brand of tape. There can be modulation of the noise, and also of frequencies occuring simultaneously that are outside of the processed band. furthermore, as all circuits containing active components add distortion, the noise reduction circuitry can be no exception.

There are other noise-reduction systems such as Dolby C (which operates over a wider band), dbx, High Com, and ANRS, all of which have appeared on domestic recorders. These all have their good and bad points, but even the bad systems have been accepted as being preferable to the noise.

While all this has been going on, tape development has been steadily moving ahead. Numerous small improvements in particle shape, size, dispersion and other features have added up to significant improvements in performance, including a notable reduction in noise.

Noises Off

You can check this for yourself. Record about a minute of silence on a high-grade tape with the recording level control right back. Now replay it at normal setting of the volume control, turning up the control until noise can be heard. This is the combined effect of all noise sources. Next, depress the pause control. The noise you now hear is that mainly due to the pre-amp circuits, the difference being that contributed by the tape. In many cases, especially in 'medium-fi' equipment there is only a marginal difference between the two levels.

So, tape noise may now be only a small part of the total. This raises the question: are noise-reduction circuits with their inherent drawbacks any longer necessary? Have they outlived their usefulness? If you record BBC music concerts you will find another type of noise far more annoying — audience noise! Which brings us back to our opening question. The answer if you haven't heard it before is: *A noisy noise annoys an oyster*; and some audiences can be very noisy!

Vivian Capel

of high-frequency train lighting systems (or high-frequency track circuiting). Perhaps the best bet is to accept that electrical noise is a concommitant of model railways and to employ flip-flops purpose-designed for noisy environments.

One of my favourite techniques is our old friend the 555 timer, configured as an interval timer whose period is infinity. Ground the timing circuit input (pin 6) and use the trigger and reset inputs (pins 2 and 4 respectively) to set and reset the device. The 555 needs a pulse of Vcc/1.5 to trip it, so it is pretty reliable when operated from a 12V supply. I've never had any spurious sets or resets with one. Its push-pull output (pin 3) can usefully sink or source up to 200mA, and the discharge path (pin 7) is uncommitted, allowing it to serve as an open-collector duplicate of the output which can interface to TTL inputs irrespective of the 555's supply voltage.

Of course, if this isn't satisfactory, you can always eliminate the source of interference. Let your trains use clockwork or live steam motive power! And if those are a bit too exotic for your tastes, you can always do as one of my friends does — run electrically-powered trains from on-board NiCad cells via a radio-controlled speed circuit!

Roger Amos

ALF'S PUZZLE

Passing Alf's workbench one day, we all noticed an interesting looking circuit diagram on a scrap of paper. 'What is it, Alf?' we asked. Alf replied that it was something he had invented, but he couldn't remember what it did. A simplified version of the circuit is shown in Fig. 1. The coffee stains and half a fish-paste sandwich have been omitted for clarity. What do you think it could be?

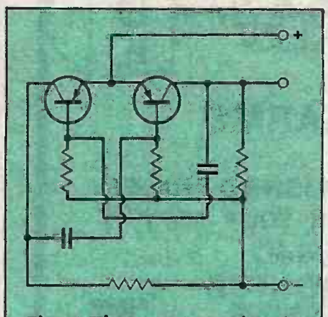


Fig. 1 The mystery circuit

When we first decided on a puzzle for the April issue, it was going to be slightly different from the one that actually appeared. It was going to begin with a capacitor charged up to 10V, which would then be connected with another capacitor of the same value. The text-book formulae would show that either some charge had been gained or some energy lost in the process.

The answer would have been that energy was lost because the first capacitor would be effec tively short-circuited by the second, so losses would occur in the form of a spark, say, on heating of the capacitor leads.

At the last moment, Alf decided to confuse the issue further by using four capacitors. We thought that would make no difference to the answer. But when we came to look at the puzzle again, we found that Alf had accidentally invented a new one! The odd effects that occur when you short one capacitor with another will do to explain the discrepancy in the puzzle as it was presented, but suppose that Alf had simply started off with the series-parallel arrangement of capacitors and compared them to a single capacitor (Fig. 2)?

The arrangement of capacitors in Fig. 2a should have the same value as the single capacitor in Fig. 2b. If we do a quick calculation of the total energy of Fig. 2a, it comes to 25µJ for each capacitor, or 100µJ total, the same as for the single 2µF capacitor. The charge, however, would appear to be 10µC for each capacitor in Fig. 2a, making a total of 40µC, as opposed to 20µC for the single capacitor in fig. 2b.

If the series parallel arrangement stores twice as much charge as the single capacitor, how can they be equivalent? Wouldn't it take twice as much current for a given time to charge Fig. 2a to 10V as it would for Fig. 2b? what is going on?

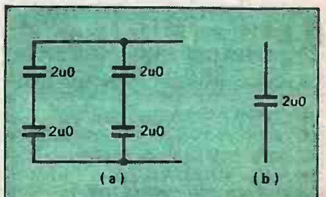


Fig. 2 Last month's puzzle?

As the rules of Alf's puzzle say that we only have to give one answer each month, we're not going to tell you. If anyone would like to write in with a solution to this little mystery, we will publish the best answer (it must be clear enough to be understood by a ten year old and convincing enough to persuade the most sceptical) and as an added incentive the author of the published reply will receive a prize of £10.

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Einstein

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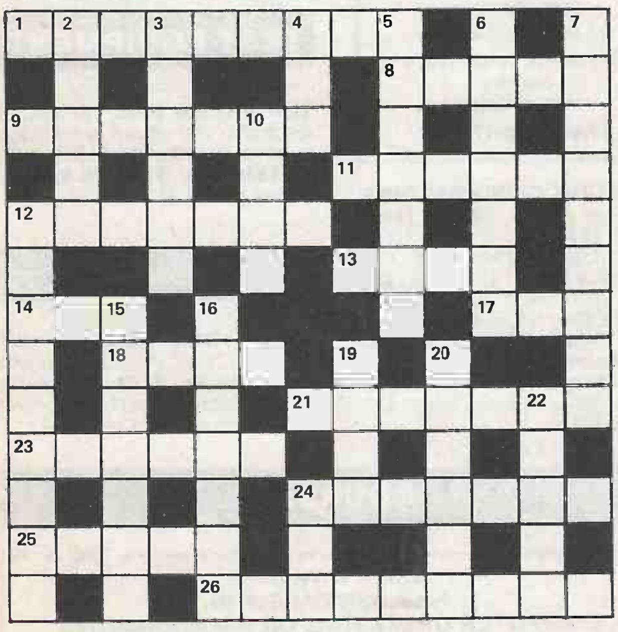

ACROSS

1) Make attractive to ferrous metals (9).
8) Computer peripheral, for converting desk top movement into cursor movement (5).
9) Method of manufacture of sturdy aluminium boxes (3-4).
11) Two channel (6).
12) Another name for an aerial (7).
13) Gas commonly used in high voltage lamps (4).
14) Commodore's famous desk top micro (3).
14) 40% of solder (3).
18) Standard equalization curve for phono signals (1,1,1,1).
21) Light-pen-detectable data found on products on supermarket shelves (7).
23) One of the qualities of a musical note — not pitch or loudness (6).
24) Standard transistor technology as opposed to, say, field-effect (7).
25) One-way conductor? (5).
26) Storing data or audio signals on magnetic tape (9).

DOWN

2) Adjust IF stages to peak performance (5).
3) Rechargeable batteries use this with cadmium (6).
4) World-wide manufacturer of electronic components and domestic electronics (1,1,1).
5) One third of a transistor? (7).
6) It flows (7).
7) Oscillation at a natural, inherent frequency or one of its harmonics (9).
10) Coordination signal so that two or more circuits are triggered or oscillate independently but mutually (4).
12) Another term for signal level.
13) Variable resistor, but board mounted and only used in setting up the quiescent state of a circuit (7).
16) HF signal on which an LF signal is super-imposed (7).
19) Most common type of aerial used in television reception (4).
20) A relay in the collector circuit of a power transistor may be called this (1, 1, 4).
22) FET terminal (5).
24) Type of UHF connector (1,1,1).

Solution to Crossword No. 3

Across
1) Female
5) Banana
8) Headphone
9) Coil
10) Steel
11) Spool
14) Hiss
15) ABS
16) Open
18) Tuner
19) PROMS
20) Ears
22) Wirewound
23) Access
24) Needle

Down
2) Electric
3) Address Bus
4) Echo
5) Band pass
6) Algol
7) Apple
9) Colour code
12) Base bias
13) Terminal
17) Tesla
18) Triac
21) Neon.

No. 4 Solution next month

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