An Argus Specialist Publication

electronics today

INTERNATIONAL

AUGUST 1984 95p

DO THE TEST!

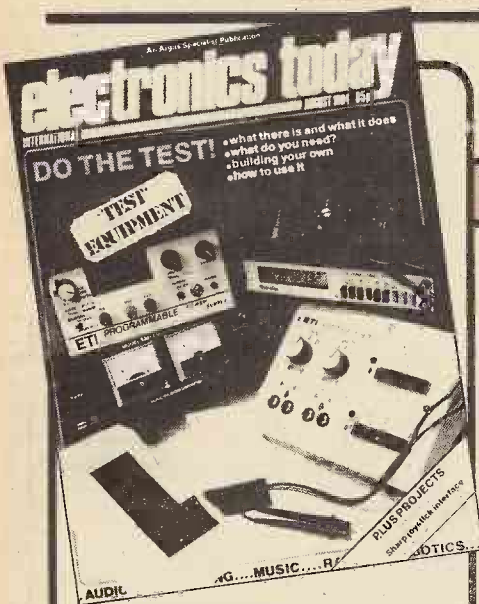
- what there is and what it does
- what do you need?
- building your own
- how to use it

PLUS PROJECTS
CMOS tester
Sharp joystick interface
JLLH power amp PSU

.AUDIO....NG....MUSIC....RA...BOTICS...

electronics today

INTERNATIONAL AUGUST 1984 VOL 13 NO 8



Dave Bradshaw: Editor
Phil Walker: Project Editor
Ian Pitt: Editorial Assistant
Jerry Fowler: Technical Illustrator
Paul Stanyer: Ad. Manager
Lynn Collis: Copy Control
Ron Harris B.Sc: Managing Editor
T.J. Connell: Chief Executive

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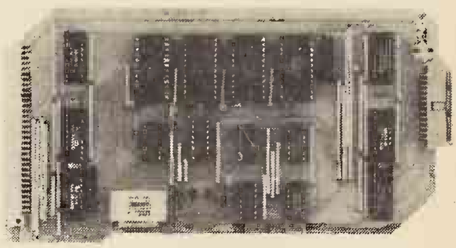
Telex 8811896.

FEATURES

PROJECTS



INFORMATION

SWITCHES

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

SUB-MIN TOGGLE

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

SLIDE 250V:

DPDT 1A	**14p**
DPDT 1A c/off	**15p**
DPDT ½A	**13p**

PUSHBUTTON 6A
with 10mm Button

SPDT latching	**150p**
DPDT latching	**200p**
SPDT moment	**150p**
DPDT moment	**200p**

Mini Non Locking

Push to Make	**15p**
Push to Break	**25p**

DIGITAST Switch
Assorted Colours
75p each

DIP SWITCHES

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

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

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

ROTARY: (Mak-a-switch)
Make a 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**

GAS/SMOKE DETECTORS
TGS812 or TGS813
£6 each

JUMPER LEADS (Ribbon Cable Assembly)

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

IDC Female Header Socket Jumper Leads 36"

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

VEROBOARD 0.1in

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

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

PROTO DECs

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

VERO WIRING PEN

+ spool	**380p**
Spare spool	**75p**
Combs	**8p**

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

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

ULTRASONIC TRANSDUCER
40KHz **475 pr**

COPPER CLAD BOARDS

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

DILL SOCKETS

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

EDGE CONNECTORS

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

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

ANTEX SOLDERING IRONS

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

IDC CONNECTORS

	PCB with Pins Strt	Plugs latch Pins Angle	Female Header Plug	Female Card Edge Conct
10 way	**90p**	**99p**	**85p**	**120p**
16 way	**130p**	**150p**	**110p**	—
20 way	**145p**	**168p**	**125p**	**195p**
26 way	**175p**	**200p**	**150p**	**240p**
34 way	**205p**	**236p**	**160p**	**320p**
40 way	**220p**	**250p**	**180p**	**340p**
50 way	**235p**	**270p**	**200p**	**395p**
60 way	—	—	**230p**	**495p**

EURO CONNECTORS

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

DIL PLUG (Header)

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

ZIF DIL SOCKETS

24 pin	**585p**
28 pin	**750p**
40 pin	**845p**

RIBBON CABLE
price per foot

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

'D' CONNECTORS

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

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

25 way 'D' CONNECTOR (RS232)
Jumper Lead Cable Assembly

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

AMPHENOL PLUGS

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

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

CRYSTALS

32.768KHz	**100**
100KHz	**235**
200KHz	**265**
455KH	**370**
1MHz	**275**
1.008M	**275**
1.28MHz	**390**
1.6MHz	**395**
1.8MHz	**515**
1.8432M	**250**
2.0MHz	**225**
2.4576M	**200**
3.12MHz	**240**
3.278M	**150**
3.5794M	**98**
3.6864M	**300**
4.0MHz	**150**
4.032MHz	**290**
4.19430M	**200**
4.433619M	**100**
4.608MHZ	**200**
4.80MHz	**200**
5.0MHz	**160**
5.185MHz	**300**
5.24288M	**390**
6.0MHz	**140**
6.144MHz	**150**
6.5536MHz	**225**
7.0MHz	**150**
7.168MHz	**250**
7.7328MHz	**250**
7.68MHz	**200**
8.0MHx	**150**
8.089333M	**395**
8.86723M	**220**
9.00MHz	**200**
10.0MHz	**175**
10.24MHz	**200**
10.5MHz	**250**
10.7MHz	**150**
12.0MHz	**175**
12.528M	**300**
14.31814M	**170**
15.0MHz	**240**
18.0MHz	**220**
18.0MHz	**180**
18.432M	**150**
19.968MHz	**150**
20.0MHz	**200**
24.0MHz	**170**
24.830MHz	**325**
26.69M	**150**
27.648M	**170**
27.145M	**180**
38.6667M	**240**
48.0MHz	**240**
100.0MHz	**295**
116.0MHz	**300**

RELAYS

Miniature, enclosed, PCB mount.

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

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

ASTEC UHF MODULATORS

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

BUZZERS

miniature, solid-state 6V, 9V & 12V	**70p**
PIEZO TRANSDUCERS PB2720	**70p**

LOUDSPEAKERS
Miniature, 0.3W- 8
2in, 3¼in, 2⅝in, 3in **80p**
2½in 40, 64 or 80 **80p**

TRANSFORMERS

3-0-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V @ 100mA **98p**
pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A **235p**
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A, 2x15V-0.2A **280p**
Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A **250p**
12VA: 2x4.5V-1.3A; 2x5V-1A; 2x9V-0.6A, 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A **345p** (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A, 2x15V-0.8A; 2x20V-0.6A **385p** (60p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A **520p** (60p p&p)
Specially wound for Multirail computer PSUs
50VA: Outputs +5V/5A; +12V, +25V, −5V, −12V at 1A **620p** (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A; 2x50V-1A **965p** (75p)

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

VOLTAGE REGULATORS
1A TO220 Plastic Casing

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

100mA TO92 Plastic package

5V	78LO5	**30p**	79LO5	**50p**
6V	78LO6	**30p**	—	—
8V	78LO8	**30p**	—	—
12V	78L12	**30p**	79L12	**50p**
15V	78L15	**50p**	79L15	**60p**

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

SOLDERCON PINS
Ideal for making SIL or DIL Sockets

100 pins	**75p**
500 pins	**350p**

ALUM BOXES

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

MONITORS

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

Carriage £7 Securicor

BROTHER HR15 PRINTER

A high quality Daisy Wheel printer at the price of a Dot Matrix printer.

Price £349

CMOS

4000	**20**	4072	**25**	4536	**275**
4001	**25**	4073	**26**	4538	**80**
4002	**25**	4075	**25**	4539	**90**
4006	**75**	4076	**88**	4541	**95**
4007	**25**	4077	**25**	4543	**70**
4008	**60**	4078	**25**	4544	**150**
4009	**45**	4081	**25**	4548	**40**
4010	**60**	4082	**25**	4549	**400**
4011	**25**	4085	**60**	4553	**245**
4012	**25**	4086	**60**	4554	**180**
4013	**60**	4089	**125**	4555	**35**
4014	**60**	4093	**37**	4556	**55**
4015	**60**	4094	**70**	4557	**250**
4016	**40**	4095	**95**	4558	**120**
4017	**60**	4096	100	4559	**395**
4018	**60**	4097	**275**	4560	**180**
4019	**58**	4098	**80**	4561	**104**
4020	**90**	4099	**110**	4562	**350**
4042	**43**	4160	**95**	4566	**165**
4021	**58**	4161	**96**	4568	**250**
4022	**67**	4162	**96**	4569	**175**
4023	**30**	4163	**96**	4572	**45**
4024	**50**	4174	**96**	4580	**255**
4025	**22**	4175	105	4581	**125**
4026	**90**	4194	105	4582	**99**
4027	**43**	4408	**850**	4583	**100**
4028	**45**	4409	**850**	4584	**60**
4029	**75**	4410	**725**	4585	**70**
4030	**35**	4411	**750**	4597	**330**
4031	**130**	4412	**805**	4599	**155**
4032	**70**	4415	**590**	40085	**90**
4033	**130**	4419	**280**	40097	**45**
4034	**146**	4422	**770**	40098	**42**
4035	**70**	4435	**850**	40100	**215**
4036	**275**	4440	**900**	40101	**130**
4037	**115**	4450	**360**	40102	**140**
4038	**75**	4451	**350**	40103	**412**
4039	**280**	4490	**450**	40104	**120**
4040	**60**	4500	**395**	40105	**220**
4041	**57**	4501	**38**	40106	**60**
4042	**50**	4502	**60**	40107	**55**
4043	**42**	4503	**40**	40108	**325**
4044	**50**	4504	**99**	40109	**100**
4045	**110**	4505	**385**	40110	**235**
4046	**60**	4506	**100**	40114	**240**
4047	**60**	4507	**45**	40161	**194**
4048	**55**	4508	**130**	40163	**75**
4049	**38**	4510	**55**	40174	**75**
4050	**35**	4511	**55**	40175	**75**
4051	**45**	4512	**55**	40181	**220**
4052	**80**	4513	**150**	40182	**80**
4053	**60**	4514	**115**	40192	**75**
4054	**85**	4515	**115**	40193	**95**
4055	**85**	4516	**55**	40194	**70**
4056	**85**	4517	**275**	40195	**75**
4057	**1000**	4518	**48**	40244	**196**
4059	**435**	4519	**32**	40245	**196**
4060	**68**	4520	**53**	40257	**196**
4061	**500**	4521	**115**	40373	**220**
4062	**986**	4522	**125**	40374	**220**
4063	**85**	4526	**60**	45106	**586**
4066	**45**	4527	**65**		
4067	**245**	4528	**68**		
4068	**25**	4529	**150**		
4069	**25**	4530	**90**		
4070	**25**	4531	**130**		
4071	**25**	4532	**65**		
		4534	**400**		

OPTO

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

OPTO ELECTRONICS

LEDs with clips

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

ISOLATORS

ILD74	145
ILQ74	275
TIL111/2/4	70
ILCT6 Darlington	135
4N33 Photo Darlington	136

7 Segment Displays

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

COMPUTER CORNER

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

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

SPECTRUM 32K UPGRADE

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

£18

SPECTRUM CENTRONICS/RS232 PRINTER INTERFACE

★ It was the first! It is still the best!
★ Centronics and BI-DIRECTIONAL RS-232 with full hand-shaking
★ Obeys SPECTRUM LLIST and LPRINT
★ Split-Speed Operation for RS-232.
(Use it to communicate with the BBC MICRO or OTHER PERIPHERALS)
★ Interface 1, Interface * & Microdrive compatible.
★ Configuration program creates customised M/C driver to suit your printer.
★ HI-RES screen dumps in 2 sizes on EPSON, SEIKOSHA, STAR, SHINWA, MANNESMAN TALLY, NEC, RITEMAN, KAGA etc This is a STANDARD FEATURE! Not an extra.
★ Compatible with TASWORD TWO and most professional programs

DISC DRIVES

(BBC Compatible)

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

5¼" **DISKETTES (Lifetime Warranty)**

- **10 3M Diskettes Single side Double density** **£17**
- **10 3M Diskettes Double side Double density** **£27**

N B Carriage on Drives £7 securicor

BBC & MICROCOMPUTER & ACCESSORIES

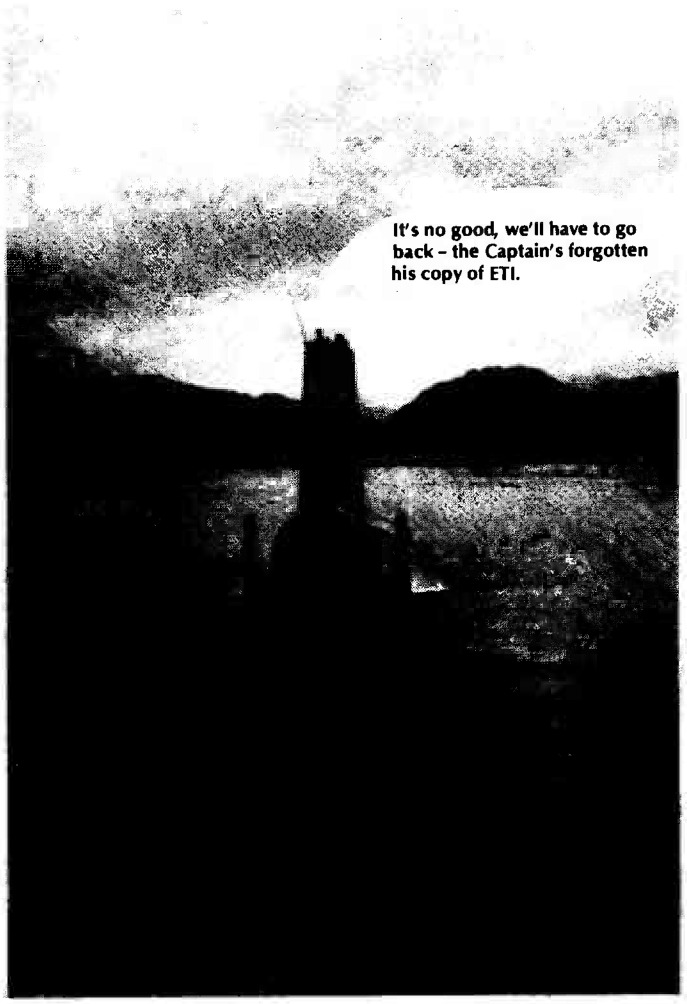
Model A .... **£299** Model B **£399** (incl VAT)
We stock the full range of BBC Micro peripherals, Hardware & Software like, Disc Drives (Top quality Cumana & Mitsubishi), Diskettes, Printers, printer, Paper, Interface Cable, Dust Covers, Cassette Recorder & Cassettes, Monitors, Connectors (Ready made Cables, Plugs & Sockets), Plotter (Graphic Tablet) EPROM Programmer, Lightpen Kit, Joysticks, Sideways ROM Board, EPROM Eraser, Machinecode ROM. The highly sophisticated Watford's 16K BEEB DFS, WORDWISE, BEEB-CALC, Software (Educational Application & Games), BOOKs, etc, etc, Please send SAE for our description leaflet.

NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION
electronics today INTERNATIONAL

EX42 KEYBOARD INTERFACE

As we said when we published the design for the EX42 printer interface, it seems a pity to have such a nice keyboard and not to make use of it. Well, now you can do, with this interface. Our next trick is to turn a ZX81 into a word processor... but don't hold your breath waiting for it!



SIREN UNIT

After doing all the feature articles in this issue (well, nearly all), Phil Walker was itching to get some dirt under his fingernails, and here's the result! The ETI banshee's wailing will scare the burglars away — it's designed to accompany the ETI Warlock, published last month, and there will be more details of how to use the two together or independently.

ACTIVE LOUDSPEAKER

Active loudspeakers have a lot to offer, especially if you can escape the 'esoteric' price tag by building them yourself. So it's hardly surprising that we have already published one or two designs for active speakers — and it will hardly be surprising if we carry on publishing designs, there's no such thing as the definitively 'right' loudspeaker.

DIGITAL CASSETTE DECK

Do you tire of the pain of using an audio cassette player to store your computer programs? Do you long for a cheap(ish), fast reliable method of storage yet begrudge the cost of a floppy? Well, the next issue of ETI will offer you the solution in the form of a digital cassette deck. The advantages of this design over a conventional audio deck are two-fold. Firstly, the cassette deck is solenoid controlled, and these will be operated directly from the computer, by means of a special-purpose interface. Secondly, by not having the conventional audio amplifier in the way, it can be designed to have a very much higher baud rate than the average tape system. However, this is not at the expense of compatibility with proprietary software.

ALL THIS AND MORE IN THE SEPTEMBER ISSUE OF ETI, ON SALE AUGUST 3RD. PLACE YOUR ORDER NOW, EVEN IF YOU'RE GOING ON HOLIDAY.

Huh! I can't afford a holiday, so the least you lot can do is buy the mag while I'm stuck here slaving away...

COMPUTER WAREHOUSE

1000's OF BARGAINS FOR CALLERS

THE 'ALADDIN'S' CAVE OF COMPUTER AND ELECTRONIC EQUIPMENT

HARD DISK DRIVES

Fully refurbished **DIABLO/DRE** series 30 2.5 Mb disk drives **DEC RK05, NOVA, TEXAS** compatible.
Front load. Free stand or rack mount **£550.00**
Exchangeable type (via lid removal) **£295.00**
me3029 PSU unit for 2 drives **£125.00**
DIABLO/DRE 44-4000A/B 5+5 ex stock from **£995.00**
1000's of spares for S30, 4000, 3200, HAWK ex stock.
Plus in house repair, refurbishing service.
Call for details or quotation.

HOT LINE DATA BASE

DISTEL©

THE **ORIGINAL FREE OF CHARGE** dial up data base 1000's of stock items and one off bargains.
ON LINE NOW - 300 baud, full duplex CCITT tones, 8 bit word, no parity
01-679 1888

COMPUTER 'CAB'

All in one quality computer cabinet with integral switched mode PSU, Mains filtering, and twin fan cooling. Originally made for the famous **DEC PDP8** computer system costing thousands of pounds. Made to run 24 hours per day the PSU is fully screened and will deliver a massive +5v DC at 17 amps, +15v DC at 1 amp and -15v DC at 5 amps. The complete unit is fully enclosed with removable top lid, filtering, trip switch, 'Power' and 'Run' LEDs mounted on Ali front panel, rear cable entries, etc etc. Units are in good but used condition - supplied for 240v operation complete with full circuit and tech. man. **Give your system that professional finish** for only £49.95 + Carr. Dim. 19" wide 16" deep 10.5" high. Useable area 16"w 10.5"h 11.5"d.
Also available **LESS PSU**, with FANS etc. Internal dim. 19"w. 16"d. 10.5"h. **£19.95**. Carriage & insurance £9.50.

EX STOCK INTEGRATED CIRCUITS

D8085AH-2	D8086	D8257-5
D8202	D8271	AM2764-3DC
74LS86	74LS112	74LS373
7407	2102-6	4116-3

CALL SALES OFFICE FOR PRICES

MAINS FILTERS

Cure those unnerving hang ups and data glitches caused by mains interference.
SD5A As recommended by ZX81 news letter matchbox size up to 1000 watt load **£5.95**
L2127 compact completely cased unit with 3 pin fitted socket. Up to 750 watts **£9.99**

COOLING FANS

Keep your hot parts COOL and RELIABLE with our range of **BRAND NEW** professional cooling fans.
ETRI 99XU01 Dim. 92 x 92 x 25 mm. Miniature 240 v equipment fan complete with finger guard. **£9.95.**
GOULD JB-3AR Dim. 3" x 3" x 2.5" compact very quiet running 240 v operation. **NEW £6.95**
BUHLER 69.11.22. 8-16 v DC micro miniature reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Measures only 62 x 62 x 22 mm. Current cost £32.00. **OUR PRICE ONLY £12.95 complete with data.**
MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 or 110 v at £4.95 or BRAND NEW 240 v at £10.50. 1000's of other fans Ex Stock. Call for Details. Post & Packing on all fans £1.60

SAVE £250 — SUPER PRINTER SCOOP

BRAND NEW CENTRONICS 739-2

The "Do Everything Printer" at a price that will **NEVER** be repeated. Standard **CENTRONICS** parallel interface for direct connection to **BBC, ORIC, DRAGON** etc. Superb print quality with full pin addressable graphics and 4 type fonts plus **HIGH DEFINITION** internal **PROPORTIONAL SPACED MODE** for **WORD PROCESSOR** applications. 80-132 columns, single sheet, sprocket or roll paper handling plus much more. Available **ONLY** from **DISPLAY ELECTRONICS** at the ridiculous price of **ONLY £199.00** + VAT Complete with full manual etc. Limited quantity -Hurry while stocks last.
Options. Interface cable (specify) for BBC, ORIC, DRAGON or CENTRONICS 36 way plg £12.50. Spare ribbon £3.00 each. BBC graphics screen dump utility program £8.60.
Carriage and Ins. £10.00 + VAT

ONLY £199

BUDGET RANGE VIDEO MONITORS

At a price YOU can afford, our range of **EX EQUIPMENT** video monitors defy competition!! All are for 240v working with standard composite video input. Units are pre tested and set for up to 80 col use on BBC micro. Even where MINOR screen burns MAY exist - normal data displays are unaffected.

1000's SOLD TO DATE

9" HITACHI very compact fully cased. dim. 21cm H x 21cm W x 22cm D. Black and white screen **£44.95**
12" KGM 320-321, high bandwidth input, will display up to 132 columns x 25 lines. Housed in attractive fully enclosed brushed alloy case. **B/W** only **£32.95** **GREEN screen £39.95**
24" KGM large screen black & white monitor fully enclosed in light alloy case. Ideal schools, shops, clubs etc. **ONLY £55.00**
14" BRAND NEW Novex **COLOUR** type **NC1414-CL.** Many exacting features such as RGB TTL and composite video input, **GREEN TEXT** key, internal speaker and audio amp. Even finished in BBC micro matching colours. Fully guaranteed **ONLY £199.00**
Carriage and ins on ALL videos £10.00

TRANSTEL PRINTERS

EX NEWS SERVICE compact, quality built 50 column matrix printer. Standard 5 bit serial, **BAUDOT CODE** current loop interface for connection to computer or radio receiver via simple filter network to decode and print most world-wide **NEWS, TELEX** and **RTTY** services. Supplied tested and in good condition with data, large paper roll and 50 and 75 baud xtals. **ONLY £49.95** Carr. £6.00

GE TERMIPRINTER

A massive purchase of these desk top printer -terminals enables us to offer you these quality 30 cps printers at a **SUPER LOW PRICE** against their original cost of over £1000. Unit comprises of full QWERTY, electronic keyboard and printer mech with print face similar to correspondence quality typewriter. Variable forms tractor unit enables full width - up to 13.5" 120 column paper, upper - lower case, standard RS232 serial interface, internal vertical and horizontal tab settings, standard ribbon adjustable baud rates, quiet operation plus many other features. Supplied complete with manual. Guaranteed working **£130.00** or untested **£85.00**, optional floor stand £12.50 Carr & Ins £10.00

DUAL 8" DISK DRIVES

Current, quality, professional product of a major computer company, comprising 2 x 40 track **MPI** or **Shugart FULLY BBC COMPATIBLE** single sided drives in a compact, attractively styled, grey ABS structured case with internal switched mode PSU. The PSU was intended to drive both drives and an intelligent Z80 controller with over 70 ic's. The controller has been removed leaving ample space and current on the +, -5, +12 and -12 supply for all your future expansion requirements. Supplied tested with 90 day guarantee in **BRAND NEW** condition with cable for **BBC micro.** Ex Stock at only **£259.00** + £10.00 carr. **Limited Quantity Only**

TELETYPE ASR 33

DATA I/O TERMINALS

Industry standard combined **ASCII** 110 baud printer, keyboard and 8 hole paper tape punch and reader. Standard **RS232** serial interface. Ideal as cheap hard copy unit or tape prep. for **CNC** and **NC** machines. **TESTED** and in good condition. Only **£235.00** floor stand **10.00**
Carr & Ins £15.00

PROFESSIONAL KEYBOARD OFFER

An advantageous purchase of brand new surplus allows a great **QWERTY**, full travel, chassis keyboard offer at fractions of their original costs.
ALPHAMERIC 7204/60 full **ASCII** 60 key, upper, lower + control key, parallel TTL output plus strobe. Dim 12" x 6" +5 & -12 DC. **£39.50.**
DEC LA34 Uncoded keyboard with 67 quality, **GOLD**, normally open switches on standard X, Y matrix. Complete with 3 LED indicators & i/o cable - ideal micro conversions etc. pcb DIM 15" x 4.5" **£24.95** Carriage on keyboards £3.00.

SEMICONDUCTOR 'GRAB BAGS'

Mixed Semis amazing value contents include transistors, digital, linear, I.C.'s triacs, diodes, bridge recs. etc. etc. All devices guaranteed brand new full spec. with manufacturer's markings, fully guaranteed. 50+ **£2.95** 100+ **£5.15**.
TTL 74 Series A gigantic purchase of an "across the board" range of 74 TTL series I.C.'s enables us to offer 100+ mixed "mostly TTL" grab bags at a price which two or three chips in the bag would nnormally cost to buy. Fully guaranteed all I.C.'s full spec. 100+ **£6.90** 200+ **£12.30** 300+ **£19.50**

DATA MODEMS

Join the communications revolution with our range of EX TELECOM data modems. Made to most stringent spec and designed to operate for 24 hrs per day. Units are made to the CCITT tone spec. With RS232 i/o levels via a 25 way 'D' skt. Units are sold in a tested and working condition with data. Permission may be required for connection to PO lines.
MODEM 2B "Hackers Special" fully fledged up to 300 baud full duplex, **ANSWER** or **CALL** modes. **AUTO ANSWER.** Data i/o via standard **RS232** 25 way 'D' socket. Just 2 wire connection to comms line. Ideal networks etc. Complete with data, tested, ready to run at a **NEW SUPER LOW PRICE** of **ONLY £65.00** + VAT + Carr.
MODEM 20-1 Compact unit for use with **MICRONET, PRESTEL** or **TELECOM GOLD** etc. 2 wire direct connect. 75 baud transmit 1200 baud receive. Data i/o via RS232 'D' socket. Guaranteed working with data **£49.95**
MODEM 20-2 same as 20-1 but 75 baud receive 1200 baud transmit **£130.00**
TRANSDATA 307A 300 baud acoustic coupler RS232 i/o **£95.00**
NEW DSL2123 Multi Standard modem selectable V21 300-300 bps, V23 75-1200, V23 1200-75 full duplex. Or 1200-1200 half duplex modes. Full auto answer via modem or CPU. LED status indicators. CALL or ANS modes Switchable **CCITT** or **BELL 103 & 202.** Housed in ABS case size only 2.5" x 8.5" x 9". **£286.00** + VAT
For further data or details on other EX STOCK modems contact sales office.
Carriage on all modems £10.00 + VAT.

THE BENEFITS OF INSURANCE

Almost four months ago, on the 29th of February 1984, we, DISPLAY ELECTRONICS were unfortunate enough to have a serious fire at our main location, reducing a substantial part of our stock, warehouse and offices to a pile of ashes and rubble. HOWEVER, we had seen the adverts about the "Benefits of Insurance" and some years ago had taken comprehensive insurance cover to protect against an event such as this.
The day after the fire we did not even have a single pen to write with, to say nothing of the non existant showroom and burnt out warehouse with direct access to the stars via our now non existant roof!!
The loss of stock and damage to the premises has resulted in losses in excess of £400,000 pounds in real money - no price can value time and effort.
We are still, although working under great difficulties, **VERY MUCH** in business. We owe this to supreme efforts by all our staff - perhaps knowing their jobs could have been at stake, stock being located at several different locations, help from business colleagues and our bank.
To these people, I say a very loud THANK YOU.
To both the mighty **PRUDENTIAL** and **GENERAL ACCIDENT** Insurance Companies who from the date of our fire have NOT even offered or paid **A SINGLE PENNY** in compensation or have not even offered an ounce of moral support . . .
To both the mighty **PRUDENTIAL** and **GENERAL ACCIDENT** Insurance Companies who only answer our requests for help and information with "We are still looking at reports . . ." I say **"STRONG STUFF THIS INSURANCE????"**
David Fisher, Managing Director, DISPLAY ELECTRONICS

EX STOCK DEC CORNER

BA11-MB	3.5" Bax, PSU, LTC	£385.00
DH11-AD	16 x RS232 DMA interface	£2100.00
DLV11-J	4 x EIA interface	£310.00
DUP11	Sych. Serial data i/o	£650.00
DZ11-B	8 line RS232 mux board	£650.00
LA36	Decwriter EIA or 20 ma loop	£270.00
LAXX-NW	LA180 RS232 serial interface and buffer option	£130.00
LAX34-AL	LA34 tractor feed	£85.00
MS11-JP	Unibus 32 kb Ram	£80.00
MS11-LB	Unibus 128 kb Ram	£450.00
MS11-LD	Unibus 256 kb Ram	£850.00
MSC4804	Qbus (Equiv MSV11-L) 256 kb	£499.00
PDP11/05	Cpu, Ram, i/o, etc.	£450.00
PDP11/40	Cpu, 124k MMU	£1850.00
RT11	ver. 3B documentation kit	£70.00
RK05-J	2.5 Mb disk drives	£650.00
KL8JA	PDP 8 async i/o	£175.00
MI8E	PDP 8 Bootstrap option	£75.00
VT50	VDU and Keyboard - current loop	£175.00

1000's of **EX STOCK** spares for **DEC PDP8, PDP8A, PDP11** systems & peripherals. Call for details. All types of Computer equipment and spares wanted for **PROMPT CASH PAYMENT.**

66% DISCOUNT

ELECTRONIC COMPONENTS EQUIPMENT

Due to our massive bulk purchasing programme which enables us to bring you the best possible bargains, we have thousands of I.C.'s, Transistors, Relays, Cap's, P.C.B.'s, Sub-assemblies, Switches, etc. etc. surplus to our requirements. Because we don't have sufficient stocks of any one item to include in our ads. we are packing all these items into the *"BARGAIN PARCEL OF A LIFETIME"*. Thousands of components at giveaway prices! Guaranteed to be worth at least *3 times* what you pay. Unbeatable value!! Sold by weight.

2.5kls **£4.25** + pp £1.25	5kls **£5.90** + £1.80
10kls **£10.25** + pp £2.25	20 kls **£17.50** + £4.75

ALL PRICES PLUS VAT

All prices quoted are for U.K. Mainland, paid cash with order in Pounds Stirling **PLUS VAT**. Minimum order value **£2.00**. Minimum Credit Card order **£10.00**. Minimum BONA FIDE account orders from Government depts., Schools, Universities and established companies **£20.00**. Where post and packing not indicated please ADD £1.00. + VAT Warehouse open Mon-Fri 9.30 - 5.30. Sat. 10.15 - 5.30. We reserve the right to change prices and specifications without notice. Trade, Bulk and Export enquiries welcome.

DISPLAY -ELECTRONICS-

32 Biggin Way, Upper Norwood, London SE19 3XF
Telephone 01-679 4414 Telex 27924

Rapid Electronics

MAIL ORDERS:
Unit 1, Hill Farm Industrial Estate,
Boxted, Colchester, Essex CO4 5RD.
Tel. Orders: Colchester (0206) 36412.
Telex: 987756.

ACCESS AND BARCLAYCARD WELCOME

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
Plugs solder lugs	60p	85p	125p	170p
Right angle	120p	180p	240p	350p
Sockets lugs	90p	130p	195p	290p
Right angle	160p	210p	290p	440p
Covers	100p	90p	100p	110p

CONNECTORS

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

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

SCRs

▶C106D	30
400V 8A	70
400V 12A	95

VOICE SYNTHESISER!

Now your computer can talk. The GI SP0256 speech processor is able through stored program to synthesise speech. Allophone (extended phoneme) system gives unlimited vocabulary. Easily interfaced with any digital system; ten TTL compatible signals are used to select the allophones.
SP0256AL2 . 550 Data 50p.

SOLDERING IRONS

Antex CS 17W Soldering iron	495
2.3 and 4.7mm bits to suit	85
CS 17W or XS 25W element	210
Antex XS 25W	525
3.3 and 4.7mm bits to suit	85
Solder pump desoldering tool	480
Spare nozzle for above	70
10 metres 22swg solder	100

VERO

Verobloc ◀	375
Veroboard Size 0.1 matrix	
2.5 x 1	22
2.5 x 3.75	75
2.5 x 5	85
3.75 x 5	95
New size 3.75 x 17	330
New size 4.75 x 17	415
VQ board	160
Veropins per 100	
Single sided	50
Double sided	60
Spot face cutter	130
Pin insertion tool	162
Wiring pen	330
Spare spool 75p Combs	6

SWITCHES

Submin toggle:
SPST 55p. SPDT 60p. DPDT 65p.
Miniature toggle:
SPDT 80p. SPDT centre off 90p.
DPDT 90p. DPDT centre off 100p.
Standard toggle:
SPST 35p. DPDT48p
Miniature DPDT slide 14p
Push to make 14p.
Push to break 22p.
Rotary type adjustable stop.
1P12W, 2P6W, 3P4W all 55p each
DIL switches:
4SPST 80p 6 SPST 80p. 8SPST 100p.

MICRO

		6116P3	600	6852	240	8228	220		
		6502CPU	325	6875	495	8251	320		
		6522VIA	295	6880	100	8253	390		
		6532	570	81LS95	85	8255	225		
2114L2	200	6551 ACIA	650	81LS96	85	8259	390		
2716	295	6800CPU	220	81LS97	85	MC1488	55		
2532	290	6802CPU	250	8080A	250	MC1489	55		
27128-25	2150	6809CPU	620	8085AC	340	Z80ACPU	290		
2732	440	6810RAM	115	8156	350	Z80APIO	260		
2764-BBC	680	6821	140	8212	110	Z80ACTC	260		
2764	600	6840	360	8216	100	Z80ASIO	900		
4116P20	85	6850	110	8224	120	Z80ADMA	1150		

SOCKETS

	Low profile	Wire wrap
8 pin	6p	28p
14 pin	8p	45p
16 pin	9p	55p
18 pin	12p	60p
20 pin	13p	68p
22 pin	16p	75p
24 pin	18p	82p
28 pin	23p	95p
40 pin	25p	135p

COMPONENT KITS

An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. ¼W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 650 resistors) . . . 530
Ceramic Cap. kit. 5 of each value - 22p to 0.01u (135 caps) . 370
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps) . 575
Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets . . . 425
Nut and Bolt kit (total 300 items): 180p
25 6BA ¼" bolts 50 6BA washers 50 6BA nuts
25 6BA ½" bolts 25 4BA ¼" bolts 50 6BA washers
50 6BA nuts 25 6BA ½" bolts

CABLES

20 metre pack single core connecting cable ten different colours	75p
Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
2.5A 3 core mains	23p/m
10 way rainbow ribbon	26p/ft
20 way rainbow ribbon	47p/ft
10 way grey ribbon	14P/ft
20 way grey ribbon	28p/ft

REGULATORS

78L05	30	79L05	45
78L12	30	79L12	45
78L15	30	79L15	45
7805	35	7905	40
7812	35	7912	40
7815	35	7915	40
LM309K	130	LM723	35
LM317K	270	78H05	550
LM317T	90		
LM323K	420		

DIODES

		▶1N4001	3
BY127	12	1N4002	5
OA47	10	1N4006	7
OA90	8	1N4007	7
OA91	7	1N5401	12
OA200	8	1N5404	16
OA202	8	1N5406	17
1N914	4	400mWzen	6
▶1N4148	3	1.3W zeners	13

OPTO

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

Clips to suit - 3p each.

Rectangular		TIL32	40
▶red	12	TIL78	40
green	17	▶TIL111	60
yellow	17	ORP12	85
ILD74	95	ILQ74	185
▶TIL38	40	TIL100	70
2N5777	45	Dual colour	60

Seven segment displays:

Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
▶FND500		FND507	
0.5"	100	0.5"	100

10 bar DIL LED display, red 180.
LCD 3½ digit 495p. 4 digit 520p.

HARDWARE

PP3 battery clips	6
Red or black crocodile clips	6
Black pointer control knob	15
Pr Ultrasonic transducers	390
▶6V Electronic buzzer	60
▶12V Electronic buzzer	65
▶PB2720 Piezo transducer	75
▶64mm 64 ohm speaker	70
▶64mm 8 ohm speaker	70
20mm panel fuseholder	25
Red or black probe clip	35
4mm terminals	33
12 way 'chocolate' block	30
ultra-min. 6 or 12v rel. SPDT	130
ditto, but DPDT	195

EURO CONNECTORS

Gold flashed contacts	Rt angle plug	Wirewrap socket
64 way A+B	195	230
64 way A+C	220	270
96 way A+B+C	320	330

TRIACS

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

JUMPER LEADS

Length	14pin	16pin	24pin	40pin
Sgle ended DIP(header plug) jumper 24 ins.	145	165	240	380
Dble ended DIP(header plug) jumper 6 ins.	185	205	300	465
12 ins.	195	215	315	490
24 ins.	210	235	345	540
36ins.	230	250	375	595

25 way D Connector jumpers
18ins. long single ended male 495p.
18ins. long single ended f/male 525p.

COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap for ZX81 . . 150
SPECTRUM 2 x 28 way edge connector wire wrap. . . 200
AMPHENOL PLUGS
24 way IEEE IDC . . 450
36 way Centronix IDC . 490

RIBBON CABLE

Grey Ribbon cable. Price per foot

10 way	14	34 way	58
16 way	25	40 way	68
20 way	28	50 way	90
26 way	38	60 way	100

CAPACITORS

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

BRIDGE RECTIFIERS

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

IDC CONNECTORS

	PCB Plug St.	PCB Plug Rt. ang	Socket	Edge Conn.
10 way	90	90	85	120
16 way	130	130	110	175
20 way	145	145	125	195
26 way	175	175	150	240
34 way	205	205	170	320
40 way	220	220	190	340
50 way	235	235	200	395
60 way	330	330	230	495

LINEAR

				LM339	40	LM3911	120	NE566	140	TL064	96
				LM348	60	LM3914	225	▶NE567	100	TL071	30
				LM358	50	LM3915	225	▶NE570	370	TL072	45
555CMOS	80	ICL7106	680	LM377	170	LM13600	105	NE571	370	TL074	95
556CMOS	150	ICL7611	95	▶LM380	75	MC1496	68	▶RC4136	55	▶TL081	25
709	25	ICL7621	180	▶LM381	120	MC3340	135	▶RC4558	40	TL082	45
▶741	14	ICL7622	180	LM382	120	▶MF10CN	350	SL480	170	TL084	90
748	35	ICL8038	295	LM384	130	ML922	400	SL490	250	TL170	50
9400CJ	350	ICL8211A	200	LM386	90	ML924	195	SL76018	150	UA2240	120
AY-3-1270	720	ICM7224	785	LM387	120	ML925	210	▶SN76477	380	ULN2003	70
AY-3-8910	370	ICM7555	80	LM393	40	ML926	140	SP0256AL2	550	ULN2004	70
AY-3-8912	540	▶LF351	45	LM709	25	ML927	140	TBA120S	70	XR2206	290
CA3046	60	LF353	85	LM711	60	ML928	140	TBA800	75	ZN414	80
▶CA3080	65	LF356	90	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3089	190	LM10	325	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3090AQ	375	LM301A	50	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3130E	85	LM311	70	LM747	60	NE531	140	TDA1008	320	ZN426E	300
▶CA3140E	36	LM318	120	LM1458	40	NE544	205	▶TDA1022	490	ZN427E	600
CA3161E	100	LM324	30	LM2917	200	▶NE555	16	TDA1024	125	ZN428E	410
CA3189	290	LM334Z	100	LM3900	45	▶NE556	45	TL061	40	ZN459	285
▶CA3240E	100	LM335Z	125	▶LM3909	75	NE565	110	TL062	60	ZN1034E	200

TRANSISTORS

				BC517	40	BF337	40	MPSU56	60	ZTX108	10	2N3055	50
				BC547	7	BFR40	23	TIP29A	30	ZTX109	12	2N3442	120
				BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶2N3702	8
		BC149	9	BC549	10	▶BFR81	20	TIP29C	37	ZTX301	16	2N3703	9
AC126	30	BC157	8	BC558	10	BFX29	25	TIP30A	35	ZTX302	15	▶2N3704	8
AC127	30	BC158	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17	2N3705	9
AC128	30	BC159	8	BCY71	18	BFX85	25	TIP30C	37	ZTX341	30	2N3706	9
AC176	25	BC160	45	BCY72	18	BFX86	28	TIP31A	35	ZTX500	15	2N3707	10
AC187	22	BC168C	10	BD115	55	BFX87	25	TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	BD131	35	BFX88	25	TIP32A	35	ZTX502	15	2N3709	10
AD142	120	BC170	8	BD132	35	BFY50	23	TIP32C	37	ZTX503	18	2N3772	170
AD149	80	BC171	10	BD133	50	BFY51	20	TIP33A	50	ZTX504	25	▶2N3773	195
AD161	40	BC172	8	BD135	40	BFY52	23	TIP33C	75	2N697	20	▶2N3819	20
AD162	40	BC177	18	BD136	30	BFY53	32	TIP34A	60	2N698	40	2N3820	40
AF124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	BD138	30	BFY56	32	TIP35A	105	2N708	20	2N3866	90
AF139	40	BC182	10	▶BD139	35	BRY39	40	TIP35C	125	2N918	35	2N3903	10
AF186	70	▶BC182L	8	▶BD140	35	BSX20	20	TIP36A	125	2N1132	22	2N3904	10
AF239	75	BC183	10	BD204	110	BSX29	25	TIP36C	135	2N1613	30	2N3905	8
BC107	10	BC183L	10	BD206	110	BSY95A	25	TIP41A	45	2N2218A	45	2N3906	10
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	45	2N2219A	25	2N4037	45
▶BC108	10	BC184L	7	BF180	35	BU206	180	TIP120	90	2N2221A	25	2N4058	10
BC108B	12	BC212	10	BF182	35	BU208	170	TIP121	90	2N2222A	20	2N4060	10
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	2N2368	25	2N4061	10
▶BC109	10	BC213	10	BF185	25	MJE340	50	TIP141	98	2N2369	16	2N4062	10
BC109C	12	BC213L	10	BF194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC114	18	BC214	10	BF195	12	MJE521	95	TIP147	110	2N2646	45	2N5458	36
BC115	22	▶BC214L	8	BF196	12	MJE3055	70	TIP2955	60	2N2904	20	2N5459	30
BC117	18	BC237	8	BF197	12	MPF102	40	TIP3055	55	2N2904A	20	2N5485	36
BC119	35	BC238	14	BF198	10	MPF104	40	TIS43	40	2N2905	22	2N5777	45
BC137	40	BC308	12	BF199	18	MPSA05	22	TIS44	45	2N2905A	22	2N6027	30
BC139	40	BC327	14	BF200	30	MPSA06	25	TIS90	30	2N2906	25	40360	40
BC140	28	BC328	14	▶BF244B	22	MPSA12	30	TIS91	30	2N2906A	25	40361	50
BC141	30	BC337	14	BF245	30	MPSA55	30	VN10KM	50	2N2907	25	40362	50
BC142	25	BC338	14	BF256B	45	MPSA56	30	VN46AF	75	2N2907A	25	40408	70
BC143	25	BC477	30	BF257	32	MPSU05	55	VN66AF	85	2N2926	9		
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23		
BC148	8	BC479	30	BF259	35	MPSU55	60	ZTX107	10	2N3054	55		

RESISTORS

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

CRYSTALS

		4.194MHz	150
		4.43MHz	100
100KHz	235	5.008MHz	240
1MHz	275	6.0MHz	140
1.8432M	200	6.144MHz	150
2.0MHz	225	7.0MHz	150
2.4576M	200	8.0MHz	140
3.276M	150	10.0MHz	170
3.579M	95	12.0MHz	170
4.0MHz	140	16.0MHz	200

BOXES

Plastic with lid & screws		Aluminium	
		3 x 2 x 1"	65
		4 x 2¾ x 1½"	95
		4 x 2½ x 2"	95
3 x 2 x 1"	55	6 x 4 x 2"	120
4½ x 3 x 1½"	88	7 x 5 x 2½"	165
7 x 4 x 2"	160	8 x 6 x 3"	205

CMOS

		4016	30	4034	140	4054	78	4081	16	40193	90	4528	45		
		4017	40	4036	270	4055	80	4082	16	4502	60	4529	150		
		4018	50	4039	280	4059	430	4085	50	4503	35	4532	60		
4000	16	4019	45	4040	40	4060	55	4086	50	4507	32	4534	400		
4001	16	4020	50	4041	45	4063	80	4089	125	4508	120	4538	70		
4002	16	4021	45	4042	38	4066	30	4093	28	4510	45	4543	60		
4006	50	4022	50	4043	40	4067	240	4094	70	4511	40	4549	390		
4007	16	4023	16	4044	45	4068	16	4095	95	4512	40	4553	215		
4008	40	4024	40	4046	50	4069	16	4097	290	4514	115	4555	35		
4009	30	4025	16	4047	50	4070	16	4098	70	4515	115	4556	35		
4010	30	4026	85	4048	45	4071	16	4099	70	4516	55	4559	390		
4011	16	4027	30	4049	30	4072	16	40106	35	4518	45	4560	140		
4012	15	4028	45	4050	30	4073	16	40109	100	4520	45	4584	35		
4013	30	4029	50	4051	40	4075	16	40163	50	4521	90	4585	60		
4014	45	4030	16	4052	50	4076	65	40173	100	4526	60	4724	140		
4015	50	4031	130	4053	50	4077	16	40175	50	4527	50				

LS TTL

		LS20	20	LS75	35	LS123	65	LS160	57	LS197	70	LS353	85
		LS21	20	LS76	25	LS125	33	LS161	57	LS221	70	LS365	38
		LS22	20	LS78	25	LS126	33	LS162	57	LS240	90	LS366	38
LS00	18	LS26	20	LS83	60	LS132	48	LS163	57	LS241	90	LS367	38
LS01	18	LS27	20	LS85	75	LS136	32	LS164	60	LS242	90	LS368	38
LS02	18	LS30	20	LS86	28	LS138	50	LS165	75	LS243	90	LS373	100
LS03	18	LS32	18	LS90	43	LS139	50	LS166	105	LS244	85	LS374	100
LS04	18	LS37	20	LS92	43	LS145	80	LS170	120	LS245	140	LS375	50
LS05	18	LS38	20	LS93	43	LS147	130	LS173	90	LS247	78	LS377	110
LS08	18	LS40	20	LS95	50	LS148	105	LS174	50	LS251	50	LS378	100
LS09	18	LS42	55	LS96	105	LS151	75	LS175	70	LS257	50	LS390	75
LS10	18	LS47	68	LS107	36	LS153	75	LS190	55	LS258	50	LS393	75
LS11	18	LS48	68	LS109	36	LS155	50	LS191	55	LS259	120	LS399	100
LS12	18	LS51	20	LS112	36	LS156	54	LS192	75	LS266	28	LS541	120
LS13	30	LS55	20	LS113	30	LS157	40	LS193	75	LS273	90	LS670	135
LS14	50	LS73	25	LS114	30	LS158	42	LS195	50	LS279	50		
LS15	20	LS74	25	LS122	50			LS196	70	LS283	58		

TTL

		7413	33	7444	70	7483	65	74122	50	74163	80	74192	120
		7414	48	7446	80	7485	100	74123	78	74164	90	74193	110
		7416	32	7447	85	7486	33	74125	40	74165	50	74194	80
7400	18	7417	32	7448	80	7489	165	74126	40	74167	200	74195	60
7401	18	7420	18	7450	22	7490	50	74132	55	74170	200	74196	110
7402	18	7421	22	7451	22	7491	60	74141	75	74173	100	74197	90
7403	18	7422	30	7453	22	7492	50	74145	80	74174	100	74198	180
7404	20	7427	30	7454	22	7493	50	74147	130	74175	80	74199	180
7405	20	7428	30	7460	22	7494	75	74148	110	74176	80		
7406	48	7430	20	7472	28	7495	60	74150	130	74177	80		
7407	48	7432	24	7473	35	7496	60	74153	60	74179	80		
7408	20	7433	25	7474	33	7497	120	74154	120	74180	85		
7409	20	7437	30	7475	55	74100	120	74157	70	74181	220		
7410	20	7438	30	7476	40	74107	35	74160	90	74182	80		
7411	20	7440	22	7480	45	74109	55	74161	80	74190	120		
7412	20	7442	60	7482	80	74121	38	74162	80	74191	120		

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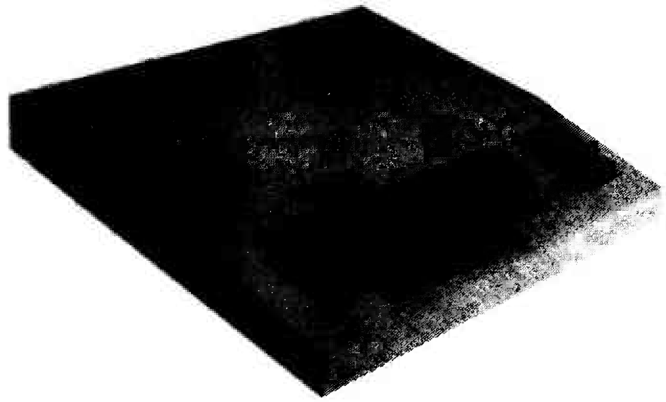
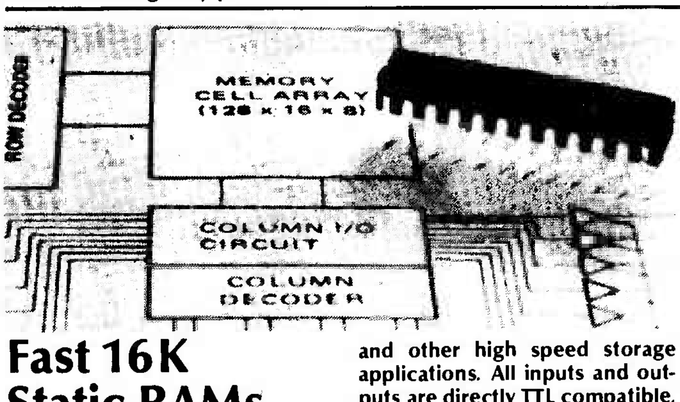
DIGEST



Cortex Facelift

The Cortex computer, as described in ETI in November and December 1982 and January 1983 (and also in a recently published edition of Electronics Digest, Vol 5 No 1) is to get a facelift, if that's the right phrase. Powertran Cybernetics will shortly be marketing the kit in a new-style case, which will be a lot slimmer than the original. The unit will include a re-designed PCB, incorporating all the modifications that have accrued since the Cortex was originally published. Powertran are also in the process of revising the Cortex manual, and hope to be able to provide a cheap disc operating system in the near future.

A users' group is being started up, and all purchasers of the Cortex should be receiving a letter about it; if you haven't already heard from him, drop Tony Lydeard a line at Powertran, as he is currently organising the group. He would particularly like to hear from people who would like to write letters or articles for the newsletter. Powertran may be found at Portway Industrial Estate, Andover, Hants SP10 3NN.



Fast 16K Static RAMs

Byte-wide 16K static RAMs operating at high speed and incorporating a low-power standby mode are now available. Organised as 2K x 8 bits, the Toshiba TMM2018D features a maximum access time of 45ns.

Maximum operating current from a single 5V supply is 150mA. A low power standby mode is entered when $\overline{CS}$ goes high and the device is deselected, when maximum standby current is 20mA.

These fully static devices are suitable for use in cache memory and other high speed storage applications. All inputs and outputs are directly TTL compatible, and inputs are protected against static charge.

Efficient operation in bus structured environments is facilitated by the provision of an output buffer control line, OE. These devices are supplied in a 24 pin cerdip package with a pin spacing of 0.3 inch width (unusual in 24 pin packages), which allows maximum utilisation of printed circuit board space.

For further details contact Impulse Electronics Limited, Croudace House, Caterham, Surrey CR3 6XQ, tel 0883 40325.

High-Tech Students In Demand

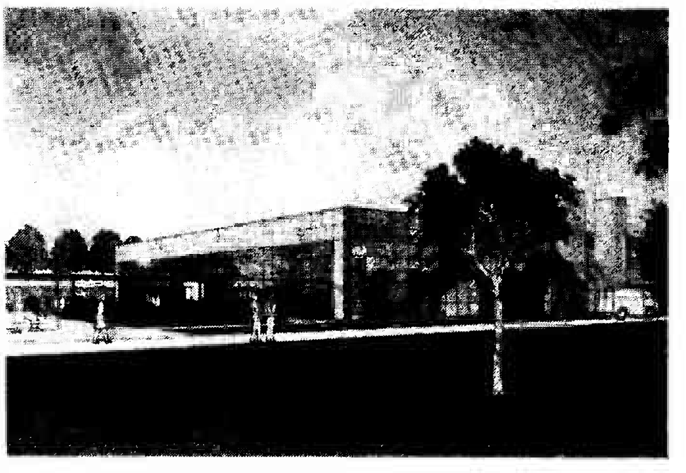
Students from a pilot training programme in the field of opto-electronics are in such demand from industry that the Manpower Services Commission has decided to repeat the project.

The courses, at Swansea, Newcastle and Coventry, are sponsored by the MSC under a scheme that aims to identify emerging high technology skill needs and stimulate the development of training to meet them. Opto-electronics is one of those new fields, and three years ago MSC sponsored a course to train unemployed graduates in the subject at Newcastle Polytechnic.

Such was its success that a further two courses, designed to retrain and update qualified engineers and technicians, began last year at West Glamorgan Institute of Higher Education, Swansea, and Lanchester Polytechnic, Coventry. "Demand for students from industry is very great, so we have decided to run all three courses again in the Autumn," said Mike Yates, Head of the MSC's Technologist and Technician Training Section.

Courses involve a period of college-based training, lasting 36 weeks, followed by about 10 weeks of industrial experience. In college, the students cover such areas as micro-electronics, optics, mathematics, electronics, data transmission, fibre optics, image processing, video displays and lasers.

These courses are likely to be over-subscribed, and ads will be appearing in the press (perhaps even ETI!) in the near future, but local MSC training division offices or job centres should be able to obtain further details for you.



Silicon Factory For UK?

Monsanto, the world's largest supplier of polished silicon wafers, plans to invest more than $35 million in a research and manufacturing facility in the United Kingdom. It is expected to create more than 400 jobs during the next five years.

This project still requires Monsanto Board approval, but is intended to provide the UK with a domestic source of Czochralski silicon polished wafers currently imported by the integrated circuit manufacturers, while the research facility should play a critical role in Monsanto's worldwide electronics research programme.

Construction of the Milton Keynes facility is scheduled to start later this year on a prime 10 acre greenfield site at Wolverton Mill. The first phase is due for completion early in 1986 and will employ 100-130 people. The new plant will be based on Monsanto's most recent technology and produce the advanced 100, 125 and 150 mm wafers used in the manufacture of the very latest VLSI circuits.

The research centre will focus on development of the near perfect crystal structures needed for the next generation of high speed memories and microprocessors. Many of the centre's planned fundamental and applied research programmes will involve collaboration with device manufacturers, universities and industry research centres in the UK and throughout Europe.

Monsanto will also consolidate its European electronic materials business management, marketing and applications groups at the new Milton Keynes site. Monsanto Europe SA, Avenue de Tervuren, 270-272 B-1150 Brussels, Belgium, tel (Belgium) 02-762-11-12.

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- ☐ **Computer Peripherals that you can build** Wolfe £12.40
- ☐ **Microprocessors and Microcomputers for Engineering Students and Technicians** Wooland £7.10

REFERENCE BOOKS

- ☐ **Electronic Engineers' Handbook** Fink £56.45
- ☐ **Electronic Designers' Handbook** Giacoletto £59.55
- ☐ **Illustrated Dictionary of Microcomputer Technology** Hordeski £8.45
- ☐ **Handbook for Electronic Engineering Technicians** Kauffman £27.50
- ☐ **Handbook of Electronic Calculators** Kauffman £35.00
- ☐ **Modern Electronic Circuit Reference Manual** Marcus £44.00
- ☐ **International Transistor Selector** Towers £10.70
- ☐ **International Microprocessor Selector** Towers £16.00
- ☐ **International Digital IC Selector** Towers £10.95
- ☐ **International Op Amp Linear IC Selector** Towers £8.50
- ☐ **Illustrated Dictionary of Electronics** Turner £12.95

VIDEO

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- ☐ **Complete Handbook of Videocassette Recorders** Kybett £9.25
- ☐ **Theory and Servicing of Videocassette Recorders** McGinty £12.95
- ☐ **Beginner's Guide to Video** Matthewson £5.35
- ☐ **Video Recording: Theory and Practice** Robinson £14.40
- ☐ **Video Handbook** Van Wezel £21.90
- ☐ **Video Techniques** White £12.95

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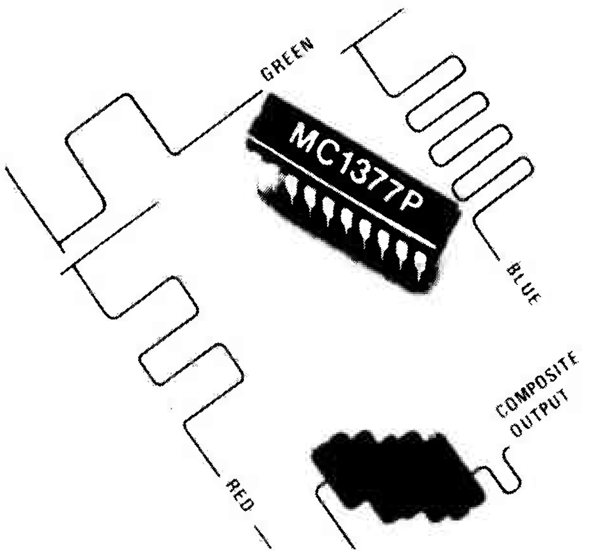


Video Encoding Goes LSI

A new LSI integrated circuit that combines the functions of a board-full of components previously required for the implementation of a colour video encoder has been introduced by Motorola. The new monolithic encoder represents a major system simplification for a wide variety of end products including colour cameras, personal computers, colour graphics computers and terminals, and is estimated to reduce the cost of implementing this function by an order of magnitude.

The MC1377P combines the RGB video information into a composite video signal in either the NTSC or PAL format. It contains a sub-carrier oscillator, voltage controlled 90 degree phase shifter, two double-side-band modulators, RGB input matrices and blanking level clamps. Its oscillator can be used as the master in a system, or it can be driven by an external source. The RGB inputs are AC coupled to simplify interfacing a variety of equipments. A 1.0 V P-P input level produces full saturation of colours in the output.

The only other input required is a composite sync signal, which is combined with the encoded video to produce the composite video output. The sync is also used to trigger the generation of the colour (burst) reference. Both chroma and luma signals are "looped out" of the chip to permit tailoring bandwidth and delay to the designer's needs. This permits very elegant applications as well as very simple ones. Motorola Ltd, Semiconductor Products Sector, European Literature Centre, 88 Tanners Drive, Blakelands, Milton Keynes, tel 0908-614614 (quote release number 16).

New Power HEXFETs

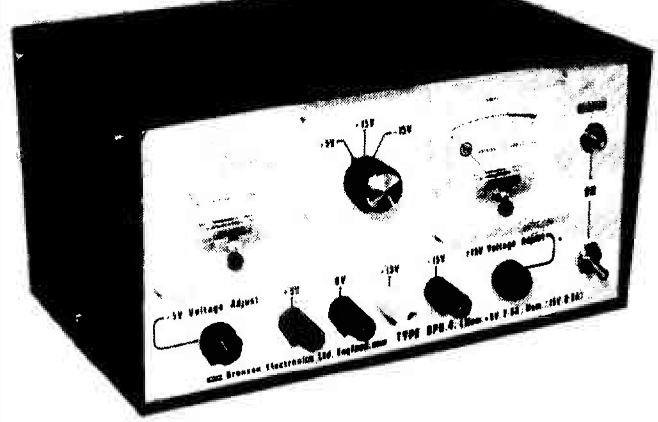
A new range of P-channel HEXFET power transistors combining high power ratings with excellent reliability specifications is now available from International Rectifier.

The new IRF9140 and IRF9240 Series incorporate the largest chip of any P-channel device yet produced, the HEX-4 size, and have the highest current capacity, with ratings from 9A to 19A. Typical drain-source on-state resistance is 0.2Ω to 0.75Ω, and the devices are available for voltage ratings of 60V, 100V, 150V and 200V.

The new products are the approximate electrical complements to the industry-standard N-channel IRF130 and IRF230. International Rectifier, Hurst Green, Oxted, Surrey, RH8 9BB, tel Oxted 3215/4231.

● Middlesex Polytechnic are running a summer school at their Trent Park site in North London from the 16th of July to the 17th of August. Courses available cover such topics as file processing, programming principles and microelectronics as well as an introductory computing course, fees range from £75 to £125 and accomodation is available for £28 a week excluding meals. For details contact Admissions Enquiries, Middlesex Polytechnic, 114 Chase Side, London N14 5PN, tel 01-886 6599.

● International Rectifier have issued a six-page leaflet describing their range of encapsulated bridge rectifiers. The range includes single and three-phase bridges with ratings from one to forty amps and from 50 to 1200 volts, and full technical information and dimensions are given. International Rectifier, Hurst Green, Oxted, Surrey RH8 9BB, tel Oxted 3215.

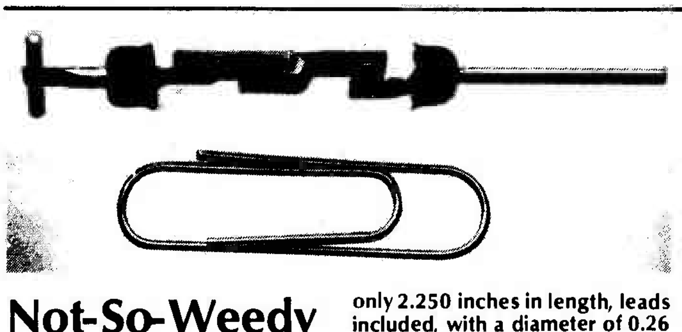


Powerful Friend

If the bench power supply unit in the picture looks familiar that's probably because you saw it as a project in the February issue of ETI. As we pointed out then, the unit is available from Grenson Electronics either as a kit or as a ready built unit, and not only has the price not risen since then it has actually fallen, albeit only by a few pence.

The prices quoted in the February issue have been rounded down slightly and the BPU-4 now costs £59.00 in kit form or £98.00 fully assembled, both prices including VAT and delivery. The unit has a single-rail supply which offers from 3 to 8V at up to 2.5A and a dual-rail supply which offers ±8 to ±16V at up to 0.5A. The negative half of the dual-rail supply is designed to accurately track the positive side so that the two are always balanced around OV, and a single potentiometer adjusts the voltage of both. The regulation is such that the output voltage varies by less than 0.1% from zero to full load, ripple is less than 0.05% peak-to-peak, and the outputs are all protected against overload, short circuit and the injection of external voltages. A pair of dual-scale moving coil meters monitor voltage and current and a single switch connects them to the plus 5V, plus 15V or minus 15V supply as desired.

The BPU-4 is available from Grenson Electronics Ltd, High March, Daventry, Northamptonshire NN11 4HQ, tel 0327-705521. Alternatively, you can order a copy of the February ETI from our backnumber service and build your own.

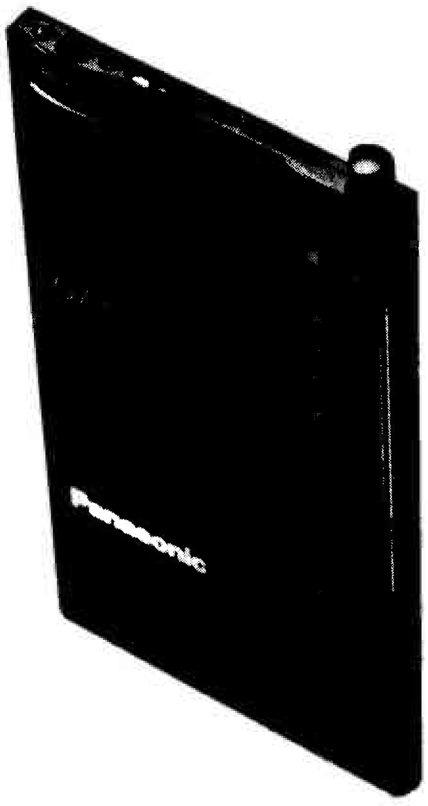


Not-So-Weedy Reedy

Hamlin Electronics has introduced a powerful new glass-encapsulated reed switch designed to switch high-current loads.

The new switch, Model 5091, is rated at 15A at 240V AC and 30A at 72-120V AC. The new device is extremely compact, measuring only 2.250 inches in length, leads included, with a diameter of 0.26 inch maximum.

The combination of small size and high switching power capability makes the model 5091 an ideal component for use in high-power relays and heavy-duty switching applications. The standard Model 5091 has single-pole, single-throw, normally open contacts. Hamlin Electroncis Europe Ltd., Park Road, Diss, Norfolk IP22 3AY, tel 0379 4411.



Is This The World's Thinnest AM/FM Stereo Radio?

Panasonic's parent company Matsushita electric Industrial Company Limited of Osaka, Japan announces the development of the world's thinnest and lightest FM/AM stereo personal radio — the RF-07. This new radio measures 91mm high, 55mm wide and 3.9mm deep — approximately the size of a credit card. The weight is a mere 38g which includes a rechargeable internal NiCad battery, which provides approximately 5 hours of playing time under normal use.

Panasonic say that to achieve such a remarkably small size, revolutionary new circuits have been designed, resulting in radio high-density circuits (RHC) — the ultimate in miniaturization and radio design. The RHC's are used in four sections of this radio: the FM front end (VHF high frequency amplifer, local oscillation and frequency mixer circuits); the FM/AM IF amplifier and AM automatic gain control circuits; and the stereo low frequency amplifier circuits.

Many new components have been developed for use in the RF-07 and include a variable condenser, volume control, tantalum condenser chips, IF transformer and ultrathin AM antenna. Each of these components has been designed to be less than 2.8mm in total thickness. The print wired board (PWB) has also been reduced in thickness from 0.5mm to 0.3mm and has been designed as part of the rear panel of the cabinet — a revolutionary new construction. Accessories include a battery recharger, stereo earphones and a carrying case for the unit.

The RF-07 is expected to be launched in the UK at the end of this year. How long will it be before they introduce a TV of the same size? Panasonic UK Limited, 300-318 Bath Road, Slough, Berkshire SL1 6JB, tel 0753-34522.

Ultra Low Noise Preamp

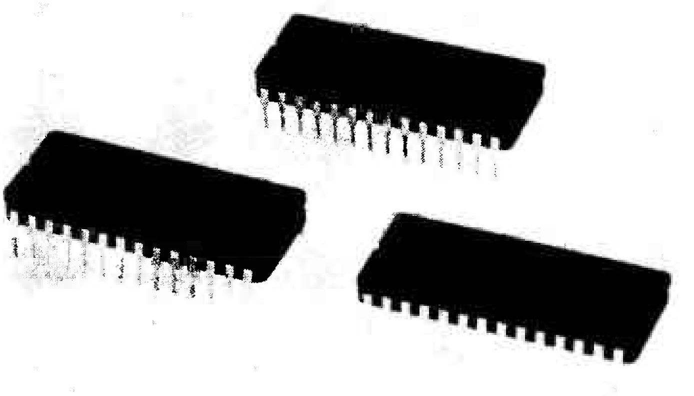
The SSM 2015 from Solid State Micro Technology is a monolithic ultra low noise audio preamplifer particularly suited to microphone use. Gains from 10 to over 2000 can be selected with wide band-width and low distortion over the full gain range.

The circuit has a wide bandwidth of 700 KHz at a gain of 100 with symmetric slew rate of 6V/μs and distortion of 0.007%. True differential inputs and a high common mode rejection of 100dB provide easy interfacing to transducers such as balanced microphone outputs, tape heads and single ended devices.

An internal feedback loop maintains the input stage current at a value controlled by an external bias resistor. This provides a programmability function which allows noise to be optimised for a wide range of source impedances up to 4k ohms; noise is within 1dB of the theoretical minimum value between 500 ohms and 2.5 k ohms.

The SSM 2015 is specified for commercial temperature ranges only and costs £9.48 one off price. Coole Marketing Services Ltd., 26 Pamber Heath Road, Pamber Heath, Nr. Basingstoke, Hants, tel 0734 700453.

High Performance 256K EPROM



High performance EPROMs with the largest capacity yet available, 256k bits, have just been announced by Hitachi.

Organised as 32k x 8 bits, the HN27256G is an NMOS EPROM manufactured in 2 micron technology. Versions with access times of 250ns (part numbered −25) or 300ns (−30) are available. Inputs and outputs are TTL compatible during both 'read' and 'program' modes.

Power consumption from a single 5V supply is 240mW (typ) when active, reducing to the low level of 80mW (typ) on standby. For programming, 12.5V $\pm$ 0.3V is required, compatible with other high capacity EPROMs.

An interesting feature is the on-chip identifier mode. This allows codes relating to manufacturer and type of device, stored in the device, to be read by programming equipment so that the appropriate programming sequence is employed.

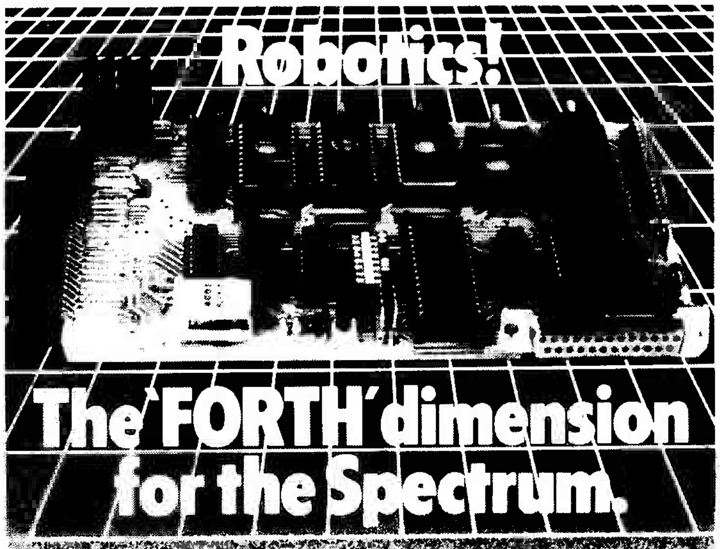
The 28-pin outline conforms to the industry standard pin-out. Hitachi Electronic Components (UK) Limited, Hitec House, 221/225 Station Road, Harrow, Middx. HA1 2XL, tel 01-861 1414.

● Thorn EMI have issued a new photomultiplier accessories catalogue. Details from The Sales Department, Thorn EMI Electron Tubes Limited, Bury Street, Ruislip, Middlesex HA4 7TA, tel 08965 30771.

● Two very fast 32K PROMs are being proferred by Microlog Ltd, 1st Floor, Elizabeth House, Duke Street, Woking, Surrey GU21 5BA, tel 04862 66771. They're the 63S3281A and 63S3281 from Monolithic Memories, and have access times of 40 and 50ns respectively.

● NEC is set to launch two new CMOS microprocessors, the 8-bit uPD70108C (or V20 for short) with 8-bit external bus and 16-bit internal bus, and the 16-bit uPD70116C (or V30) which has both internal and external busses 16 bits wide. Both products employ NEC's two-micron fine pattern technology, and NEC claim a speed improvement of 1.5 times over equivalent NMOS products. NEC Electronics (UK) Ltd, Carfin Industrial Estate, Motherwell ML1 4UL, Scotland, tel 0698-732221.

● Supercat Electronics, whose first mail order test equipment catalogue we mentioned in the February issue, have now brought out a second, larger catalogue. It contains details of test and measurement instruments, connectors, kits, leads and accessories and is available free of charge from Supercat Electronics Ltd, PO Box 201, St. Albans, Hertfordshire AL1 4EN, tel 0727-62171.



Robotics!
The 'FORTH' dimension for the Spectrum.

Colour Screen From Mitsubishi

Visitors to the CETEX (consumer electronics trade exhibition, were treated to the sight of a new flat colour display from Mitsubishi. Called the crystal colour modular screen, it is, as the name suggests, a modular display, with the basic unit a few inches square.

As yet technical information is rather thin on the ground as the product is still very new, and apparently only at the prototype stage, but we have been told that the display is illuminated from the back using flourescent lighting, then an RGB gate operated by a crystal diode determines the transmitted light colour through to the viewer.

We hope to be able to give you more information — perhaps even a picture — in the near future. Mitsubishi, Hertford Place, Denham Way, Rickmansworth, Herts, tel 0923-770000.

The Feelies Are Here?

Left gibbering in front of the telly, after that ad for that computer, and wondering how you can make your micro's screen touch sensitive? Perdix components may have the answer for you, though it could be a while before it finds its way on to the hobby/small user market.

The product in question is a transparent touch keyboard, available in custom and standard formats, and in matrix or analogue versions. Perdix say that the keypad should be suitable for LCD, LED, plasma and CRT displays, that the unit has been cycle tested over a million times with no degradation, and that it will operate between −10°C and +60°C. Perdix Components Ltd, Unit 4, Airport Trading Estate, Biggin Hill, Westerham, Kent TN16 3BW, tel 09594 71011.

This Is 448 K-bytes

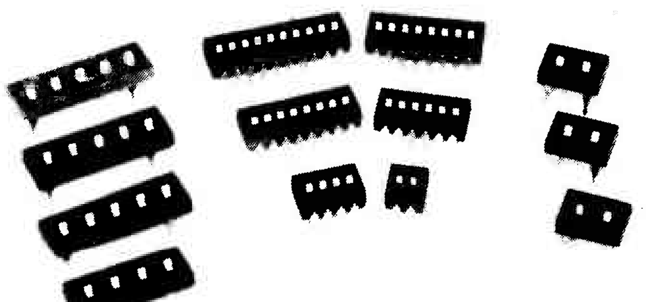
A reliable, high-density assembly of dynamic random access memory in a single-in-line package (SIP) has been announced by Texas Instruments. It uses plastic leaded chip carriers on a low-cost printed circuit board substrate and provides four times as much memory on the same board area as conventional dual-in-line DRAMs.

The memories are built using a number of 64K DRAMs in 18-pin plastic chip carriers which are mounted on a printed circuit board with de-coupling capacitors and connection pins all on one side. Texas Instruments claims that the SIP offers high reliability and gives significant savings in material and test costs by reducing the need for expensive multiple-layer boards.

To date, the SIP product family enables users to utilise memory components in the density range of up to 500K-bits without penalising space. Initially seven types are available: 64K by 4, 5, 8 or 9 bits; 256K by 1 bit; 32K by 8 bits and 16K by 16 bits.

All present and future SIP products are density upward compatible enabling the users to design with DRAM densities well ahead of silicon availability. By the end of the year, TI plans to announce a second generation of SIP modules intensively using its family of 64K DRAMs, and 256K DRAMs, thus providing the first 2 meg DRAMs component on the market.

All family members will feature identical pin functions and spacing for easy upgrade. The TI SIP products are available in three versions: 120, 150 and 200ns max access time. They operate from a single 5-volt power supply in a 0-70°C free-air temperature range. Texas Instruments Limited, Manton Lane, Bedford MK41 7PA, tel 0234 67466.



Switches With Integral Resistors

B&R Electrical Products claim to have scored a world first with their series W range of DIP switches. The devices feature a thick-film resistor network, thereby saving on board space and assembly time when compared with discrete switch/resistor attenuator networks and also offering improved performance and reliability.

The series W switches feature slide-actuated, knife-edge, ultra-high pressure contact mechanisms and moulded-in resistor networks which are environmentally sealed. They are available in chip select, digital attenuator and digital trimming potentiometer types and are rated for operation at up to 24V AC/DC and 125mW, with the exception of the digital attenuator types which are rated at 50mW. The chip select switches come in 2, 4, 6, 8 and 10 pole versions and with resistor values of either 3.3 or 10 k ohms. The digital attenuator switches come in 2, 3, 4 and 5 pole versions with impedance ratings of 50, 75, 150, 300 and 600 ohms and offer attenuation steps of 0.5, 1, 2, 4, 8 and 16 dB. The digital trimming potentiometer switches also come in 2, 3, 4 and 5 pole versions and in a range of resistance values from 100 ohm to 1M ohm.

Full details of the series W switches are given in a twelve-page brochure which is now available. B&R Electrical Products Ltd, Temple Fields, Harlow, Essex CM20 2BG, tel 0279-443351.

● Don't lose your memory on power-down with a new device from Newport Components Limited, 134 Tanners Drive, Milton Keynes MK14 5BP (tel 0908 615232). The NM221 storer-caller is designed to provide the correct store and recall control signals for non-volatile RAM devices, such as the X2201, X2210 and X2212, on power-down and power-up. At all other times, the NM221 is inactive.

● Holsworthy Electronics supply 0.1% and 0.5% tolerance precision metal film resistors in E96 values between 100R and 256K ohm. The minimum charge is £20.00, orders received by 3.00 p.m. will be despatched on the same day, and there are plans to expand the range available in the future. For details contact Holsworthy Electronics (Sales) Ltd, Hacche Mill, South Molton, Devon EX36 3NA, tel 07695-3151.

● Ferranti have issued a new 60-page technical hand-book detailing their range of high quality opto-electronics products, and a brochure on their power MOSFETs. Details from Ferranti Electronics Limited, Fields New Road, Chadderton, Oldham, Lancs OL9 8NP, tel 061-624 0515.

ETI

TEST EQUIPMENT

In this, the first of four special features on test equipment, Phil Walker takes a look at the types of equipment available and the uses to which they are put.

The best test equipment you will ever possess cannot be bought in any shop. We hope you keep it on your shoulders. The human brain has the ability to store vast amounts of information and to make sense of often incomplete or erroneous data, and the prime duty of test equipment is to provide clear, accurate and useful data so as to enable the user to reach valid conclusions.

Test equipment generally falls into two categories. The first provides stimuli to the circuitry under test and includes power supplies, waveform generators and other signal sources. The second group is comprised of all the measurement and display instruments, such as voltmeters, current meters, frequency and period meters, power and energy meters and many others. The division between the two categories is sometimes a little blurred by the inclusion of a measurement device in a stimulus unit. An example of this is the provision of voltage and current meters on a power supply.

Power supplies

Except in the case where the device to be tested has its own internal power supply, some form of external supply will be needed. This could be derived from dry batteries or from the mains, either direct or via an isolating transformer and probably some form of rectifier and regulator arrangement. For some purposes a variable transformer will be required but these are often quite expensive.

The most common power supply type encountered is the mains powered DC voltage supply. They come in many shapes, sizes and ratings. For logic testing of most computer type circuits a well regulated supply of +5 volts at a few amps is needed. Sometimes +12 and −5 volt supplies are needed in addition. Other types of logic may need different supply voltages: CMOS +5 to +15 volts, ECL −5 volts. Linear circuits will often need split rail supplies of plus and minus 12 to 15 volts or single supplies of 10 volts upwards at currents which are deterimed by the application. Usually power supplies are built to withstand a certain amount of mistreatment but it is not a wise thing to prolong the agony. Power supply circuits are probably the type of test gear most commonly built by hobbyists.

Signal Sources

This is possibly the largest subject in test equipment. The basis for most signal sources is one of the many types of oscillator, and the final output may be sinewave, squarewave, triangular, sawtooth, pulse or anything else you particularly want (and can generate). The amplitude and frequency of the output are usually variable, but in some cases other parameters need to be controlled as well. A very useful facility found in some instruments is that one parameter may be controlled by either an external voltage or an auxilliary oscillator inside the instrument. If the controlled parameter is frequency then the result is a sweep oscillator. Amplitude modulation in this manner is also useful when testing some radio circuits.

Logic pattern generators give either serial or parallel output according to application. The actual pattern may either be preset by the operator or be pseudo-random. This latter has the characteristics of noise or random data but the pattern is known even if its repetition period is very long. These pattern generators are often used in conjunction with a logic analyser to test large logic systems.

The Voltmeter

There are several basic types of voltmeter and we shall look at two of the most common. The first consists of a sensitive moving coil meter movement which has a large value resistance in series with it. The meter movement requires a certain amount of current flowing through its coil to deflect the needle or pointer. The resistance in series with the coil is calculated such that when the maximum voltage to be measured is applied to the instrument the resulting current will deflect the pointer to the end of its scale. If several ranges of voltage are required then different values of resistor can be switched into the circuit. Until recently this method of construction formed the basis of most voltmeters in use with a few exceptions such as moving iron and electrostatic.

The normal measure of merit for the moving coil voltmeter is the 'ohms per volt' (opv) figure. This is determined almost totally by the deflection sensitivity of the meter movement. The lower the current needed to deflect the pointer the more sensitive the meter, the lower the loading on the circuit under test and the higher the 'ohms per volt' figure. A typical figure for this type of instrument would be 20,000 ohms per volt, although up to 50,000 is not unknown.

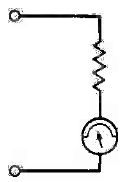
It must be realised that a voltmeter of the moving coil variety will take all the power it requires to deflect the pointer from the circuit being tested. On a 10 volt range, a 20,000 OPV meter will appear as a 200k resistor and will disturb the circuit to a greater or lesser degree accordingly.

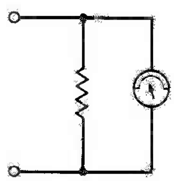
One way of at least partially getting around the limitations of the simple moving coil voltmeter is to provide an amplifier to drive the meter movement.

The circuit under test then has to provide only enough power to drive the amplifier input. This avoids the loading problem and permits the use of a cheaper and/or more robust meter movement. However, other problems are introduced such as zero drift, gain drift and noise. These are usually reduced to a lower level by good circuit design but another disadvantage remains and that is the need for a power supply. The first instruments of this type used valve amplifiers but semiconductors were later introduced and a great saving on space and power consumption resulted. Both types are capable of excellent results.

The second type of voltmeter has only really come into its own in the past two decades. This works by converting the measured voltage into a series of digits and displaying them on some suitable device. One of the earlier attempts at this actually used a set of moving coil meter movements to display the numbers. Later versions used filament lamps, cold cathode tubes and most recently light emitting diodes and liquid crystal displays. This has led to a steady reduction in the instruments' power requirements.

At the measuement end, semiconductor technology has advanced rapidly to give ever greater accuracy and convenience in use. Hand held instruments are now available which give readings to wthin 0.2% accuracy with comprehensive auto-ranging facilities, 10M ohm input resistance and whose internal batteries will last for up to a year. The penalties one pays with this type of device are that it is relatively easy to misread the display and rapid changes of input can give a confusing read out. This latter problem is alleviated to some extent by the provision of a bar-graph readout on some instruments, but the response time of the whole device is often quite slow and the momentary flicker of the moving coil with fast pulses is lost.


VOLTMETER


AMMETER

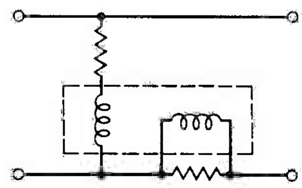
The Ammeter

The ammeter uses the same basic principles as the voltmeter. The difference is that most of the current is allowed to flow through a low resistance in parallel with the meter movement, leaving only a small but known fraction of the original current to flow through the moving coil. It is this which deflects the pointer and provides the reading. In the case of digital ammeters, the value of the shunt resistor is determined almost entirely by the measured current as very little is needed by the circuitry. This is not true with the older type of meter, especially when used on the lower ranges.

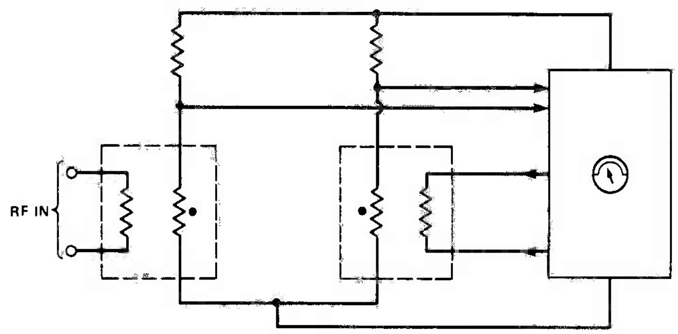
Better quality meters and those used in industry were sometimes designed so that 75mV was dropped at full deflection.This allowed a range of standard shunts to be used with many different meters. The arrival of digital meters has led to the adoption in some quarters of a new standard in which the voltage drop at full deflection is set at 199mV

Power Meters

This is an instrument which is rarely found in the hobbyist field as the movement has to be specially constructed. However, the advance of semiconductors has made it possible to construct power meters using integrated multiplier devices. There are problems when using these meters as they are prone to errors when one input is very large and the other is very small but the resulting power is in range. Approximations to true power meters can be made if the resistance of the load is known. In this case a normal voltmeter can be calibrated to read in units of power although the scale will be cramped at the low end.


MOVING COIL POWER METER

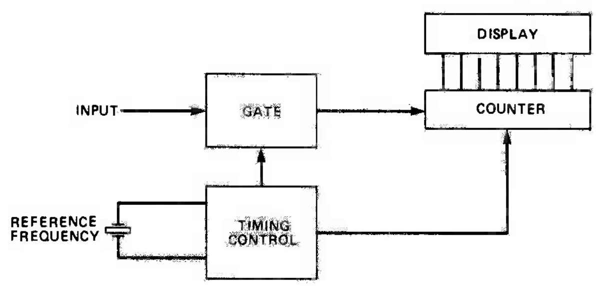
A rather different type of power meter is used at microwave frequencies. This consists of a bridge circuit containing two thermistors. One of these is heated by the RF energy while the other is heated by the meter circuitry. When the bridge is balanced the RF power is equal to the DC power and since this latter is known it can be displayed.



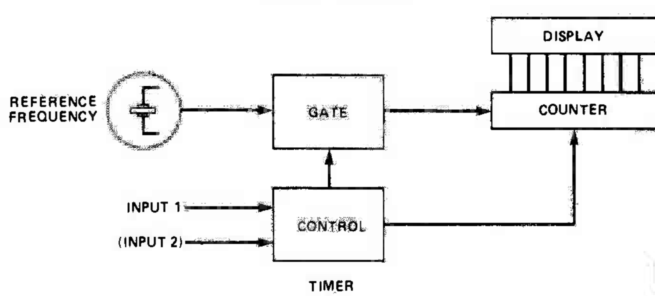
THERMISTOR POWER METER

Frequency and period

These two measurements have been lumped together as they are closely related and are usually provided in a single instrument. To measure frequency it is necessary to count the number of complete cycles of the input waveform occurring in a



FREQUENCY COUNTER



TIMER

standard time period. This standard time period should be as long as possible to get the greatest accuracy. Unfortunately, unless complex circuitry is used, this can mean long waits for a valid display when measuring low input frequencies.

It is possible to construct analogue frequency meters but they are not particularly accurate. The normal digital frequency meter should be able to give readings in the 100Hz to 10MHz range to better than 1%.

Measurement of time period is the inverse of frequency and consists of counting the number of standard time periods occurring between two input events. These events may arrive on two separate inputs or may be two similar transitions on the same input. A normal instrument should be capable of reading 100μs to 100s periods to at least 1% accuracy.

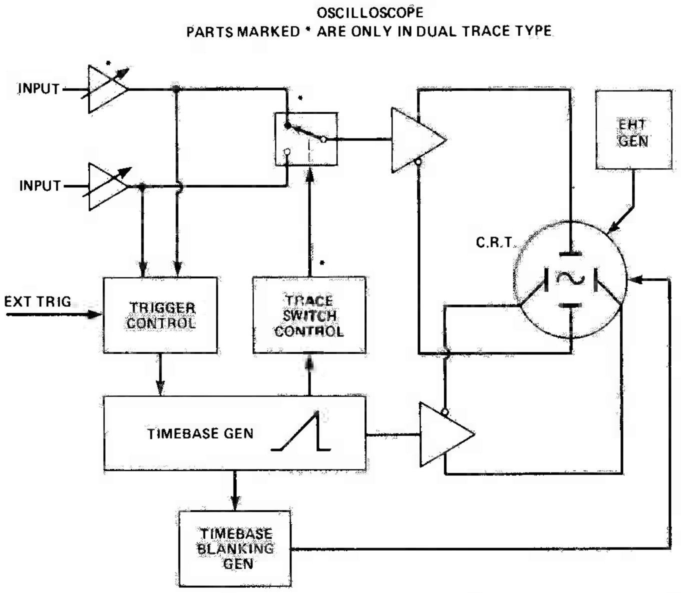
With either or both of these instruments it may be possible to use a pre-scaler on the input or reference signals to extend the range. Some types also allow ratio measurements where the standard input is derived externally.

The Oscilloscope

The oscilloscope is a very versatile piece of equipment which, to some extent, can replace many others. The key to its usefulness lies in the fact that it displays a picture of the signal under test and as everyone knows, "a picture is worth a thousand words".

The main disadvantages of the oscilloscope are its bulk and cost, but these are easily outweighed by its ability to do the jobs of frequency counters, timers and voltmeters where great accuracy is not the prime requirement. Even the simplest oscilloscopes can be very useful but the more complex instruments offer facilities which cannot be obtained in any other way. The very simple instrument will probably have a single beam, simple timebase with limited triggering facilities, and signal amplifiers which have a bandwidth of 5MHz or so. More complex and expensive units will offer two or more traces with bandwidths of 50MHz or more, timebase circuits with delayed triggering and other facilities and better trace visibility at high frequencies.

Equipment	Uses	Approximate range of specifications	Comments
Analogue multimeter	measuring AC/DC voltages, currents, resistance	100 mV to 1000 V 10 mA to 10A 1 Ω to 10 MΩ	
Digital multimeter	measuring AC/DC voltages currents, resistance	10mV to 1000 V 1 mA to 2 A 1 Ω to 10 M Ω	3½, 4½, 5½, 6½ digit
AC voltmeter	measuring small signal and other AC voltages	5 μV to 500 V	wideband (up to 100 kHz), input DC blocking
Function generators	providing input signals of known waveshape, amplitude, etc.	0.01 Hz to 20 MHz	various output waveforms
Pulse generators	specifically for use with logic, etc	1 Hz to 50 MHz 10 ns to 1 s pulse width	fast rise times, variable width pulse
Sweep generators	RF test equipment	1 MHz to 20 GHz	
RF generators	RF test equipment	500 kHz to 1 GHz	AM, FM, PM
AF generators	audio testing	10 Hz to 100 kHz	low distortion sinewave
Oscilloscopes (non-storage)	examining and measuring repetitive waveforms	10 mV to 10 V 0.5 us to Is	one, two or sometimes four-trace
Oscilloscopes (storage)	examining and measuring non-repetitive (one-off) events	similar to above	digital or non-digital, dual-trace, some have floppy disc storage
Counter/timers	counting input pulses, times between input pulses, frequency display	over 100 MHz 100ns to 1 s	digital display
Frequency counters	general RF display	up to ≈ 20 GHz	
Spectrum analysers	measuring signal power against frequency	50 Hz to 20 GHz	general AF or RF
Modulation meter	measuring percentage modulation of carrier	AM, FM 1 MHz to 1 GHz	
Distortion meter	measuring AF distortion, in applied signal	20 Hz to 100 kHz	
Audio analyser	measuring distortion, S/N ratio, frequency	20 Hz to 100 kHz	
Power supplies	providing DC and sometimes AC power to equipment under test	0 V to 15 V or more, up to ≈ 50 A	DC suplies regulated, current limiting, sometimes dual rail
Chart recorders	plot a number of voltage inputs	1 mV to 500 V FSD up to ≈ 12 channels	useful for hard copy
Tape recorders	recording processes for later analysis	DC to 300 kHz up to 12 ≈ 12 channels	
Logic analyser	analysing microprocessor bus signals, timing, state, software analysis	16 to 32 channels up to ≈ 100 MHz clock	



In some oscilloscopes the waveforms measured may be digitally stored for display later. These are known as Digital Storage Oscilloscopes (DSO) and they can usually record a number of waveforms taken at the same or at different times and display them later with altered x and y axis scales if desired. Whereas ordinary oscilloscopes can only be used to examine repetitive waveforms, DSOs can be used to examine pulse phenomena and other one-off events.

As with all test equipment the effect of the test probe on the circuitry being tested must be taken into account. In the case of the oscilloscope the effect will not be significant until high frequencies and high impedances are involved.

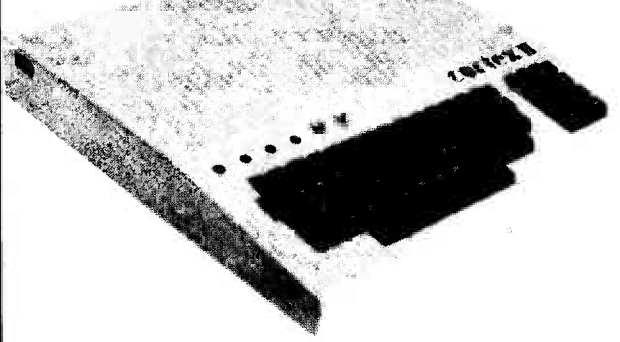
Logic Pattern Detectors

These range from the simple logic gate circuit through to very sophisticated logic analysers. Their purpose is to enable the user to understand what is happening on the various signal lines of a logic system. This is usually more difficult than in an analogue system simply because of the number of signals which change at the same time. The difficulty is further compounded by the fact that everything happens in a fraction of a microsecond.

Logic analysers allow many different voltages, say 8 or 16, to be displayed and compared over selected time intervals. The mode of operation is to select one signal and use it as a reference against which all the others are measured. In the very simplest device a latch will be set when the state of the signal lines being monitored matches a preset condition and the reference signal is also valid. In more complex units the states of other signal lines may be stored at the same time for display on a suitable readout device. In the most complex units the states of many signal lines are stored before and after the trigger point and will usually be displayed on a CRT. In some units the available information can be processed by a microprocessor to give a display which is most suited to the user's requirements. This makes it much easier to understand.

ETI

sweet sixteen



The Cortex II offers serious users speed (12 MHz CPU) and power (16-bit) at an easily affordable price.

Cortex II offers over 34K byte memory for basic programmes. High speed 24k byte basic interpreter. Auto-line numbering facilities and full renumbering command. Full textural error messages. Arrays and strings limited only by memory. Extended Basic (IF-THEN-ELSE). Assembler/Disassembler. Machine code monitor. Real time clock.

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Cortex II is the successor to the popular Cortex, which first appeared in November 1982. The new model incorporates a number of modifications to the original and is supplied with a 216 page users manual.

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Centronics printer interface kit	**Contact Sales**
E-bus kit	**Office for details**

Cortex II Built and Tested
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All prices are VAT exclusive and are correct at time of going to press.

Cortex II is available by mail order from:

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Portway Industrial Estate
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cortex II

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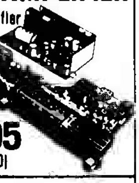

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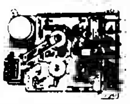

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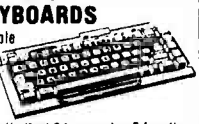

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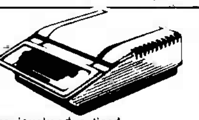

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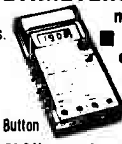

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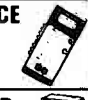

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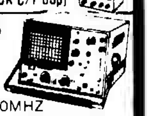

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CORTEX CENTRONICS INTERFACE

In the slightly delayed second part of this article, we present the construction and use details.

The overlay of the PCB is shown in Fig. 4. There have been three modifications between this and the original circuit given in the June ETI. Firstly, the address lines A4 and A8 were the wrong way round in the original circuit diagram and this has been corrected.

Secondly, an extra package, IC6, has been added, of which only one inverter gate is used. This is to provide a complement of STROBE as well as STROBE itself on the Centronics output; this is to increase flexibility, as some printers will require the complement rather than the original.

Finally, and also to increase flexibility, the W and Y outputs of IC4 are link-selectable; using the Y output, the BUSY IN line is

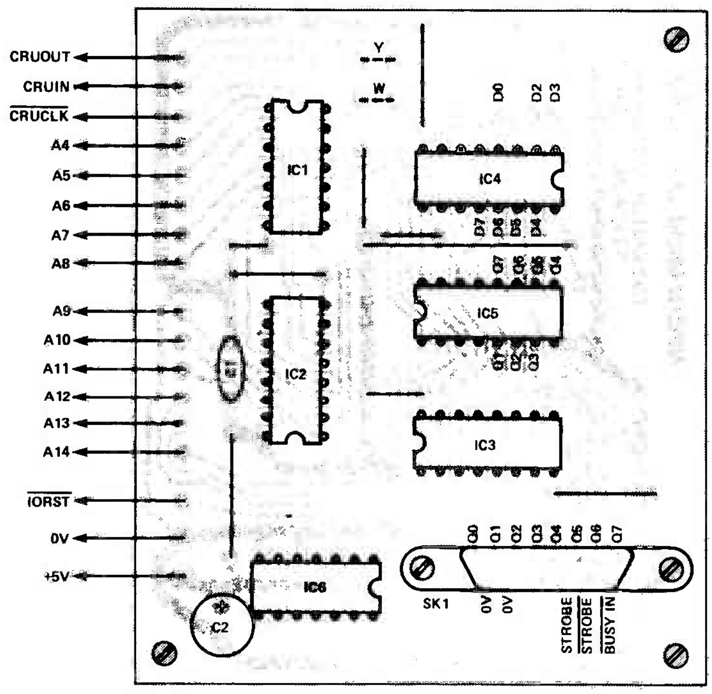


Fig. 4 Overlay diagram for the PCB. The points marked D0, D2, D3 etc and Q1, Q2, etc on the PCB (not the connector) are for the unused locations that readers may wish to make use of. Note that there are two additional decoupling capacitor location points, in the unlikely event of any supply line problems arising.

inverted to become the CRUIN signal; using the W output, it is not; one or other of these will be appropriate to your printer. Needless to say, you should not use both links at the same time!

Using the special PCB, assembly of the circuit should be quite straightforward, but do make sure you get the links in the right places and be careful with IC orientation. Some clearances are a

PARTS LIST

CAPACITORS

C1	100n ceramic
C2	10µPCB electrolytic

SEMICONDUCTORS

IC1	74LS32
IC2	74LS138
IC3,5	74LS259
IC4	74LS241
IC6	74LS04

MISCELLANEOUS

15-way D-type connector socket & plug; PCB; connector to suit printer; ribbon cable, etc.

BUYLINES

A full kit of parts for this project will be available through Powertran Cybernetics Ltd, Portway Industrial Estate, Andover, Hants SP10 3ET. Powertran hold the copyright on the PCB so it will be available only from them.

Fig. 5 Test program for the interface, to print a row of 'A's.

```
1Ø  BASE  Ø8ØØH                    ! I/O BASE ADDRESS
2Ø  CRB (8) = Ø                    ! RESET STROBE
3Ø  CRF (8) = Ø 41H                ! O/P ASCII 'A'
4Ø  IF CRB (9) = 1 THEN GOTO 4Ø    ! WAIT FOR FREE
5Ø  CRB (8) = 1 : CRB (8) = Ø      ! PULSE STROBE
6Ø  GOTO  3Ø                       ! LOOP
```

bit tight, so do check carefully for any solder bridges after you have finished.

In Use

Once the interface is connected between the computer and the printer, then typing in the command UNIT 4 will enable printing, while the command UNIT — 4 will disable printing. If the printer fails to print or a paper-out condition arises, then pressing both the GRAPH and RUBOUT keys together will cause all output to be reset to UNIT 1 only.

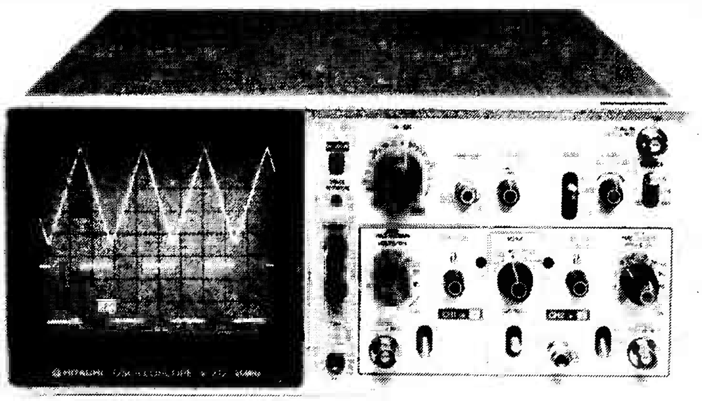
The BASIC program shown in Fig. 5 can be used; this should print a stream of letter 'A's.

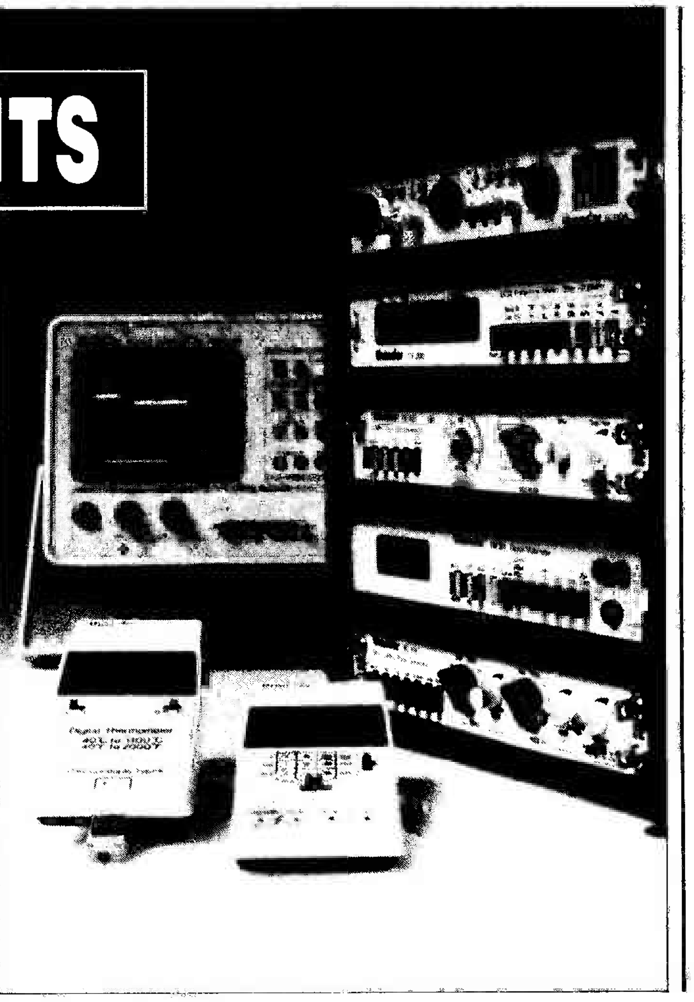
Having built the printer interface you will have noticed that there are seven spare I/O bits and if the printer is not in use then seven other parallel data ports with separate strobes and status bits can be used with a common data port. Also six other I/O address slots are decoded by IC2 as shown:—

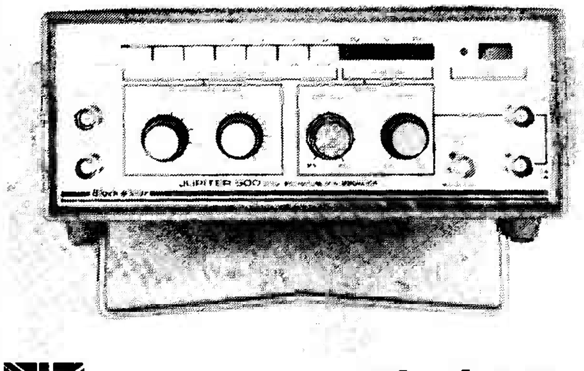
O/P	ADDRESS	
Y0	0800	Parallel data output
Y1	0810	Single bit I/O
Y2	0820	
Y3	0830	
Y4	0840	Unused
Y5	0850	
Y6	0860	
Y7	0870	

We look forward to receiving project ideas from readers that make use of these!

ETI







CHOOSING TEST EQUIPMENT

The second of our special features looks at the items of test gear likely to be of value to the home constructor and offers some advice on choosing the right equipment for your needs.

Buying test equipment can be a pain. Low volume production test equipment tends to be expensive compared with mass-produced, consumer-orientated equipment of similar complexity and even a basic multimeter can easily set you back thirty pounds or more. If you want anything special out of your meter you can wave goodbye to hundreds of pounds, and from there on in the price of test equipment seems to rise according to a square law. Large electronics manufacturing companies do not appear to think twice when spending hundreds of thousands of pounds on test equipment, but whatever your budget, it is obviously essential to see that your money isn't wasted and that you make the right choices.

But what is the right test equipment? The answer is not simple. The difficulty lies in choosing equipment that you really need rather than equipment that you happen to like. There is little point in buying a £10,000 digital storage oscilloscope (even if you can afford it) just because you like the colour of its knobs when what you really need is a £1,000 non-storage oscilloscope with less attractive knobs.

You cannot hope to make a sensible choice until you have some idea of what each type of equipment can do for you. There are many different kinds of test equipment and each kind has, in turn, an enormous variety of specifications, depending on manufacturer and intended function. At first sight, the task appears huge. By considering how the test equipment is to be used, however, it becomes less daunting.

We can broadly classify all varieties of test equipment into three main areas of use:

- In the first area is test equipment used to aid research, design, and development of new products.
- In the second area is test equipment used to help in the manufacture and quality testing stages of production.
- In the third area is test equipment used to service and repair other equipment which has become faulty after initial commissioning.

Inevitably, there is a considerable overlap between these areas with some equipment being used in two or even all three areas, but, on the whole, distinct divisions do exist.

A good place to start our look at test equipment is with the varieties which overlap onto all three areas. In this way we may build up a picture of a 'minimum list' of general purpose items needed in any electronics environment.

Meters

The first thing that most people will consider buying is a multimeter. This is one of the most important pieces of test gear you will possess so spend as much as you can reasonably afford and shop around for one that suits you. Try out as many as you can before committing yourself.

Two main types of meters exist, analogue and digital, and many different varieties of each type are common. A meter's task is to measure a given electrical parameter, such as voltage or current in a circuit, and display it either by pointing a needle at a number in the case of an analogue meter or by activating the appropriate digits or segments of digits in a digital meter.

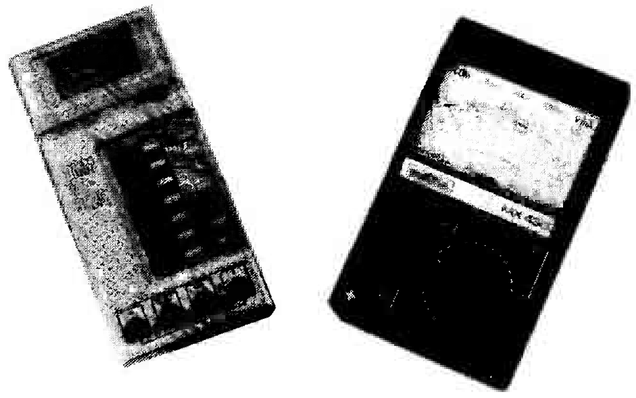
If a meter is capable of measuring voltage, current and resistance, it is generally classed as a multimeter. Ranges of multimeter measurements vary between fractions of volts, amps and ohms through to thousands of each, and the cost of a meter depends largely on the size of the range required, together with the desired accuracy.

Some meters feature extra facilities such as automatic ranging or a high humber of display digits. Also available are meters which can measure other quantities, such as capacitance, electrical power, temperature, frequency and distortion.

A good choice for a first time buy would be a moving coil type with at least 20,000 ohms-per-volt sensitivity on the DC voltage ranges. It should have a clear scale from which any range can be read accurately without feats of mental arithmetic or resort to a magnifying glass.

For general use your selected meter should be able to read AC and DC voltage up to 1000V with at least 4 ranges for each. DC current should be available up to 1000mA (1A) and resistance from 1 ohm to 1 Mohm in two or more ranges. Note that the sensitivty on the AC voltage range will be much lower than that on the DC range.

If you decide to select a digital type of instrument in many cases the input resistance will be fixed and



should be at least 1 Mohm. Some meters of this type can offer autoranging on AC and DC ranges and this can be very useful.

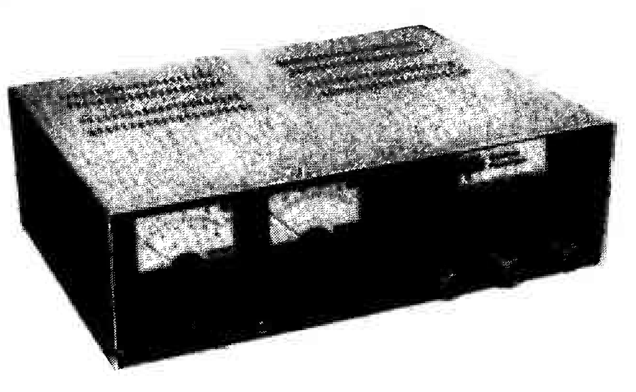
Power Supply Units

When developing, building, or testing a circuit a power source of some type is needed. A general purpose power supply, providing a range of voltages and currents, is therefore an essential item.

Initially you may well use dry cells for small projects but this can soon get a little expensive. One alternative is to use Ni-Cd rechargeable batteries. The initial outlay on the cells and charger is quite high but soon repays itself if used frequently. The more common way, and certainly the best for the 'serious' hobbyist, is the buy or construct your own mains powered DC supply. For a complete beginner buy one of the small battery eliminators which are sold to power transistor radios. When some constructional experience has been accumulated you can attempt to construct your own. A useful avenue to try may well be to construct a kit from one of the many advertisers in this magazine.

Generally, power supplies are of two main types, either single or twin. The first type will provide a two-rail output (0, + V), and the second a three-rail output (−V, 0, +V). A useful feature found on some power supplies is a current limiting circuit which allows you to set the maximum current available. If, for example, a short circuit exists in a connected circuit (which would otherwise draw too much current) the power supply will only provide the set amount of current, thus preventing damage.

The cost of a power supply will dpend largely on the current it is able to supply rather than on the voltage. This is because the power the supply is capable of delivering defines the cost of each component



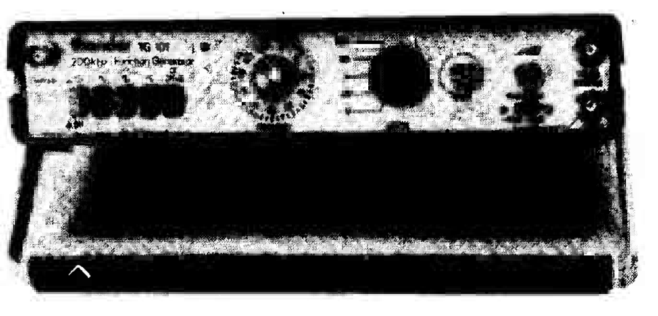
within the supply. A power supply providing, say, 40 V at only 100 mA is supplying only 4 watts of power whereas one providing only 10 V but at 5 A is supplying 50 watts.

The precise power supply you require depends greatly on what you want to play around with. For computer circuits the main requirement is for +5V at 1 to 3 amps or so. Other voltages are occasionally needed but need not be a priority. On the other hand, for analogue circuits you will need a variety of voltages and these can best be met by a dual supply whose output can be varied from 0V to 20V at currents up to 500mA. Audio amplifier circuits often need higher voltages and currents but these are better considered when the occasion arises.

Function Generators

It is useful when testing the majority of circuits to have some means of providing an input signal of known quantity. The circuit may then be studied as this input signal is applied. Items of test equipment which allows us to generate such known input signals are loosely classified as function generators, and are generally oscillators of some description.

Sinewave, squarewave and triangular wave oscillators generating frequencies in the range 1 Hz to 1 MHz are often used to test audio circuits. Radio and TV circuits require radio frequency oscillators and many are available which generate signals in the range from a few kHz up to and over 100 GHz. Digital circuits are often tested with pulses, and generators exist in which pulse duration, amplitude, and position can easily be controlled.



Function generators are available ready made or in kit form from many sources. You can, of course, make one yourself from one of the many excellent designs which have appeared in these pages. This latter course will probably be the cheapest but for ease of use the former course is to be preferred unless you are prepared and able to engineer it properly.

Oscilloscopes

The last item of test equipment forming the minimum list of essentials is the oscilloscope. This is probably the single most versatile piece of test gear available. It's fundamental job is to measure and display a voltage over a period of time. Thus a waveform is displayed on a cathode ray tube screen which represents the measured voltage.

From this basic idea of an oscilloscope, many different forms have originated. The simplest is the single-trace oscilloscope which measures only a single voltage, but by far the most popular is the dual-trace oscilloscope which allows two voltages to be displayed on the screen simultaneously.

The scale of the axes of the displayed waveform (ie, volts on the y-axis, time on the x-axis) may be varied by controls on the oscilloscope. Generally, the scales are between, say, 5 mV to 10 V per vertical division, and 0.5 us to l s per horizontal division. By setting the controls to suit a large variety of waveforms may be displayed, from only a few millivolts in amplitude to hundreds of volts, and with frequencies from a fraction of a hertz to many megahertz. Cost varies largely according to the range of scale settings, and the maximum usable frequency of the y-amplifier.

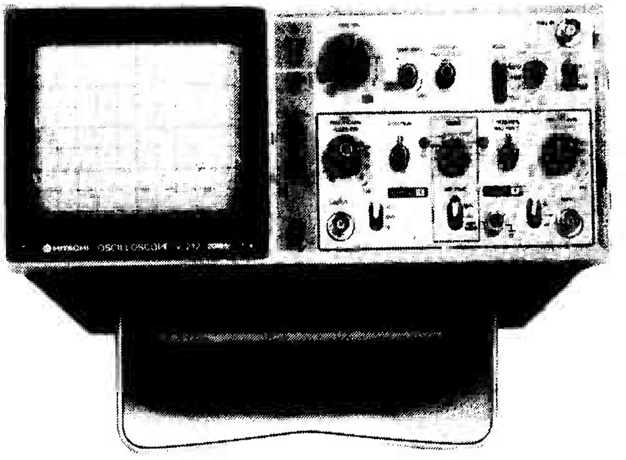
For the hobbyist, a general requirement for an oscilloscope might look something like this:

> Dual trace, 15MHz bandwidth, 5MV to 50V per division, AC or DC coupling, 1μsec to 100msec per division with variable and x5 or x10 magnification. Triggering from either channel or external socket with AC, DC variable level and slope selection.

There should also be a probe calibration output and a pair of probes either x10 or switchable x1/x10. For TV work, x100 probes may be useful for higher voltages.

The instrument should be one which will give a readable trace at fast timebase speeds and give stable triggering to a frequency higher than the Y bandwidth. Other facilites such as delayed timebase can be very useful for digital work but should not be sacrificed for basic performance.

Unfortunately, such machines are expensive, but if at all possible it is well worth purchasing one in the



£350 to £500 range. Don't neglect to consider the second hand market, especially if a suitable unit is available with a warranty after reconditioning.

One thing you should obtain with your oscilloscope, whether new or second hand, is a complete handbook telling you how to calibrate it. Even if you do not intend to do it yourself it may be useful to whoever does.

Of course, once you have a good oscilloscope you will be able to make and set up all the signal generators and such that you want. In fact with a 'scope, signal/pulse generator and reasonably versatile power supply added to your basic multimeter you should be able to tackle almost anything.

ETI

DATA DIRECTORS
MAX 100
PROBES
2001 FUNCTION GENERATOR
BREADBOARDS
4001 PULSE GENERATOR
GLOBAL SPECIALTIES CORPORATION
Tomorrows tools for todays problems
5001 COUNTER TIMER
6001 FREQUENCY TIMER
6002 FREQUENCY COUNTER
1301 POWER SUPPLY
DATA ROUTER
PROTO BOARDS

AUDIO DESIGN

Power amplifiers need a source of power, and the usual place to get it from is the AC mains. In this third part of the description, John Linsley Hood describes the PSU and a power meter.

In the previous part of this article, referring to the power amplifier, I outlined the advantages which arose from the use of a stabilised power supply unit, which had persuaded me that this kind of arrangement was essential if I was aiming for the highest standard.

I was, indeed, responsible for a bit of propaganda in this cause in an earlier article (ETI May, 1983) describing such a stabilised PSU unit, and the basic elements of its design were analysed at the time. Inevitably, therefore, my thoughts returned to this as a useful working design, though, in this case, I wanted to add somewhat to the facilities offered by the earlier design.

These additions are a pair of stabilised, lower current, power supplies to drive the earlier, class-A (voltage gain) stages of the power amplifier, and a DC offset monitoring facility which could be used to detect any abnormal DC voltage present on the LS output terminals — as might arise, for example, in the event of a catastrophic failure of one of the output devices — and switch off the high current sections (+ve and −ve) of the PSU, before any damage could occur to LS units or the like.

Since the power supply described previously has a re-entrant output characteristic (which means that the DC output current will decrease as the output voltage falls to very nearly zero output current into a short circuit), it will also perform the function of overload protection for the PA in the event of an abnormally low impedance output load. I happen to know that this works, since during bench testing, to see just how much power I could get out of a single channel driven just short of clipping (117 watts, as it turned out) and how well the PSU would hold the line voltage under these conditions (−1 volt) the soldered connections holding my load resistor melted off, the resistor dropped onto the floor, and the two liberated lengths of wire connected to the output terminals promptly soldered themselves together! After I had restored the load, everything was still perfectly functional, and apparently unruffled by the event.

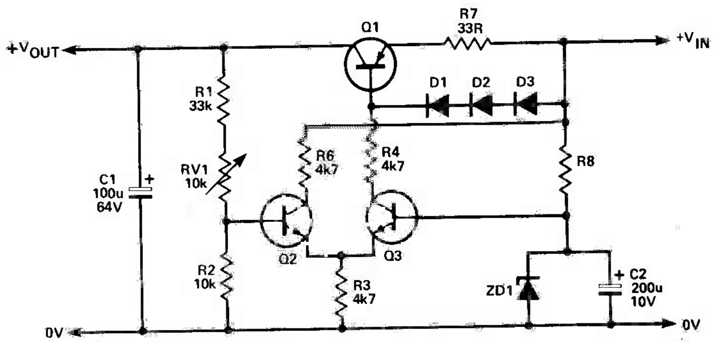


Fig. 1 Low-current stabilised PSU.

Experimental work, and inward deliberation, has convinced me that it is very advantageous to separate out the power supply lines feeding the output and the class-A stages of a power amplifier — indeed I think it is a false economy not to do this — and if one is using a stabilised PSU, it makes sense to put in a few more components to generate a pair of independently stablilised lines for the early stages.

Since the current requirement at this stage is quite small, typically about 12mA per channel, no problems of 'secondary breakdown' will arise in the series control transistors, so a simple constant-current overload characteristic will suffice, at 35-40mA total output. This will prevent anything inconvenient happening in the event of an accidental output short-circuit across these DC supply lines, as can so easily happen during setting up or testing.

I have shown the circuit I have adopted in Fig. 1. Once again the input and output voltage requirements prevent the use of an IC voltage stabiliser, though I guess that 60-80V input voltage IC stabilisers will be on the market (at a price) within the next few years. As in the higher current supply previously described, the pass transistor, Q1, is turned round so that the output current is drawn from its collector. This allows the forward base bias current to be derived from the 0V line, rather than from the forward voltage drop across this transistor. This makes for more efficient working and allows a much lower minimum voltage differential between input and output.

This last factor is important, because although the output voltage is very smooth, the input voltage across the power supply reservoir capacitors will show a fairly large 100Hz 'sawtooth' waveform, of 5 to 10V P-P amplitude, when a significant amount of current is drawn from it. The stabiliser circuit must work as well at the minimum input voltage represented by the bottoms of these input voltage waveforms (see Fig. 2) as at their peak.

Circuit Operation

This method of operation of the circuit is quite straightforward: a 10 volt reference voltage is generated across ZD1 and C2 by

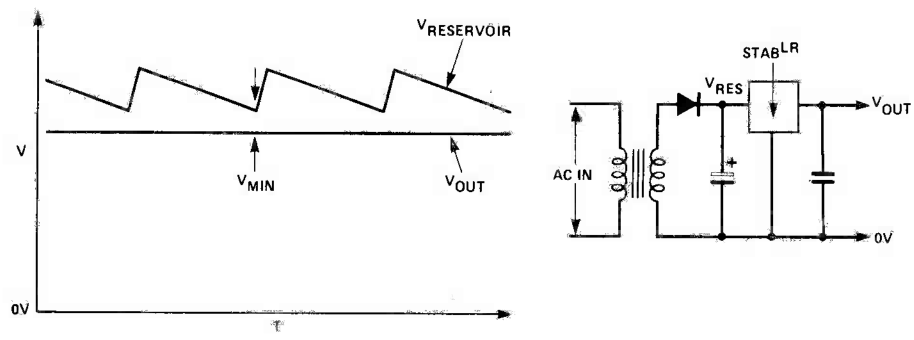


Fig. 2 The effect of ripple on stabiliser input — output voltage.

current flowing through R8. This is applied to one of the long-tailed pair of transistors Q2/Q3, and turns Q3 on. This passes current through R3, Q3 and R4 into the base of Q1, which causes Q1 to conduct and feed current to the output. A proportion of the output voltage, developed across R1, RV1 and R2 is applied to Q2, and if this exceeds the 10 volt reference fed to Q3, the current flowing through the 'tail' resistor, R3, will be progressively diverted away from Q3 and Q1, and will, instead, pass through Q2 and R6.

By this means, the voltage permitted at the output of Q1 is controlled so that the current flowing through R2 (which is, in turn, controlled by the values of R1 and RV1) produces a 10 volt drop across it (remember, V=IxR).

Overload (over-current) protection is obtained by putting a resistor R7 in the emitter circuit of Q1, and three small diodes (D1, D2 and D3) between the DC input and its base. Q1 will require about 0.6V forward bias to conduct, while the diodes will conduct at about 0.55V each. This limits the voltage which can develop across R7 to 1.65-0.6V=1.05V. If the voltage tends to exceed this value, Q1 will run out of forward bias, and will progressively turn off. With a value of 33R for R7, the circuit will limit at about 35mA, under output short-circuit conditions, which makes it effectively disaster proof.

To calculate the circuit component values, we first select a pass-transistor, Q1, as a device which will withstand 70 volts input, and carry the necessary current: a BD538 will serve. This has a minimum H_{fe} of 40 at 100mA, so it will need, say, a 1mA base current. Therefore let us make Q2 and Q3 both pass 1mA normally. This requires a 'tail' resistor of 4k7 (R3). The output voltage divider chain is chosen to pass about 1mA and give +10V at Q2 base when the output voltage is +50V. R4 and R6 are just protection resistors to prevent damage if a faulty transistor should be inadvertently installed in construction. RV1 is adjusted to set the output voltage to +50V. A mirror-image of this circuit is used to provide the −50V supply.

LS DC offset protection

I have made use of the two transistor 'thyristor' circuit shown in Fig. 3 to provide the offset protection function. (Note that component numbers here refer to Fig. 3) In this arrangement, Q1 and Q2 are both normally non-conducting. However, if an input voltage is applied to Q2, even briefly, it will conduct and feed current into the base of Q1. This will make Q1 conduct, which, in turn, will feed current into Q2, which holds the circuit on, or 'latched'.

In order to make the circuit respond only to long-term averaged DC offsets, a 1M0 and 2μ2F input integrating circuit is connected to the LS outputs, with an emitter-follower transistor Q3 interposed as an impedance conversion system. A similar circuit, with Q4, R4 and C2, can then monitor any offset occurring on the other channel. To avoid quadrupling C1 and C2, the offset voltages averaged across these are taken to a mirror image circuit controlling the other half of the PSU. The circuit I have shown is for the positive half of this.

When Q1 and Q2 are latched, the voltage drop across them falls to about 0.65V, and they will stay in the latched condition until the power supply to them is removed by switching of the equipment. it is possible to provide a momentary reset by S1, R5 and C3. If the fault persists the circuit will cut-out again almost at once. I prefer to switch off in the event of failure, so I haven't provided this facility on my prototype. The output of this 'thyristor' is taken to a point on the main PSU where a 0.65V clamp on the circuit voltage will cause the system to cut off.

A simple resistor and zener diode network, shown in Fig. 4., monitors the relative voltages on the +ve and −ve supply lines. If these differ by more than 20V, as will happen if one of the supplies is cut off, it will then turn the other line off as well. Since the tripping of one of the DC offset monitor circuits will automatically trip the other, the power supply failure warning can be given by a LED, in seies with a zener, and a suitable limit resistor, between the reservoir and the output on either DC line, so that the LED will light if the difference between input and output voltage exceeds 30V. This will happen briefly on switch-on, because the power supply has a slower rate of voltage rise (deliberately) than the voltage rise across the reservoirs. However, the LED will extinguish, in the absence of any fault condition, in a few seconds, when the supply lines have reached their proper operating voltage.

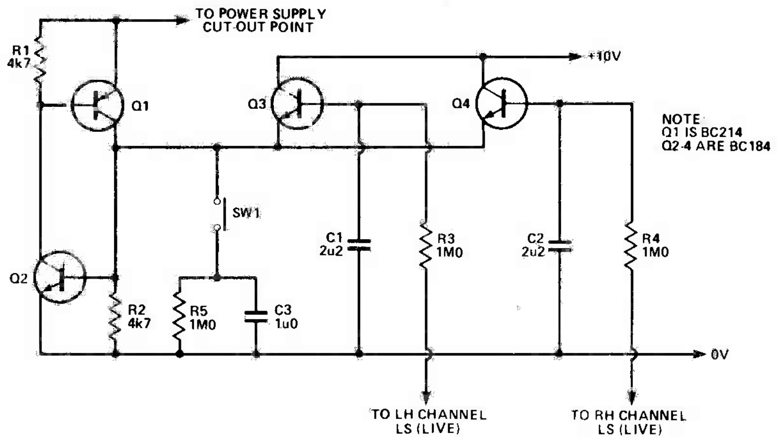


Fig. 3 Amplifier output DC detection and trip circuit.

The Full Circuit

The complete circuit diagram, apart from the transformer and rectifiers, of the power supply is shown in Fig. 5. The low current supplies, built around Q1, Q2 and Q3, with their mirror-images (Q4, Q5 and Q6), are as have been described above. The protection circuitry (Q9, Q10, Q11, Q12, Q13, Q14, Q15 and Q16) in its two mirror-image forms, is also as described above. The rest of the circuitry, comprising the twin high-power stabilised units, is largely as described in May 1983, but I will run through its operation to explain the method of the cut-out trip function, and to avoid difficulties for those who missed the May '83 issue (Shame! — Ed.).

Taking the positive-line supply section, a power Darlington transistor, a Motorola MJ2501, is used as the series control or 'pass' device. This is a moderately beefy component, with a maximum current of 10 amperes, an 80V_{ceo} rating, and a maximum dissipation

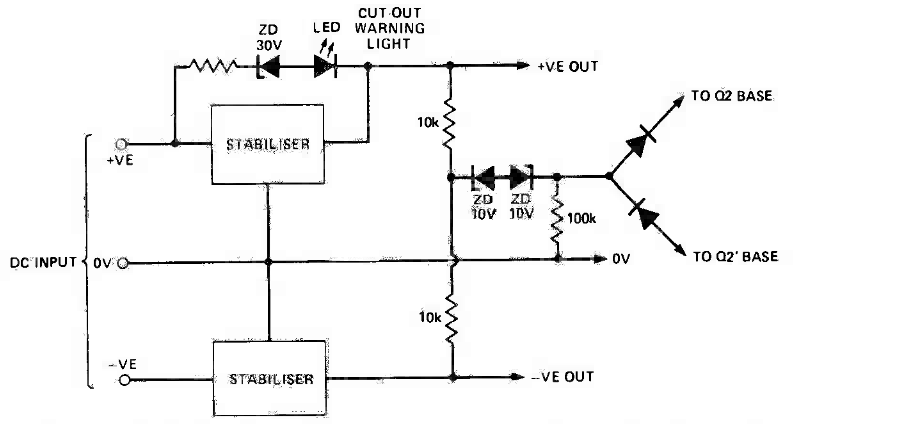


Fig. 4 Method of making both power supplies cut out simultaneously.

of 150 watts. The 'safe operating area curve' is shown in Fig. 6, and the actual output currents, with voltages, given by the PSU are as shown, for two different values of R15/R16.

To check on my calculations with these I have run the PSU into a low resistance (0.1 ohm) ammeter, which gives an effective output short-circuit, with the transformer fed from a 'variac. I have also, inadvertently, made screw-driver-type shorts from supply lines to chassis, without any disasters. This is *not* a practice I recommend, but it does happen, especially if one is developing or debugging a new circuit and one forgets to switch off.

The pass transistor Q17/Q20, is normally turned on by current flow from the 0V line through a control transistor, Q18/Q19, and a current limit resistor, R29/30. The control transistor is itself made conducting

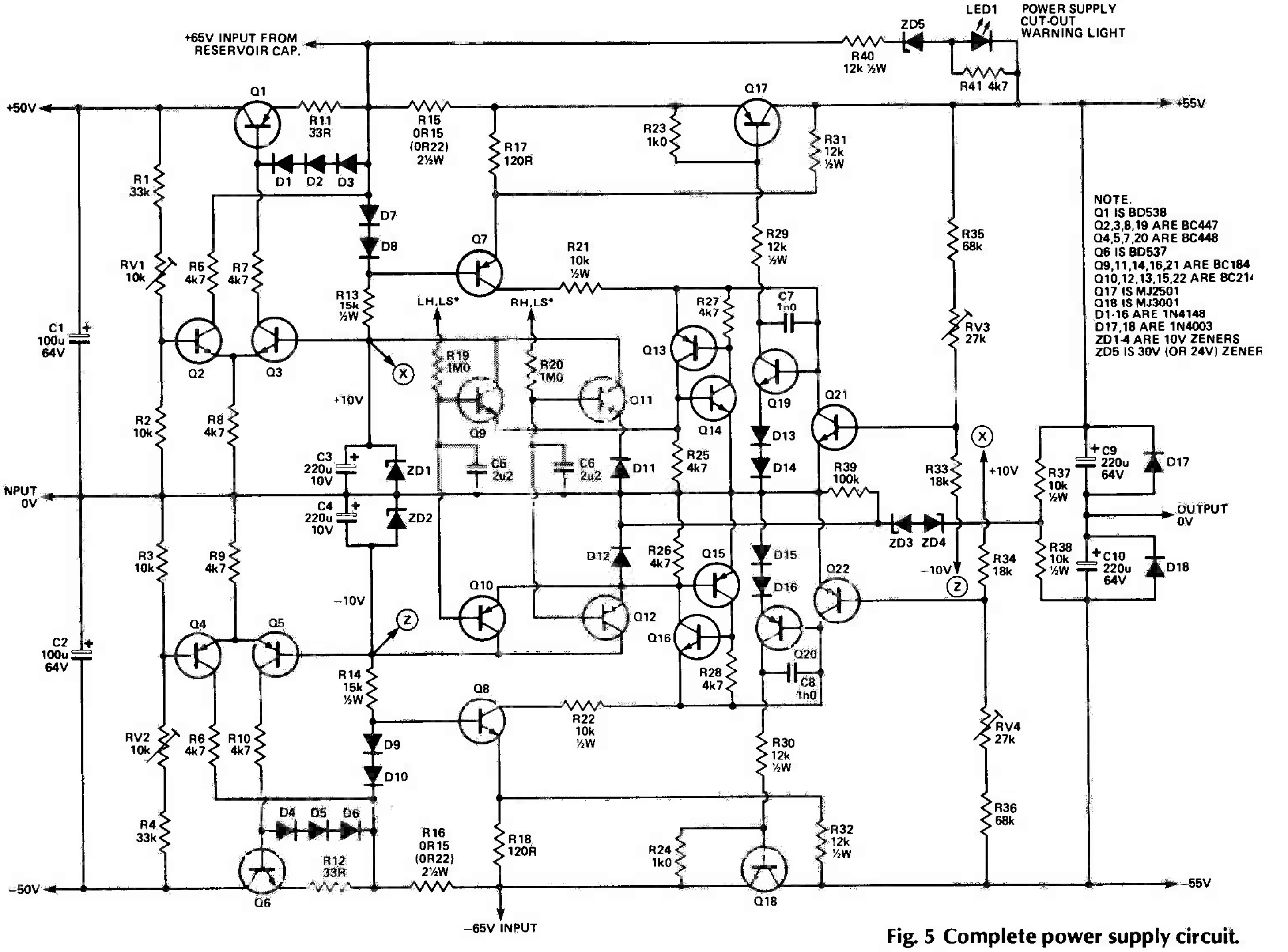


Fig. 5 Complete power supply circuit.

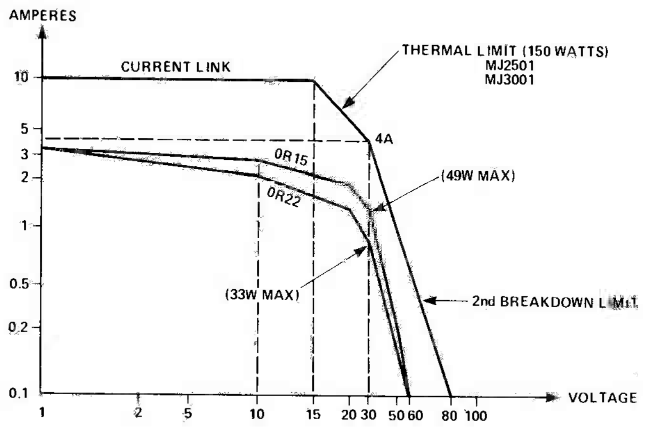


Fig. 6 Safe operating area curve for MJ2501/3001 and output current/voltage limits for PSU.

by a current flow from the input line through the protection transistor, Q7/Q8. A further transistor, Q21/Q22, sits between the 0V line and the base of the control transistor. This monitors the potential developed at its base from the voltage dropper chain, R35, RV4, R33/R34, RV3 and R36, connected between the output voltage line and the internal zener reference potential. If the output voltage should increase, this transistor is turned on more, and 'steals' more current from the control transistors base supply. This in turn reduces the current flow through the pass transistor, to oppose the detected increase.

Because there is a very high loop gain in this three transistor amplifier loop (Q17,Q19,Q21) — much higher than that of the low power supply which has a much less onerous job to do — some HF loop stabilisation is needed and this is provided by the small capacitors C7 and C8.

The current limit transistor, which sits astride the supply to the control transistor, is normally turned on by a forward voltage developed across the diodes, D7D8/D9D10, in the path to the zener supply. However, if too much current flows through the circuit this foward bias will be diminished by the voltage drop occurring across R15/R16, and will ultimately switch this transistor off again. A similar function is carried out, in respect of the voltage across the pass transistor, by the two resistors R32 and R17/R33 and R18. Acting together, these current flow and voltage sensing networks generate the limiting characteristics shown in Fig. 6.

In order to help the operation of the cut-out circuit, a pair of diodes, D13,D14/D15, D16, have been added in comparison with the original circuit. This means that the base potential of the control transistor normally sits at about 1.65V with respect to the 0V line. When the trip circuits operate, this is clamped at 0.65V, and the control transistor and the pass transistor are both cut off. The LED is then illuminated, to indicate a fault condition.

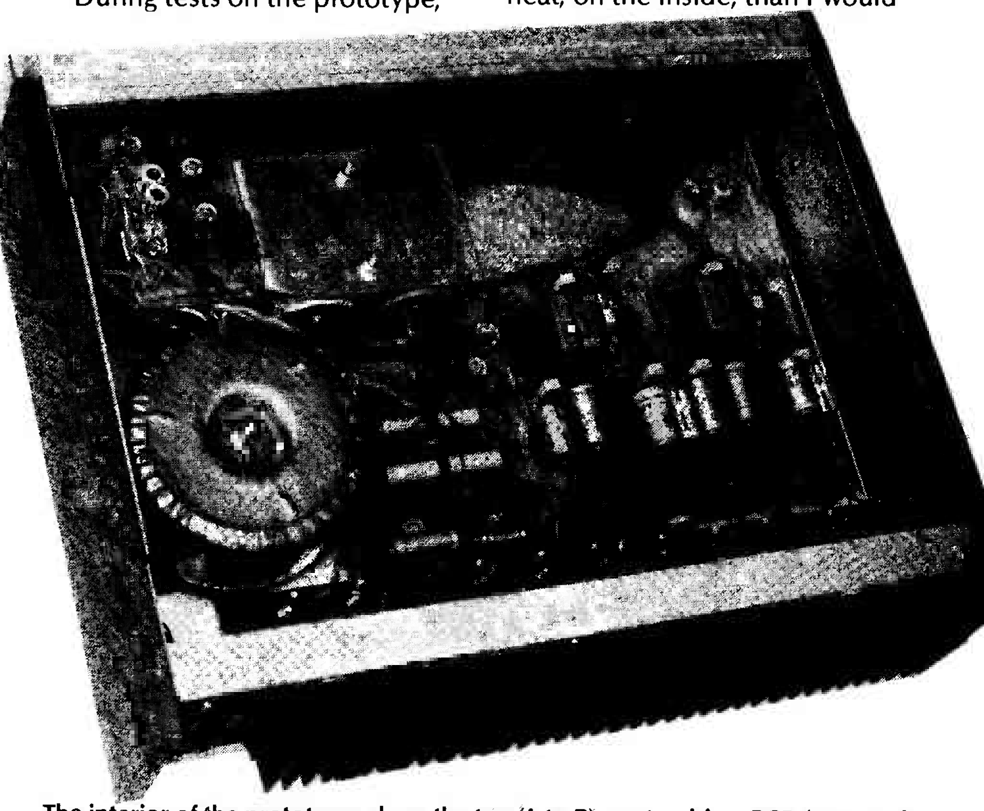
As mentioned above, the power supply can be momentarily reset by applying a discharged condenser between the 0V line and the bases of the trip transistors, Q14/Q15.

During tests on the prototype, the output voltage of the PSUs, under quiescent conditions, were constant for mains input voltages varing between 170V and 260V RMS, and the output AC ripple was less than 3mV. The measured voltage drop, from minimum to maximum measured load (one channel driven at 117 watts) was less than 1V.

Setting Up The Amplifier

Normally my amplifiers start more or less as a plain sheet of aluminium, of a bit larger than the expected necessary size to allow for oversights, on which the bits and pieces are fixed in a way which looks sensible when all of them are eventually to hand, and working as I hope. The result inevitably looks a bit less polished than the commercial equivalent. In this instance, through the good offices of Electronics Today International, I was provided with some nicely made metalwork from Newrad Instrument Cases, into which I fitted the various PCBs which I had previously made, along with the other essential major components, in the best practicable arrangement in relation to the plugs, sockets and controls installed by Newrad.

The result, shown in the photograph is perhaps a little less neat, on the inside, than I would



The interior of the prototype: along the top (L to R): meter driver PCB (mounted over on/off and mute switch), reservoir caps, switch-on muting PCB; bottom: transformer, PSU, 2 x power amps

expect the final kit version to be.

Externally I am very pleased.

I have mounted all the ten power transistors (eight from the amplifier, and two from the power supply) on a length of substantial gauge angle aluminium which is clamped to the back plate of the amplifier. On the outside of this back plate, four Redpoint heat sink blocks are mounted, side by side, to give a heat sink 32cm long by 5cm deep with total fin length of 3cm. This heat sink has a calculated capacity of 0.4°C/watt, and gets only mildly warm in use. This arrangement, in which the transistors are mounted horizontally inside the box, is one which I prefer, since it protects the exposed cases of the transistors from inadvertent electrical contact, and makes their connections easy to join. The white silicone/zinc oxide heatsinking paste should be applied to all the joins through which heat is to pass.

I have used 4mm insulated terminal binding posts (10 amp rating) mounted on the rear panel, for the LS output connections, and these are joined to the output pins on the PA PCB by twisted pairs of 24x0.2mm PVC insulated cable (4.5A rating). The 0V pins at the output of the PA boards are taken, using the same type of wire, to a conveniently positioned chassis earth point, which should not be too far away from the reservoir capacitors.

I have shown the mains input, transformer, and reservoir capacitor circuit and suggested layout in Figs 7 and 8, and I have indicated, by heavy lines, which of the connections it is preferred should be short, and of the thickest gauge of stranded wire which it is practicable to solder. The important thing to remember is that the wires from the capacitor tags to the earthing post are carrying heavy currents and will have significant voltage drops along them. They should therefore go directly to the earthing post, and nothing else should be joined to the lug on the capacitor case.

The output 0Vs from the PAs, and the input and output 0V lines from the power supply unit, are similarly taken directly to this post, with as substantial a gauge of wire as reasonable. The input earths for the amps. are commoned both at the input phono sockets and at the gain control, and joined to the earth post with a single wire. By this means, the heavy pulsating

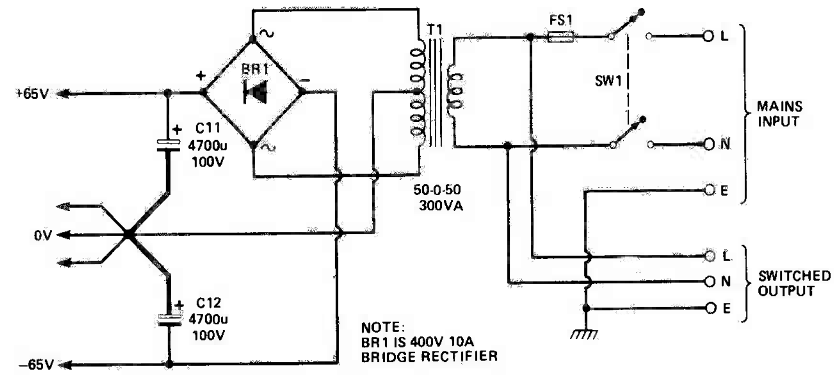


Fig. 7 Mains input circuit for power supplies.

currents in the output DC supply and return lines are kept out of the input signal path, where they can introduce significant amounts of distortion, and impair the performance of an otherwise impeccable amplifier.

(It is a very useful thing to have some form of distortion meter to check that all is well, if one is building such a unit from scratch, rather than following a previously researched plan, and if the Editor of ETI will approve, I will show how a simple, but sensitive unit can be built without too much difficulty.)

Since the input sockets are also mounted on the back panel of the amplifier, it is necessary to screen these so that they do not pick up capacitatively coupled signals from the cases (which are connected to the output) and wiring associated with the output MOSFETs. It is also necessary to isolate these input sockets from the chassis earth, to avoid earth path signals which could contain both hum and distortion inducing voltages. I solved this problem on the prototype by making up a little tin box, with soldered corners, on which the input phono sockets were mounted, and which itself was held to, but insulated from, the back plate.

Signal Muting

This is a facility for which there is provision on the PA PCBs, but which I did not describe in the last part of the series. This employs the circuit layout shown in Fig. 10. In this a normally closed push switch (two-gang) is inserted in place of the link shown on the PCB. This is bypassed by a 1nF capacitor and a 470k resistor, so that when the switch is opened, the gain of the amplifier is reduced from 122 to 1.3, at all frequencies below about 100kHz — which are safely supersonic.

The 1nF capacitor is there to avoid jeopardising the feedback safety margins at HF which are a lot less at unity gain than at 122.

By the use of this control, the amplifier can be effectively 'muted' during switch-on, to minimise plops, or during other operations where it may be desired to avoid unwanted noises. I have suggested this technique, as an option, since my decision not

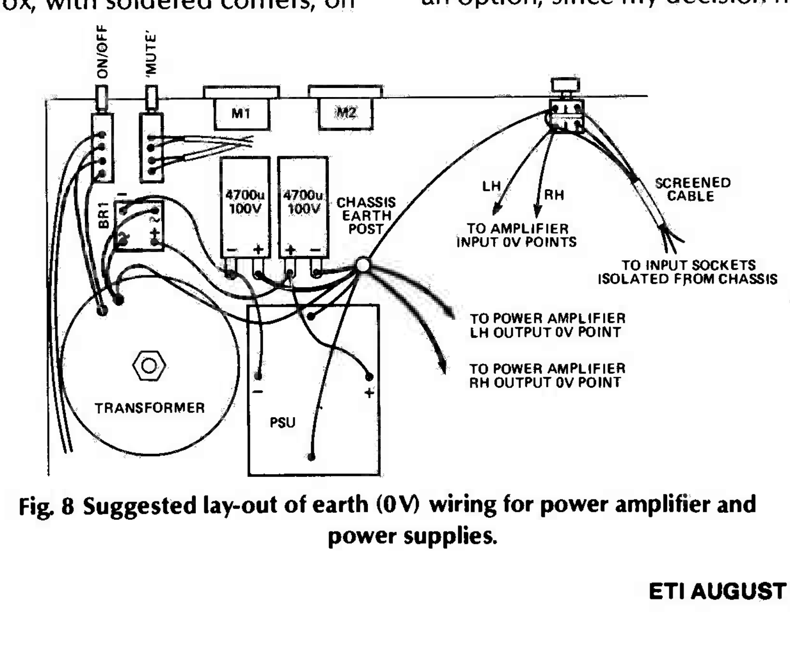


Fig. 8 Suggested lay-out of earth (0V) wiring for power amplifier and power supplies.

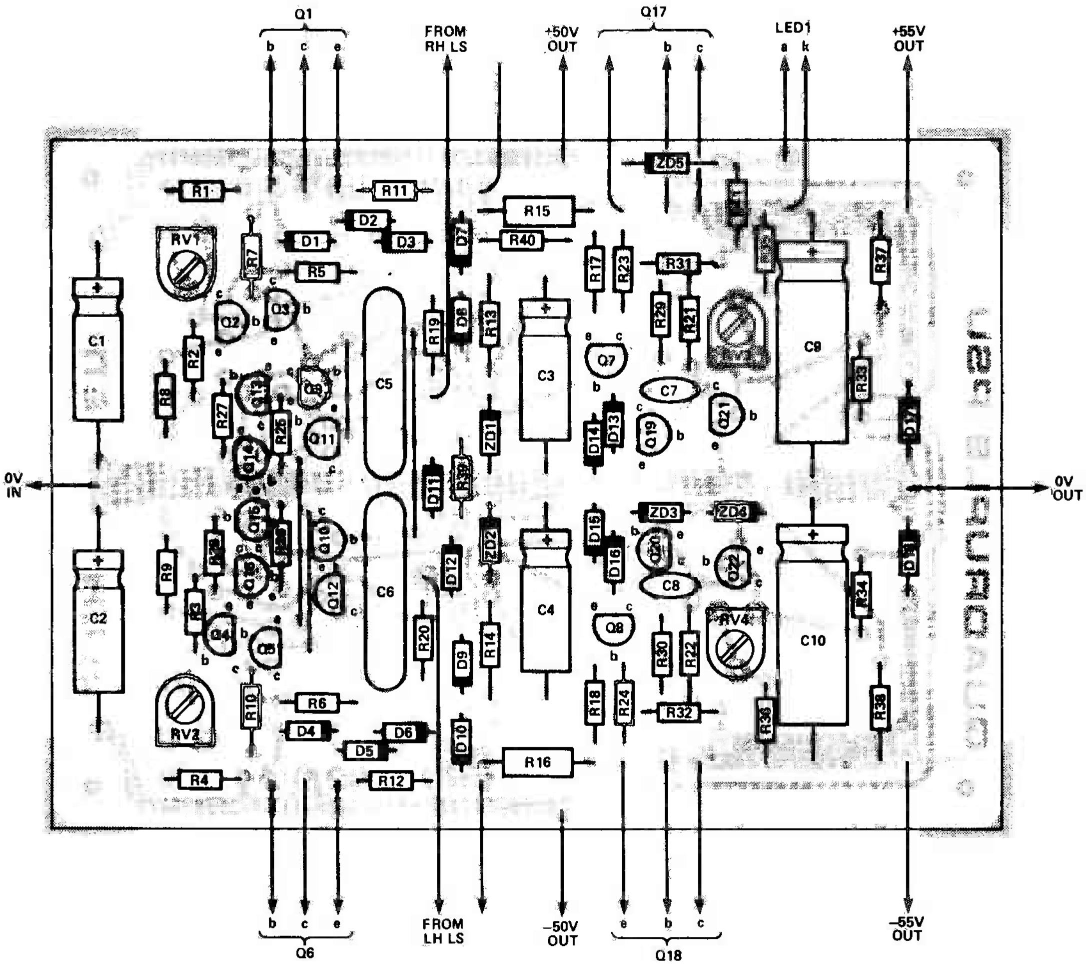


Fig. 9 Overlay diagram for the PSU.

PARTS LIST — PSU

RESISTORS (all ¼W 5% unless stated)	
R1,4	33k
R2,3	10k
R5-10	4k7
R11,12	33R
R13,14	15k ½W
R15,16	0R15 (or 0R22, see text)
R17,18	120R
R19,20	1M0
R21,22,37,38	10k ½W
R23,24	10k
R25-28	4k7
R29-32	12k ½W
R33,34	18k
R35,36	68k
R39	100k
R40	12k ½W
R41	4k7
RV1,2	10k horizontal preset
RV3,4	27k horizontal preset

CAPACITORS	
C1,2	100µ 64V axial electrolytic
C3,4	220µ10V axial electrolytic
C5,6	2µ2 63V polyester, radial
C7,8	1n0 disc ceramic
C9,10	220µ 64 V axial electrolytic
C11,12	4700µ 100V can

SEMICONDUCTORS	
Q1	BD538
Q2,3,8,19	BC447
Q4,5,7,20	BC448
Q6	BD537
Q9,11,14,16,21	BC184
Q10,12,13,15,22	BC214
Q17	MJ2501
Q18	MJ3001
D1-16	1N914 or similar (16 off)
D17,18	1N4003
ZD1-4	10V zeners, 400mW
ZD5	30V (or 24V, as available) zener, 400mW
BR1	400V 10A bridge rectifier
LED1	single LED to choice

MISCELLANEOUS	
T1	50-0-50 (or 48-0-48) V 300VA mains transformer
FS1	1A mains fuse and holder
SW1	mains switch to choice

PCB; mains input socket; mains output socket; wire, etc.

to use a relay has removed the otherwise attractive option which this offers to disconnect the LS lines until the amplifier has had a chance to settle. The 470k resistor across the mute switch gives C7, in the feedback line, a chance to charge, over a few seconds, to its normal operating DC level.

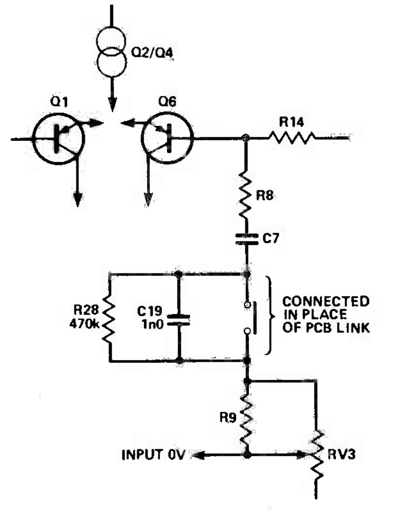


Fig. 10 Circuit arrangement for amplifier muting.

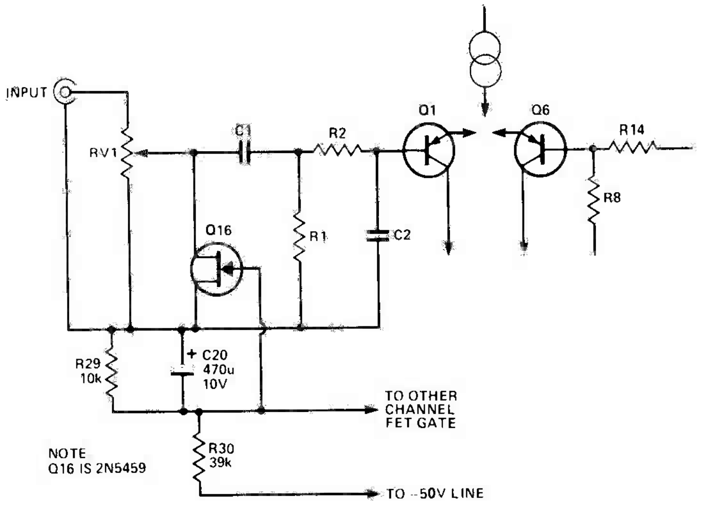
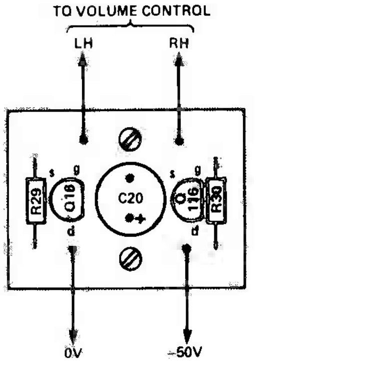


Fig. 11 FET input clamp circuit.

Fig. 12 Overlay for circuit of Fig 11.



Additional facility to which I had referred in an earlier article, as a possible option, is the use of an FET as a normally open switch across the amplifier inputs, as shown in Fig. 11. Normally, at the moment of switch-on C20 will be uncharged, and the FET, Q16 (a 2N5459), will act as a low-impedance resistive path across the inputs, which will effectively zero the volume control and prevent the amp from producing distorted signals for the few seconds during which the DC supply lines from the power supply rise up to their final operating voltage. The FET bias is derived from the −50V line, and lags behind this in its rate of voltage rise, as C20 charges through R30, towards its final operating voltage of −10V, at which the FET is fully cut-off, and is effectively removed from the signal circuit.

Power Amplifier Quiescent Current

I had omitted to discuss this, inadvertently, from the description in the previous part of this article. The optimum value, if twinned MOSFETs are used in the outputs, is 250mA/channel. The amplifier can be operated, at a lower maximum output power but without any other penalties, with a single N-P-MOSFET pair. This will give about 65W. In this case a quiescent current, per channel, of 120-150mA is required. With the circuit shown, the 250mA quiescent current allows 0.5 watts of output in pure class-A, and it is surprising just how much of ones programme, in almost everything except heavy rock or reggae, falls below this level. (To organise the circuit with single MOSFETs, just delete one pair of N- and P-channel devices from each output four.)

On this score, on tidying up the wiring to the output power MOSFETs, it became clear to me that its actual layout was a bit over-critical. I therefore propose that the gate resistors, mounted close to the MOSFET gate pins, should be increased from 150R (16/17) and 220R (18, 19/21, 22) to 1k0 each. This solves the awkwardness. When single MOSFET pairs are used, this problem doesn't arise.

As can be seen from the photograph of the prototype power amplifier internal layout, I have laced quite a few of the input cables together, in the interests of neatness and in keeping them together in a safe position. Please **do not** do this with the output wiring or the wiring to the MOSFET pins, which should be spaced out, but not more parallel than inevitable. MOSFET pairs are likely to see parallel wiring to their pins as an invitation to oscillate (this problem is even worse with the recent very fast T-MOS devices, and I decided that these were not sensible for use by DIY amplifier builders, in spite of their otherwise superb technical possibilities).

Output Power Meter

It is certainly a useful feature to have a pair of channel power output meters mounted on the front of a power amplifier. However, that is where agreement ends. If the meters, which should be peak reading, with a fairly slow decay rate, have a scale which is linear in voltage it will result in the necessary calibration for power output being very cramped at the top end, since $P = V^2R(\text{load})$. It will also require the meters to be hand calibrated, which isn't an easy thing to do oneself if the result is to be neat-looking. On the other hand, the circuit is simple to organise.

If the purpose of the meters is to make the user aware of his proximity to the amplifier overload margins, so that he can use it within its limits, it is much more satisfactory to have a measuring circuit which is linear in terms of power output. This also solves the problem of a neat scale calibration. I have therefore adopted this approach based on a 100uA meter movement, scaled 0-100 as watts. This makes it very easy to see where one is operating in relation to the overload threshold, but it does mean that the meters will be sitting near the zero mark for most of the time (unless one likes ones music very loud!)

The circuit I have adopted is shown in Fig 13. In this I have used a junction FET as the 'square law' element, in the input limb to an inverting mode IC amplifier. The gain of the amplifier depends on the ratio of the impedance of Q1 to the resistance of R5 and RV1. When the FET has zero bias, its AC impedance is low, and the amplifier gain is (relatively) high.

PARTS LIST — POWER AMPLIFIER

There are additional parts to implement the switch-on mute.

R29	**10k**
R30	**39k**
C20	**470μ 10V PCB electrolytic**
Q16,116	**2N5459**

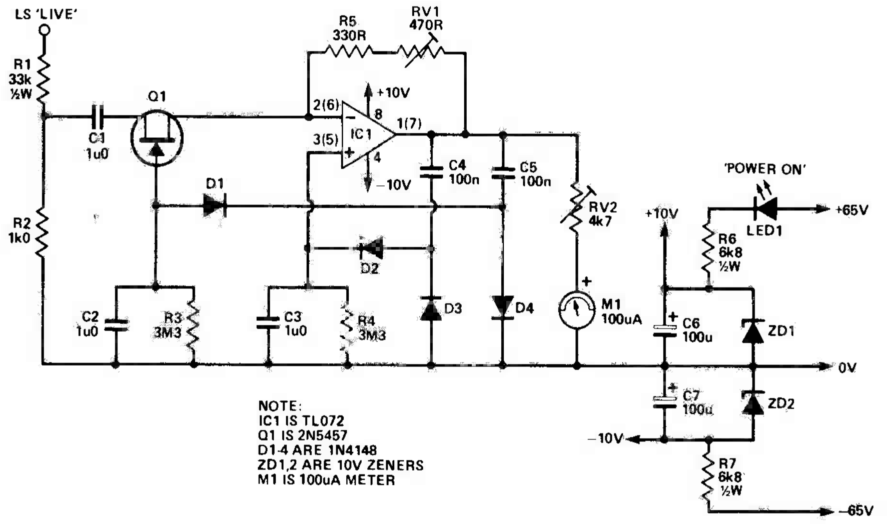


Fig. 13 Peak-reading linear scale power meter (8 ohms load).

BUYLINES

Kits are available for the pre and power amplifiers from Newrad Instrument Cases Ltd, Unit 19, Wick Industrial Estate, Gore Road, New Milton, Hants BH25 5SJ (telephone 0425 615774). Prices are as follows: pre-amp, including the yet-to-be published modification, £98; power amp (including meters, mute and switch-on mute circuitry) £120. Newrad will supply the PCBs alone as follows: preamp £15; power amp £11. Here prices are for a full set of PCBs. Newrad can also supply the components required for the pre and power amps, but we suggest you contact them directly for details. All the prices given here include UK postage but no VAT, so please add 15% for this.

PARTS LIST — POWER METER

RESISTORS (all ¼W 5% unless stated)

R1,11	33k
R2,12	1k2
R3,4,13,14	3M3
R5,15	330R
R6,7	6k8 ½W
RV1,11	470R horizontal preset
RV2,12	4k7 horizontal preset

CAPACITORS

C1,2,3,11,12,13	1µ0 polyester
C4,5,14,15	100n polyester
C6,7	100µ 16V PCB electrolytic

SEMICONDUCTORS

IC1	TL072
Q1,11	2N4557
D1-4, 11-14	1N914 or similar (8 off)
ZD1,2	10V 400mW zener
LED1	single LED to choice

MISCELLANEOUS

M1,11	100µA FSD moving coil meter to choice

PCB, wire, etc.

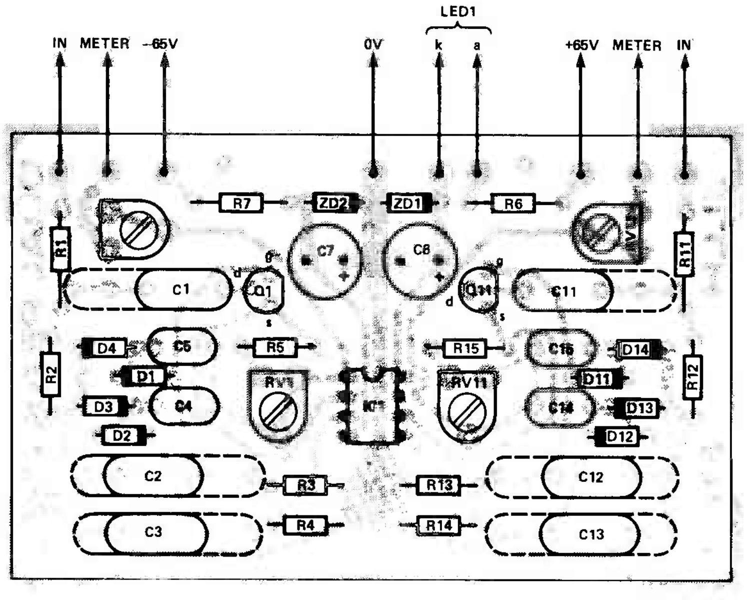


Fig. 14 Overlay diagram for the power meter.

When an AC signal is applied to the input, via R1, R2 and C1, the amplifier output is rectified and applied as a positive-going voltage to the non-inverting input of the op-amp (which makes its output, and consequently its inverting input voltage also move +ve), and as a negative-going voltage to the gate of the FET, in relation to its positive-going source and drain. This biases the FET to a higher impedance and reduces the gain of the amplifier. The large the input signal, the lower the gain of the amp, and the higher the bias voltage.

Although FETs vary a bit from one to another, every one of about a dozen Motorola 2N5457s could be adjusted to give a reasonable square-law characteristic. The technique is to apply a measured input voltage (Vin(RMS)= √P.Rload) — for example 12.65V RMS for 20 watts into 8 ohms, and 26.8V for 90 watts — use the 'linearity' pot, RV1, to set the power reading at say 20 watts, and use the 'scale' pot, RV2, to set the meter reading at the high end. This will need to be done iteratively, going from one to the other and back again, since they influence each others readings. However, one wins in the end. I have shown in Table 1, below, the results on my prototype using 20W and 90W as the adjustment points.

V (rms)	P. (8 ohms)	Meter reading
4.0V	2W	2W
6.32V	5W	5W
8.94V	10W	10W
10.95V	15W	14W
12.65V	20W	20W
15.5V	30W	31W
17.9V	40W	41W
20V	50W	52W
22V	60W	63W
23.7V	70W	72W
25.3V	80W	82W
26.8V	90W	90W
28.3V	100W	95W

Table 1 Calibration of the prototype power meter.

Unfortunately, a number of oversights and ommisions have crept into the design — of which the most serious which has come to light is the need for a buffer after the RIAA stage. I will do my best to clear up all these in a short post-script next month. **ETI**

BUILDING TEST EQUIPMENT

You know what's available and you have decided what you need; all that remains is to acquire it by some means. Phil Walker offers a little encouragement to the impecunious.

All test gear can be built (well, someone has done it) but you must consider whether it is worth your while and weigh up the cost of components and the time you spend against the price of ready made equipment. You must also consider such problems as how to calibrate it — test equipment is of little use if you cannot trust the readings you get from it.

There is little advantage to be gained from constructing multimeters or oscilloscopes unless they are for a special purpose. The cost of a home brew is likely to be similar to a comparable commercial unit and unless you are very good and have workshop facilities the result will be bulkier and less convenient to use. Even where a specialised measurement is needed it is probably better to add a conversion box or modify an existing unit.

For most other types of test equipment needed by the enthusiast it is quite useful to consider home construction. Signal sources of many sorts have appeared in this and other magazines and will no doubt continue to do so. The real challenge here is not only to understand the operation of one circuit before building it but to take the most useful parts of several circuits and combine them to get just what you require. Note that this is a long term goal and will not be attained overnight.

Other types of equipment which can be constructed by the amateur will include frequency counters and timers. Years ago this type of instrument required great masses of components, took lots of power to operate and cost a small fortune. Sometimes suitable ready built surplus gear could be bought and modified or repaired to get the desired result but this is not so common these days. However, the tremendous surge in semiconductor technology has brought with it new devices which can replace most of the circuitry with a single chip. This means that a very sophisticated instrument can be constructed with a few components and at quite a reasonable cost.

Having decided that you are actually going to build a piece of test equipment the first step is to decide exactly what you want. This does not mean, for example, a "voltmeter" it means: "A DC voltmeter, moving coil readout, ranges 1V, 3V, 10V, 30V, 100V, 300v. Input resistance 10M constant on all ranges, overload protection to 1000V on all ranges, manual range switching, automatic polarity switching with indicator, automatic power-down after 20 mins. with warning buzzer. Meter to be approx. 2in. scale in same case as circuitry, single 9V battery and switch. Case to be suitable for holding in hand. Accuracy of instrument to be better than 1% on all ranges."

Having written down all the requirements you can think of for your new unit you can start thinking about how to make it. At this stage you will probably find that changes have to be made in the specification, sometimes to improve it but more often to make construction possible. Your constraints will usually be determined by your knowledge, what you can find in books and magazines and what components are available at the price you can afford.

Having decided that the construction of your dream testgear is possible you must consider how to put it together so that it is usable. Bear in mind that you will probably use it often so a little thought will be to your advantage. Look at or measure the components you are to use, make models if you do not have them yet and try to fit them together in different ways until you find one which allows easy access to all the controls you need and easy sight of any readout devices. Make sure that switches can be operated without undue pressure or scraping your knuckles. Make the layout logical and neat from the front while making sure that you have enough room behind to wire it up where necessary. Always leave room for batteries, power supplies, fuses and power cables and provide a way of securing them.

As a matter of common sense, always use top quality components for your test equipment projects as any shortcoming here will often cost more in replacements and unsatisfactory performance later on.

When you have all the components and know where everything is going, the case should be prepared by drilling all the necessary holes and painting and lettering the front panel. A subsequent coat of clear varnish will keep things looking good. When this is dry you can assemble and test out the whole thing. If possible make sure it is working before you put it into the case as access is more difficult afterwards.

If you do all this it will take quite a long time but you should end up with a unit which is useful, usable, good to look at and reliable. This is more than you can say about some commercial products. In addition you will have gained a wider understanding of electronics than just the circuit principles involved.

A list of recent ETI test equipment projects is given in the table overleaf. Photocopies of the original articles are available from the ETI Photocopy Service, 1 Golden Square, London W1R 3AB, and cost £1.50 each. You should give all relevant information including page number when ordering, and cheques, postal orders, etc should be made payable to ASP Ltd.

ITEM	MONTH	YEAR	PAGE No.	DESCRIPTION
MULTIMETER				
Digital Test Meter	September	1980	79	3½ digit LCD; 100mV - 1kV FSD AC & DC in 5 ranges; 100uA - 1A FSD AC & DC in 5 ranges; 100R - 10M FSD in 6 ranges; 1kHz - 1MHz FSD in 4 ranges
RESISTANCE METERS				
Linear Ohmmeter	June	1980	34	1K - 1M FSD in four ranges; linear analogue display
Low-ohm Meter	April	1981	40	100mR -100R in four ranges (mR = milli-ohms)
CAPACITANCE METERS				
Capacitance Meter	August	1980	93	low-cost meter with linear analogue display; 10pF - 10uF
Autoranging Capacitance Meter	March April	1982 1982	48 108	100pF - 1000uF in eight automatically selected ranges; 3½-digit LCD display
FREQUENCY METERS				
Digital Frequency Meter	January	1980	56	0 - 150 MHz; crystal timebase; 8 digit LED display; frequency, period, unit counter and stopwatch functions
Linear Frequency Meter	July	1980	99	low-cost analogue unit; 10 Hz - 100 kHz
FUNCTION GENERATORS				
Function Generator	December	1979	20	Sine, square and triangular waveforms; 1Hz - 100 kHz; integral analogue frequency meter
Audio Oscillator	November	1980	27	low-cost sine and square wave generator; 30 Hz - 60 kHz
Pulse Generator	February	1981	46	Dual pulse generator; width and delay variable from 100ns to 150ms; internal 0.5Hz - 500 kHz clock
Precision Pulse Generator	November	1982	39	lus - 99.9s pulse width; 1:999 - 999:1 mark/space ratio
POWER SUPPLIES				
Laboratory PSU	September	1981	87	0 - 30V @ 1.2A; 20mA - 1.2A constant current limiting
Programmable Power Supply	January	1983	83	0 - 25.5V @ 1.6A; local manual or remote digital control of voltage and/or current
Bench Power Supply	February	1984	41	3 - 8V @ 2.5A and ±8 - 16V @ 0.5A; over-current protection on all outputs
OSCILLOSCOPES				
10 MHz Oscilloscope	May June July	1982 1982 1982	53 30 63	Single beam 10 MHz miniature oscilloscope; 12V DC or 240V AC operation
Update	February	1983	41	
Telescope	July August	1983 1983	21 30	Plug-in unit converts television into 1MHz, single beam, storage oscilloscope
LOGIC PROBES				
Dual Logic Probe	September	1982	68	CMOS and some TTL; high, low and pulse indication; pulse detection to above 2MHz; integral logic pulser; pulse memory
Logic Probe	March	1983	73	CMOS and some TTL; indicates high, low, pulsed, positive going, negative going, or open circuit stages
Logic Clip	November	1983	91	TTL and CMOS; simultaneous indication of state of all 14 or 16 pins of DIL device; high, low, pulse and undefined state indication
AUDIO TEST EQUIPMENT				
Audio Power Meter	March	1979	67	True audio power reading; current handling up to 10A, voltage up to 300V
Bench Amplifier	August	1979	67	Integral loudspeaker; four inputs offering flat and RIAA equalisation and various sensitivities
Noise Generator	December	1979	67	digital white noise generator
Bench Amplifier	December	1980	74	4 watts output into 8R external loudspeaker; single 10M ohm input; response flat to 200 kHz
Sound Pressure Level Meter	February	1981	74	30 - 120dB; switchable 'A' weighted or flat response
Audio Power Meter	March	1984	35	Dual channel (stereo); true audio power reading; 10 - 200W FSD in 3 ranges

ETI

SHARP JOYSTICK INTERFACE

Bring some joy to your Sharp with this design by John Garnham.

With the current influx of new computers onto the British market, the Sharp looks a little lost, when most come with joystick sockets as standard, e.g. Commodore 64, Vic 20, Lynx, Dragon 32, BBC Micro, Sord M5, etc. This unit is both inexpensive and simple to use.

The joystick required is of the microswitch type. The one I purchased came from Cambridge Computing, although there are many available. This joystick has two fire buttons which is useful as I have used one of these for 'hyperspace'. An added advantage of the joystick over the Sharp keyboard is that it is easy to detect when two switches are being held down together. When the Sharp scans the keyboard, certain keys have preference over others and trying to move a space ship and fire at the same time can cause problems for the programmer. With the joystick interface unit the joystick's switches correspond to different bits of the data bus and can be easily detected, especially in machine code using the 'bit' Z80 opcode. Table 1 shows the codes possible to the corresponding switch closures.

HOW IT WORKS

This interface works in a similar way to the Spectrum Joystick interface described in ETI in June '84. A particular memory location is decoded by ICs 1 and 2, and the interface places its data on the data bus when a read to this location occurs. However, only eight 'address' lines can be used, of which two must be positive true (ie high for a read to take place; A15 and A14 are shown as these), and a further one of which must be used to sense the RD control line, which must be negative true (and this must be set so using the links). The remaining five lines can be either positive or negative true, and this can be selected by setting links as shown in the inset to the circuit diagram, so that the inverter on the line is either in or out of circuit. It is suggested that either A10 or A9 should be inverted, giving the interface address 64000d or 65000d.

If two interfaces are required, so that two joysticks may be used simultaneously, then they should have different addresses, and 64000d and 65000d are suggested. However, the use of links on the PCB should make it possible to set up virtually any desired location; however, because only part of the address bus can be used, the interface will always respond to a number of addresses. If a computer other than the Sharp is used with the interface, more than one control line may have to be used to prevent data bus contention, so that the number of addresses to which the interface will respond will be even larger!

When all the inputs to IC2 are high, its output will go low, driving the EN and OC inputs to IC3 low; the former latches the current state of the inputs into the internal flip-flops and the latter makes the IC output stages go from the high impedance state into the output driving state. So the inputs to IC3 are latched and put onto the data bus.

The joystick outputs are wired active low, with pull-up resistors R1-6; IC4a to f clean up and invert the output from the switches, and feed them to IC3 inputs.

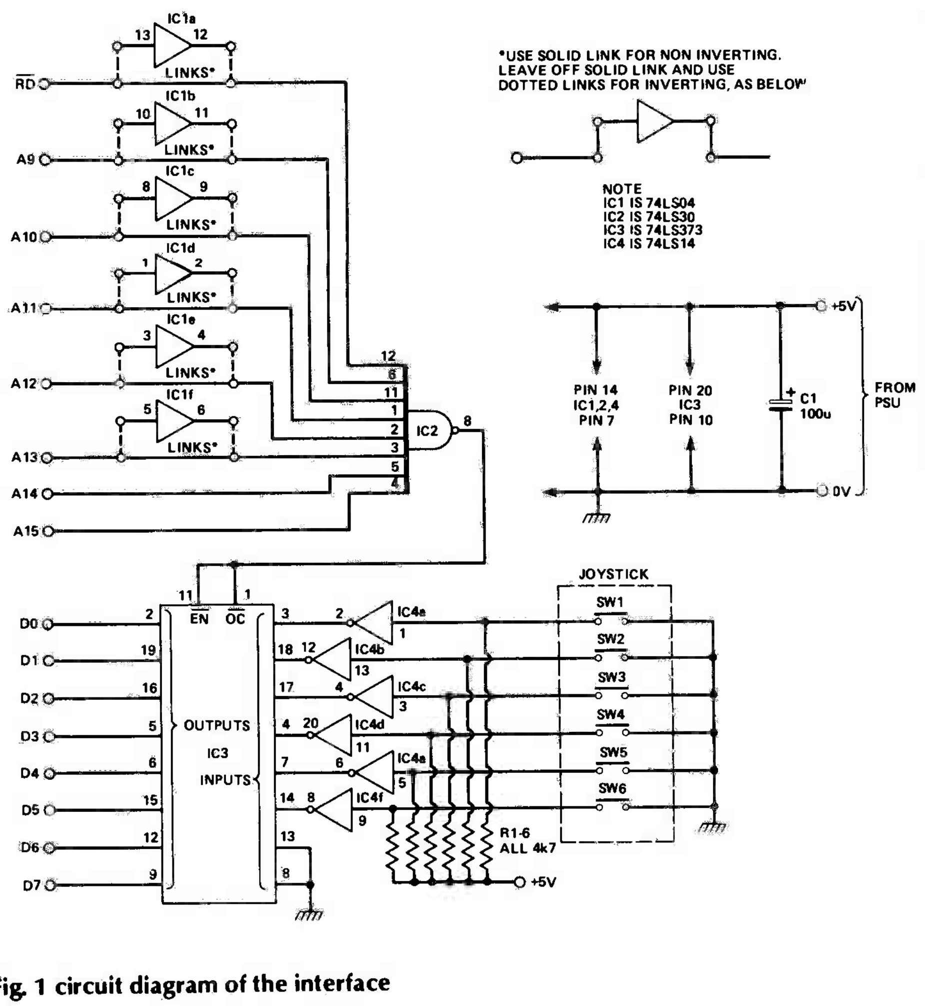


Fig. 1 circuit diagram of the interface

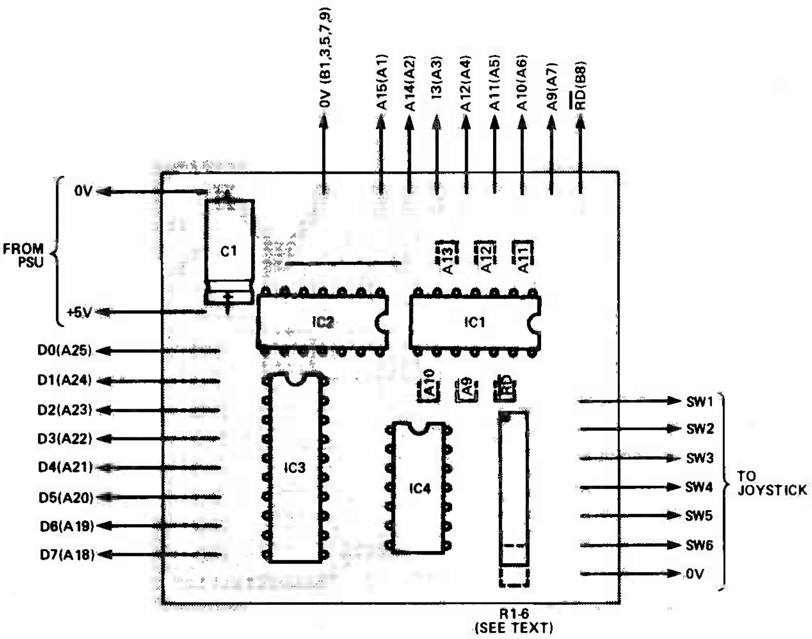


Fig. 2 Overlay diagram for the PCB; the bracketed labels refer to the Sharp connector (a full connection list for the Sharp connector was given in the Sharp Centronics Interface article in ETI May '84)

PARTS LIST

RESISTORS
R1-6 — 4k7 (6, 7 or 8 SIL resistor pack)

CAPACITOR
C1 — 100µ 10V axial electrolytic

SEMICONDUCTORS
IC1 — 74LS04
IC2 — 74LS30
IC3 — 74LS373
IC4 — 74LS04

MISCELLANEOUS
50 way IDC connector (socket)*; 50-way ribbon cable*; PCB; Joystick (switch type) + socket to suit; case to suit*.

* If building a dual joystick interface, you need two of all the components *not* marked with a *.

Table 1 (below) The codes generated by the different switch closures.

	CODE	WITH FIRE	WITH HYPERSPACE	WITH BOTH
STATIONARY	0	16	32	48
UP	1	17	33	49
DOWN	2	18	34	50
RIGHT	4	20	36	52
UP-RIGHT	5	21	37	53
DOWN-RIGHT	6	22	38	54
LEFT	8	24	40	56
UP-LEFT	9	25	41	57
DOWN-LEFT	10	26	42	58

The interface described here may be used either singly or in pairs, with the two boards connected in parallel but with different addresses set using wire links. Actually, the PCB is laid out so as to make the interface fairly widely applicable, ie, you can set up different address locations and control line conditions using the wire links to select in or out the inverter gates — however, you'll have to work out the particular details for your computer yourself!

Construction

The Sharp does not provide +5V on its external bus, so you can either build a separate power supply for the unit (or use one you have to hand) or 'steal' +5V from inside the computer as detailed in ETI May '84 ('Centronics Interface', P49); before you take this latter option, you might like to speculate that there could be a good reason why the designers didn't want you to take any current from the Sharp's PSU, but we'll leave the decision to you. The circuit shown here will consume around 50mA.

There should be few problems with construction of the PCB, although it is necessary to take some care over the wire links close to IC1. The pads here are necessarily fairly small, and exces heat will lead to them parting company with the board. If you intend to relocate the interface at all within the Sharp's or other computer's address space, then it is advisable to use PCB pins for the links anyway. Also, be sure never to use all three links on any of the inverters or you will end up with a very cross little gate! Table 2 shows the

LOCATION	LINKS
6400	A9, RD inverted (use dotted links) A15-10 non-inverted (use solid links)
6500	A10, RD inverted (use dotted links) A15-11, 9 non-inverted (use solid links)

Table 2 Suggested links for the memory positioning.

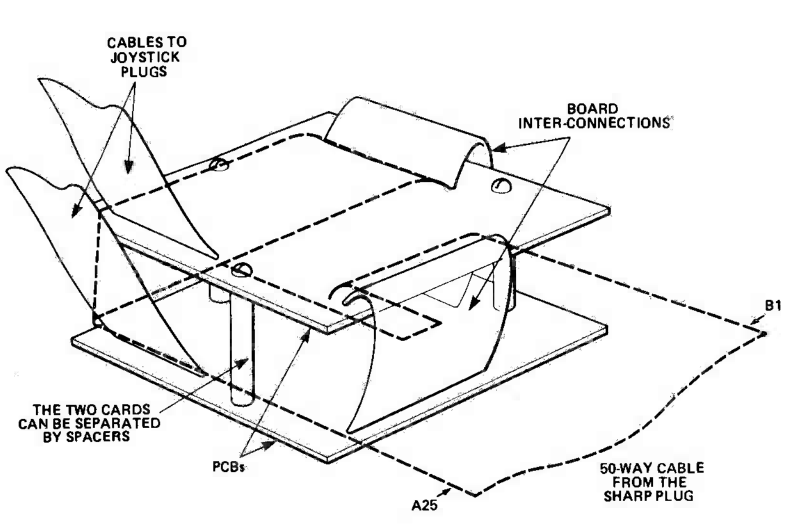


Fig. 3 Suggested method of assembling a dual interface

suggested links for the recommended locations for the Sharp.

If you're using two interfaces together, then a method of interconnecting them is shown in Fig. 3. There are two sets of holes on each board for the address and data bus connections, and it will probably be easier to use the outer set for the paralleling connections, and the inner set of one board for the connections to the computer.

The PCBs can be mounted in a suitable box, and a small cut-out can be filed in the lid so that it traps the 50-way cable and acts as a strain-reliever. What sort of connector you use for the Joystick depends on the type of Joystick you use; most use D-type connectors, and a common format for these was given in ETI June '84 ('Spectrum Joystick Interface', p50), although this did not allow for the use of two 'fire' buttons, so you'll have to investigate the connections yourself.

```
org 5000H
LOAD 5000H
LD HL,64000
LABEL:LD A,(HL)
JR LABEL
END
```

Fig. 4 Assembler program to generate a series of pulses

Once the interface is constructed, it's time to plug it into the computer. First, however, if you've built a special PSU, check this out with a suitable dummy load (47R 1W). If you've used IC sockets, first of all, plug in the board without any ICs and check that the computer doesn't crash. Then insert IC1 and 2 (with the power off, of course) and check that IC2 pin 8 goes low when the appropriate address is PEEKed (either 64000 or 65000 if you've used the suggested locations). Fig. 4 shows a method available to those with a Zen assembler, and this will produce a string of pulses.

Fit the remaining ICs (or start here if you soldered them straight in) and, after re-connecting the supplies, read the value at location 64000; if this is zero, try typing in the program in Fig. 5. If the location does not read zero, try to see what the effect of pressing the buttons or moving the stick is; if this changes the value read, then check the connections to the joystick from the board. If nothing changes, or if the processor crashes, check the wiring of the ribbon cable, the construction of the PCB, etc.

Use

The program in Fig. 5 can be used to check the correct functioning of the interface unit. Converting programs you have already written can be along the lines shown in Fig. 6, where the program lines on the left are for the computer without the interface, and those on the right are for use with the interface.

Happy zapping!

```
1 REM**TEST PROGRAM**
2 S=20000:LIMIT S
3 FOR X=1TO11
4 READ D:POKE X+S,D
6 DATA 33,0,250,126,198,48
7 DATA 205,18,0,24,248
```

Fig. 5 Test program for the interface

Fig. 6 Converting programs to use the interface

10 GET A$	10 X=PEEK(64000)
20 IF A$=" " THEN 10	20 IF X=0 THEN 10
30 IF A$="Z" THEN 100	30 IF X=8 THEN 100
40 IF A$="C" THEN 200	40 IF X=4 THEN 200
50 etc	50 etc

BUYLINES

No problems here — everything should be available from advertisers in this magazine. The PCB is available from our PCB service.

ETI

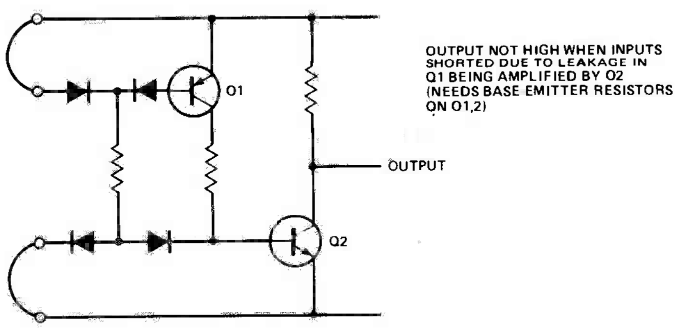
DEBUGGING AND FAULT-FINDING

Having looked at the types of test gear available and considered ways of acquiring it, our fourth special feature offers some suggestions on how to use it.

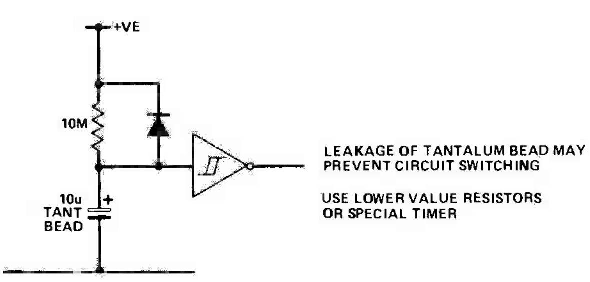
As we have pointed out elsewhere in this issue, test equipment is likely to find employment in three main areas — design and development, production, and fault-finding on completed and previously functional equipment. Production testing is only employed in industry where large numbers of identical units are being assembled, and is therefore of little relevance to the hobbyist. Similarly, anyone capable of producing their own designs is unlikely to need us to tell them how to use their test equipment. For this reason, we will concentrate here on the test procedures involved in debugging new equipment and locating faults in finished equipment.

Debugging

This is the process of getting a new design or installation working correctly. The first necessity is to get a firm idea of what the equipment should do and what it should not.



Figs 1 (above) and 2 (below) A couple of design traps here, both due to not allowing for leakage current.



It is advisable to check power supply lines for short circuits, correct routing and make sure they go nowhere that they shouldn't. Other wiring should also be checked but wait a day or so if you are the one who wired it in the first place. This will reduce the risk of your making the same mistake twice. Similar comments apply to the construction of PCBs but mistakes here will tend to be components in the wrong place, the wrong way round or even the wrong value.

When all appears to be correct, the moment of truth arrives. Switch it on. Three things are now possible: it appears to work, it does not work or it emits a cloud of smoke. These have been listed in order of increasing cost.

If the first possibility occurs then you can proceed with your tests to make sure that all the parts of the circuitry work as designed. Be very wary of circuits which work but you cannot explain why. In the second instance, if the unit just sits there not working, you must find out why. For logic circuits try turning off and on a few times. If it then starts to work your problem is undefined logic states at power up, see Fig. 3. This can usually be avoided by a power-on-reset circuit at strategic points. If this is not possible then you must re-design the logic so that it has no hang-up states.

Analogue circuits can also exhibit this type of problem if the power supplies turn on in the wrong sequence. This is usually due to parasitic thyristor action in some ICs and can only be avoided by changing the type of device or including circuitry to prevent it. A more common problem in analogue circuits is that they often

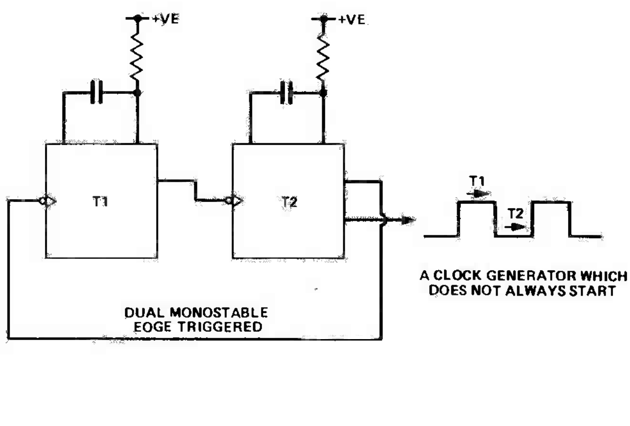


Fig. 3 A problem with oscillator start-up due to undefined logic states at switch-on.

contain capacitors for signal path coupling, decoupling and response shaping. At switch-on these must charge up via their associated circuitry to their operating voltage. This can put potentially damaging strains on other parts of the circuit or output devices. This is especially true in some types of audio amplifier.

If you are unfortunate and your circuit produces clouds of smoke when you turn it on... turn it off. Before everything cools make a note of which components were involved. Then you can test all the active devices connected to these components to make sure they are still functional. If, not replace them, checking carefully that they are correctly connected. Now study the circuit and see what could cause excess power, not forgetting that high frequency oscillation has killed many a home-brew amplifier with incorrect compensation.

Digital circuits can suffer from a particularly awkward type of problem as they operate very quickly but not instantaneously. The problem occurs when signals change state, especially where the outputs from a multi-bit counter are being decoded. What happens is that after a clock pulse the outputs start to change state. Unfortunately not all of them change state at the same time and the signal paths through the decoding logic can take different times. This means that the decoding logic "sees" a series of logic combinations which, although they are of very short duration, can give rise to spurious outputs. This does not matter too much where the output drives a slow, level sensitive device. These spurious outputs are called "glitches". The usual method of avoiding them is to prevent any action being taken until the decoding logic has had time to settle down. Then the result is stored in a latch and held while the next change occurs. Glitches and timing errors are among the most common causes of faulty operation of logic circuitry. Most of the remaining faults are caused by the designer not fully understanding the full purpose of the circuit in the first place.

When designing logic circuits, bear in mind that individual devices may respond to pulses much narrower than those specified for reliable operation in the manufacturers data sheet, see Fig. 4. In most logic families, the delay caused by one gate can produce a pulse which will clock a latch or counter.

Once you have got to the state where nothing is actually destroying itself you can start to find out where the signal stops. The process from now on is very similar to fault-finding.

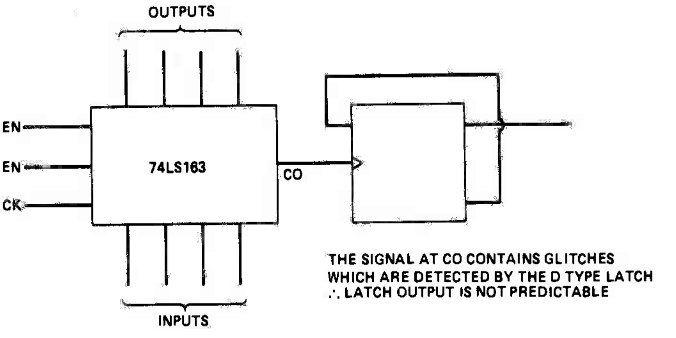
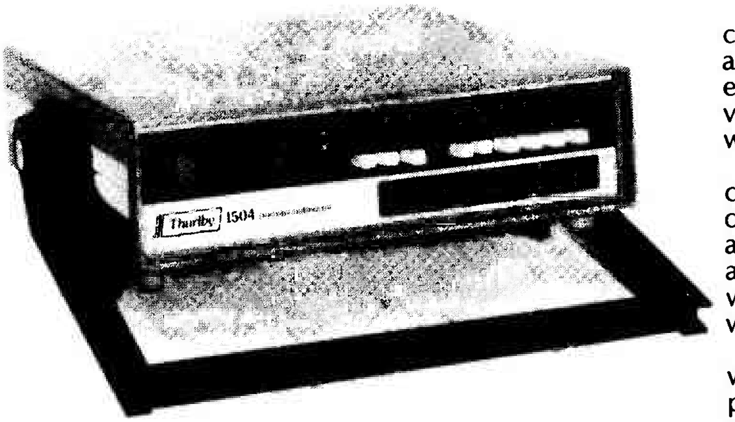


Fig. 4 A design problem with glitches; this particular problem took about 6 hours of frustration to find; when eventually located, the glitch pulses were only a few nanoseconds wide and very difficult to see. The basic problem here is using a device designed for synchronous logic in a non-synchronous application.



Unless a multimeter has 'true RMS' or words to that effect written on it, like this Thurlby instrument, it will find the value it displays for its 'RMS' voltage and current readings by finding either the average or the peak value and dividing by a fixed correction factor. This is acceptable for a pure sinusoidal wave, but can be very misleading for any other wave-shape.

Fault-finding

This is the process of finding out what has gone wrong with a piece of equipment which has previously worked satisfactorily but for some reason has failed.

The first operation is to remove any obvious faults such as short circuits on input or output. Next check all wires for breaks or poor joints. Look at connectors for damage or misuse. If this reveals nothing then examine the circuitry for mechanical damage and foreign bodies (including coffee, fruit juice, beer, jewelry, dead insects etc.). Repair any damage and remove unwanted contamination with a suitable solvent and allow to dry thoroughly.

If the circuit has suffered a catastrophic failure, ie things burnt or fused, check all components associated with the cause of the fault very carefully. When this is complete, switch on and observe. If the original cause of the fault was not found it is wise to include some sort of protection such as reduced supply voltage and current limiting with a suitable resistor. When all appears to be safe you can remove the protection and proceed to eliminate any remaining problems.

There are three main approaches to finding non-catastrophic faults. The first and least reliable is to poke around with a multimeter and guess. In the hands of an expert with years of experience this can sometimes be very quick. But not always. The other methods are somewhat slower but more reliable.

The second method is to start from the input and check that the correct signals appear at the input and output of each stage. For this type of testing you will need a signal source and probably an oscilloscope or possibly a bench amplifier with AM and FM detectors for radio work. In this way it should be relatively easy to pinpoint where the signal stops and thus find the fault.

The final method is to work from the output backwards. This requires that the loudspeaker or other output device is connected and working. Your signal generator must be controllable so that you can inject suitable stimuli into the various stages. Once again when you find the stage where the signal is lost that is usually where the fault is.

Either of the two latter methods will give valid results and the one you choose will be a question of personal preference tempered with consideration of the nature of the fault and the equipment available to you.

Bugbears

The worst fault to find is one which is intermittent. In most cases it will disappear totally for the period you are testing the equipment and you will need to coax it out of hiding. Three things can be used here, the first is the 'engineering thump' to get it rattled, then there is heat treatment with a hairdryer or table lamp and finally the cold shoulder using one of the freezer aerosols now on the market. Beware of the latter near valve equipment.

With a bit of luck one of these methods will lead you to the culprit. This will usually be either a crack in the PCB, dry joint, bad contact or broken component.

Faults which only manifest themselves after a period of operation are often due to heat. In old valve equipment the effect can be to make capacitors leaky (insulation resistance decreases) or to dry them up if electrolytic (capacitance reduces drastically). Resistor values also change with time and valve cathodes become less efficient. All these effects lead to incorrect operation. Semiconductor equipment does not usually suffer quite so much from this problem but is more vulnerable to damage from misuse.

Test Traps

However you go about testing a piece of apparatus and whatever equipment you use to do it there are a few basic things which must be borne in mind. The first is that all practical test equipment has some effect on the circuitry being tested. In many cases the effect will be negligible but sometimes it will not. Times to take care are when measuring low voltages in high impedance circuits or low currents in low impedance circuits, as in Figs 5 and 6. In either case using a moving coil type of multimeter is likely to result in a reading which is far removed from the normal value and may also seriously affect the circuit operation. In bad cases damage may also occur, usually to the circuit under test.

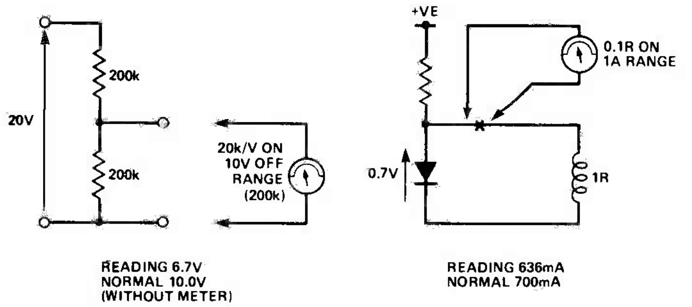


Fig. 5 (left and 6 (right) Classic problems with meters' finite impedance.

Another instance where erroneous readings may occur is when trying to read DC values in the presence of large AC signals. An example of this is measuring DC current between a bridge rectifier and reservoir capacitor in a power supply. The result will probably be a large drop in capacitor voltage and a somewhat strange reading on the ammeter. The reason for this is that the current only flows for a small proportion of the mains cycle and will therefore have a peak value many times that of the DC output current. Putting in your ammeter adds an ohm or so to the circuit and also some inductance. The effect of this is to restrict the peak current and therefore the amount by which the capacitor is charged.

Another example to bear in mind is to be found when connecting an oscilloscope probe to a high impedance, high frequency circuit. As shown in the diagram (Fig 7) this can severely distort the amplitude response of a simple high pass filter and could cause malfunction where none previously existed.

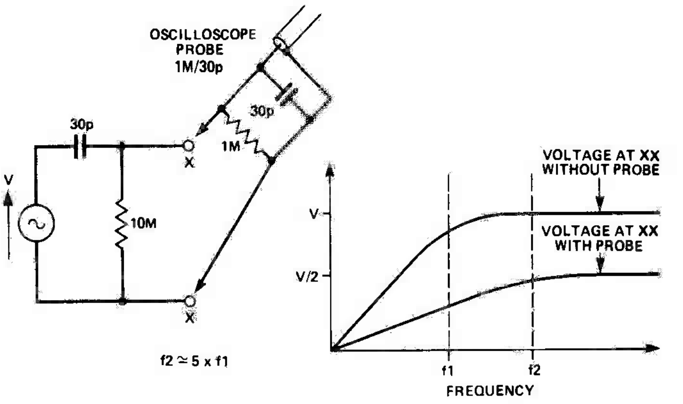


Fig. 7 Don't forget that oscilloscopes apply a load to the circuit which is not always negligible. Frequency counters, too (below) can also give significant circuit loading.

A final example is where a meter is connected between the wrong points. This can cause the circuit to fail when the meter passes enough current to the base circuit of a simple charge pump pulse detector, Fig. 8. In rare instances it has been known for measuring devices such as frequency counters, oscilloscopes and others with internal oscillators to inject spurious signals into the circuit being tested causing great puzzlement.

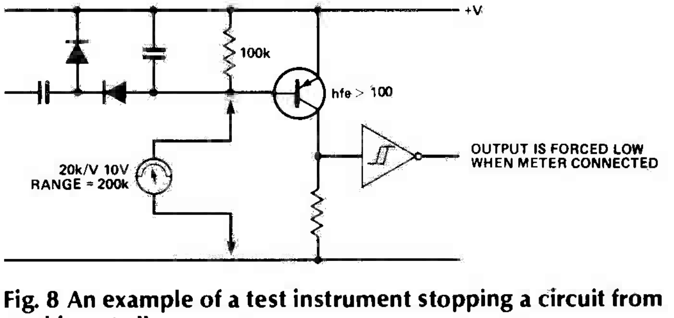


Fig. 8 An example of a test instrument stopping a circuit from working at all.

The final problem worth mentioning is earth loops. You may have heard that they are not desirable in amplifiers, well, nor are they in test gear. Unfortunately they are all too easy to create. Whether you buy or make your equipment you will probably find that, if it is mains powered, one terminal or test lead will be connected to earth via the mains. This is not a big problem while all your tests are ground referenced as you can bond everything together with a nice thick wire. The problem comes when floating measurements are needed. The choice is either to use battery powered equipment or instruments with dfferential inputs. There is actually another way but it is prone to errors and potentially lethal so don't do it! **ETI**

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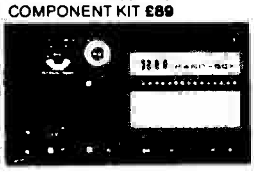

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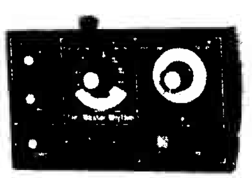

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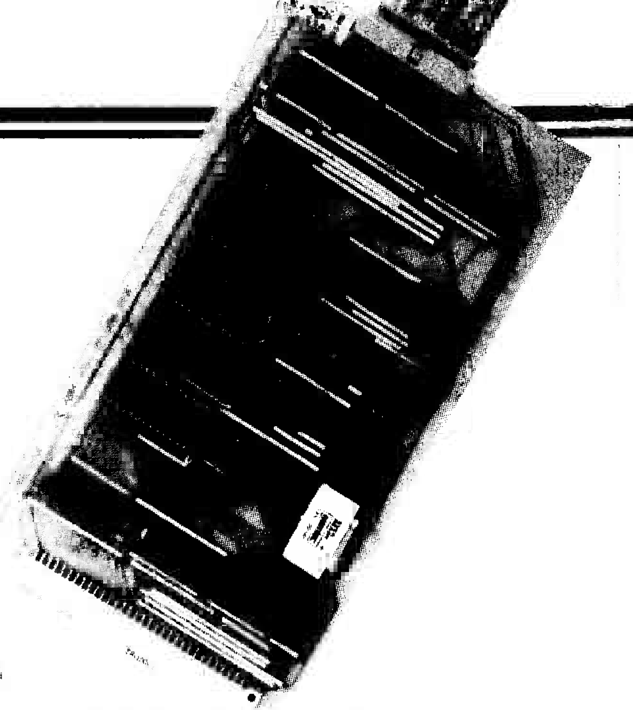
VERSATILE EPROM EMULATOR



Following on from last month's article in which the design process was examined in some detail, Mike Bedford describes the construction of the board and offers some advice on interfacing it to your microcomputer.

Construction is quite straightforward and, with the exception of link selection, the board requires no setting up. The circuit has been artworked as a single sided board to keep its cost to a minimum. The inevitable result of this, in a circuit of even moderate complexity, is that there are a number of wire links on the board. It is suggested that these are fitted first.

Sockets for the ICs are not absolutely essential, but since their omission would not greatly reduce the component cost it is suggested that they are used, especially for the 6116L devices. The proper precautions (ie, not touching the pins) should be taken when handling the CMOS devices. These are the 6116Ls and the 4071.

No assumption should be made regarding the state of charge of the PCB battery as supplied. It should not be placed pins-down on a conducting surface, but neither should the board be expected to function correctly in battery back-up mode until it has been powered up for a number of hours, hence allowing the battery to charge.

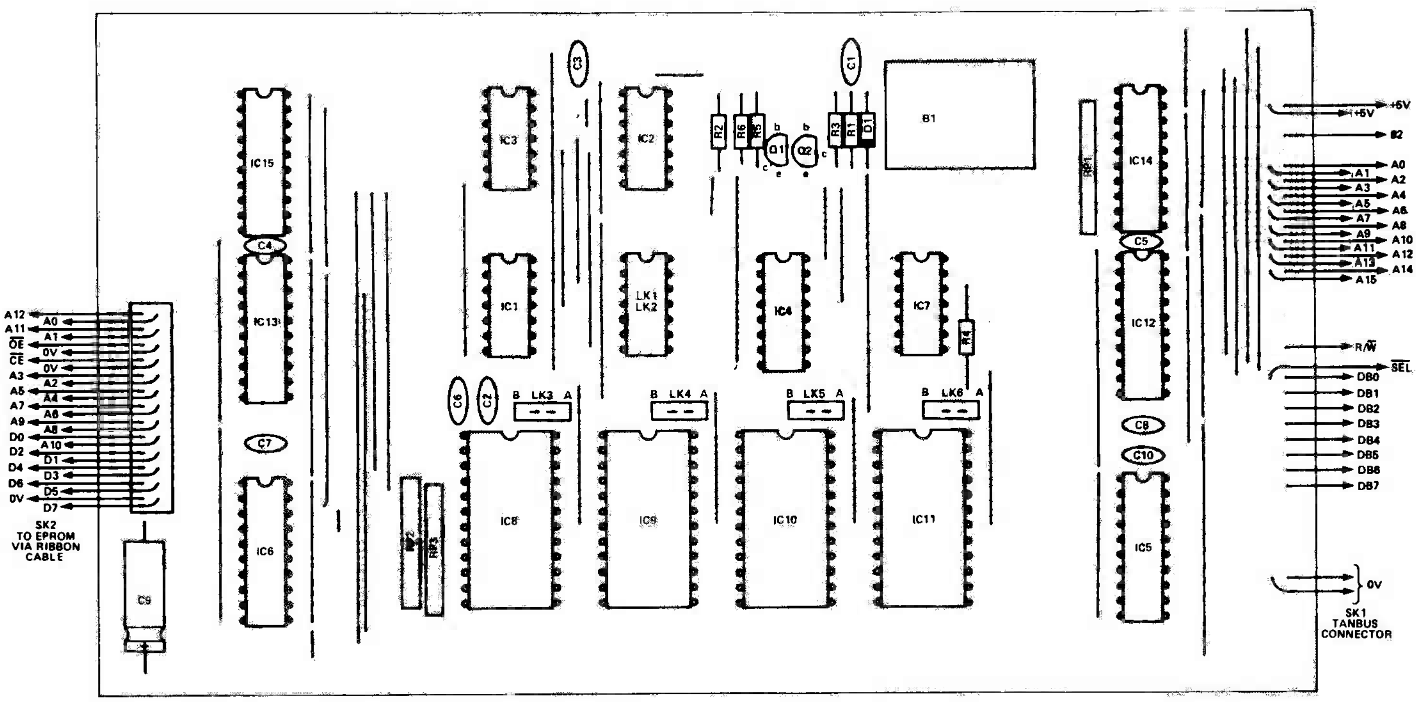


Fig. 8 Overlay diagram of the PCB.

For users not wishing to fully populate the board, IC11 should be fitted to give a 2K board whereas IC11 and IC10 should be fitted to give a 4K configuration. When emulating EPROMs smaller than 2764s, unless tied low by use of pull down resistors, the unused address lines (A11 and A12 on the 2716 and A12 on the 2732) will float high, causing the emulated RAM to occur at the top of the 8K space on the host system. So long as this is realised it presents no problems unless, of course, the board is only partially populated, in which case non existent memory will be accessed. To avoid this problem any such unused address lines should be connected to 0V.

Links LK3 — LK6 should be fitted to select whether or not battery backed up operation is required on each of the RAMs. LK3 affects IC9, LK4 — IC10, LK5 — IC11 and LK6 — IC12. In each case, if the board is held component side upmost with the TANBUS edge connector at the right of the board, connecting the centre to the left pin of the link will select battery backed-up operation whereas connecting the centre to the right pin will select the system 5V supply. If the non-battery backed up option is selected for a particular position, a less expensive 6116 or 2016 device may be substituted for the 6116L.

Links LK1 and LK2 are fitted onto a 14 pin DIL header which then plugs into a DIL socket on the board. Figure 9 may be used to select these links to give the required positioning of the board within the host address space.

After building up the board, the final aspect of construction is the making up of a cable to connect the emulator to the EPROM socket on the target system. This will consist of a 26-way female IDC connector, a length of ribbon cable and either a 24 pin or 28 pin DIL header. Separate leads will be required for 2716/2732 and for 2764 devices unless there is room on the target board to enable only the lower 24 pins of a 28 pin DIL header to be plugged into the EPROM socket, in which case the same lead may be used for all these EPROMs. Table 1 shows the details required to make up the cables.

A length of ribbon cable can cause read errors from the target system due to noise pick-up resulting from the capacitance between adjacent conductors. This is a particular problem since the signals present on EPROM sockets are not usually intended to drive lengths of ribbon cable. The problem is reduced by keeping the cable length to a minimum, and 12" should be considered an absolute maximum. Initial experiments also showed that a good

IDC connector pin no	EPROM signal	2716 2732 pin no	2764 pin no
1	A12 (Only 2764)	—	2
2	A0	8	10
3	A11 (Not 2716)	21	23
4	A1	7	9
5	OE	20	22
6	0V	—	—
7	CE	18	20
8	0V	—	—
9	A3	5	7
10	A2	6	8
11	A5	3	5
12	A4	4	6
13	A7	1	3
14	A6	2	4
15	A9	22	24
16	A8	23	25
17	D0	11	
18	A10	19	21
19	D2	11	13
20	D1	10	12
21	D4	14	16
22	D3	13	15
23	D6	16	18
24	D5	15	17
25	0V	12	14
26	D7	17	19

Table 1 Details of the connections required between the emulator and the EPROM socket.

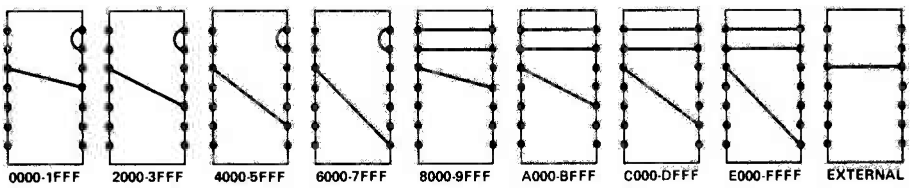


Fig. 9 Link arrangements to give various positions of the board within the host system address space.

PARTS LIST

RESISTORS (All ¼W 5%)		**Q1**	**BC184**
R1, R5	**1k5**	**Q2**	**BC214L**
R2	**330R**	**D1**	**1N4001 or similar**
R3,R4	**10k**		
R6	**68R**		
RP1-RP3	**47k, SIL, 8 commoned**	**MISCELLANEOUS**	
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IC2	**74LS32**		
IC3	**74LS08**	**B1**	**3.6V 100mAh, PCB mounting nicad battery**
IC4	**74LS139**		
IC5	**74LS245**		
IC6,12,13,14,15	**74LS244**		
IC7	**4071**		
IC8,9,10,11	**6116LP-3 (OR 6116P, 6116P, 2016 — see text)**		

PCB; sockets for ICs; female IDC connector to fit SK2; ribbon cable; 24 and/or 28 pin DIL headers.

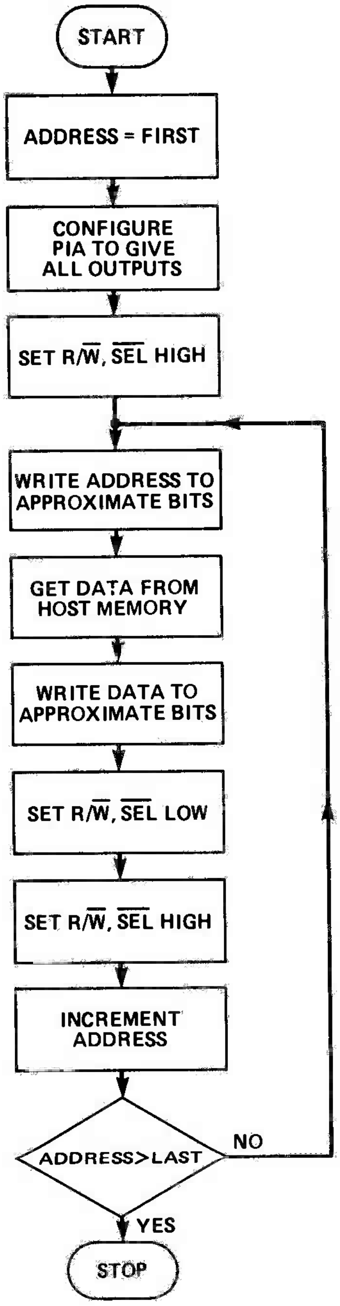

Fig. 10 Flow diagram showing how data should be written to the emulator from the host system via a parallel port.

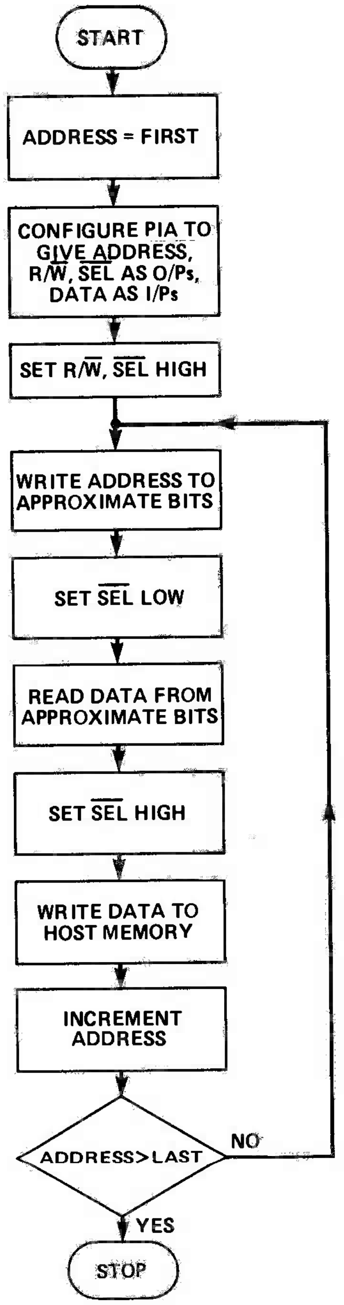

Fig. 11 Flow diagram showing how data should be read from the emulator by the host system via a parallel port.

earth connection is essential between the emulator and the target system; the single ribbon cable conductor could well be inadequate and a separate, thicker wire might be required. It was also found that the emulator can be sensitive to the path taken by the cable. In particular, care should be taken to ensure that it is not stretched tightly across the target board or interference may result.

Using The Emulator

Before making use of the emulator, the user must first check that it is compatible with the target system. This is determined by viewing the access times required by the target system in view of the fact that, if 150nS RAMs are used on the emulator card, the OE or CE to data valid time (whichever is later) will be about 210 ns. This means that the emulator will generally work with target systems having processor frequencies up to about 2.0 MHz. In fact, the prototype has been used consistently at 1.7MHz and with faster RAMs at 2.2MHz.

Another thing to remember about the emulator is that only one of the ports may have access to the memory at any one time. This card has been designed so that the port to the target system is the one which is normally enabled, but whenever the development system requires access it takes priority, hence denying access to the target system. The host computer will thus always be able to read or write to the RAM. The fact that the target port will sometimes be denied access to the emulator is not a big problem because whenever the development computer writes to the emulator it will generally be to change the program and, accordingly, it will usually be required to do a target system reset.

The method of driving the emulator depends very much on which method of interfacing is used. If the board is interfaced directly onto the system bus of a 6502 or 6809 based computer, there is really nothing to be said. It is simply a matter of writing the data to the emulator in just the same way as to any other memory on the computer. On the other hand, the hardware for implementing a stand alone emulator with an RS232 interface has not yet been described, so the method of using the emulator in this configuration will be left to a future article. The only interfacing method which therefore requires any amount of instructions is via a parallel port. Since a variety of different machines employing various PIAs, PIOs & VIAs could be used it seems pointless to give a BASIC or assembler program for one particular hardware. One flow diagram is for transferring data from the computer to the emulator and another for carrying out the reverse process. In either case the following signals require connecting to PIA pins: A0-A12, D0-D7, F/W and SEL. In addition, $\varphi 2$ should be connected to +5V and link 2 should be selected to the 'd' position.

BUYLINES

All of the semiconductors (including the various memory options), the passive components, the SIL resistors, etc, are available from our regular advertisers. The only item likely to cause any problems is the PCB mounting nicad; we obtained ours from a trade source, but if you are unable to find an identical item there is a Maplin equivalent which has slightly different pin spacing. The PCB is available from our PCB service, see page 54.

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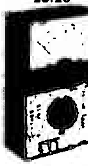

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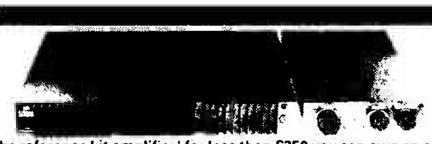

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COMMUNICATIONS SATELLITES (PART 2)

Roger Bond continues his look at communications satellites with a look at the Single Channel Per Carrier transmission system, beam polarisations and the different satellite circuits we connect up to.

Single channel per carrier (SCPC) is similar to SPADE except that SPADE is on a demand assignment basis, SCPC is preassigned. As before a 36 MHz transponder is divided into 800 channels but to avoid interference with the system pilot the two channels at mid band are not used. This leaves 789 usable channels.

As in the SPADE system, a 14 kHz audio channel is converted to a digital rate of 56 Kbit/s. Add to this synchronisation pulses and the bit rate increases to 64 Kbit/s. About four years after SPADE, SCPC was introduced. Since there was a good demand for data transmission at a higher rate than could be used on SPADE, a preassigned link had to be established and there are several 48 Kbit/s and 50 Kbit/s data links over SCPC.

A transponder uses so many carriers that the frequency deviation of each must be limited to 250 Hz compared with 80 kHz permissible deviation when operating in a frequency division multiplex mode (FDM) using, say, a dozen carriers.

The low speeds of data are 1.2 Kbit/s, 2.4 Kbit/s and 4.8 Kbit/s. Medium speeds are 9.6 Kbit/s, 19.2 Kbit/s, 48 Kbit/s, 50 Kbit/s and 56 Kbit/s. So a TDM (time division multiplex) terminal could interleave several low speed data streams into say a 48 Kbit/s stream. This is an example of how flexibility of ground equipment can cope with traffic demands. One other point of interest: a 4kHz speech channel is converted to 64Kbit/s of digital information; therefore, with data speeds of 56Kbit/s we are approaching this limit. However, lower speeds can be combined to give this maximum.

Such demands must of course be met in the air and to cope with heavy traffic. four of the transponders on both Intelsat IV and Intelsat IVA can be switched from global beam to spot beam by remote telemetry from the ground.

A frame is a cycle of bursts from all stations. Each burst starts with a preamble of station identification, signalling and so on. There are also start of message words which aid synchronisation. Only one station transmits a reference pilot which is used by all the other stations for automatic frequency control (AFC) and automatic gain control (AGC).

If speech is being transmitted, a voice detector switches on the carriers, switching them off again during silent periods to conserve both satellite and earth station power. However a speech detector would cause clipping and sound quite annoying to a listener but if a delay line is used in the speech path to delay the speech by a few milliseconds while the detector switches on the carriers, then no speech would be lost. For data transmission, the voice detector is disabled and the channel is in continuous use.

The error rate for SCPC is 1 in 10^4 which is good enough for speech but poor for data. This can be improved to 1 in 10^7 by the rate ¾ encoder or the rate ⅞ encoder. To produce an error correction code, the rate ¾ encoder converts the incoming data stream into three parallel streams i, j, k and arithematic operation produces a fourth stream p from a parity generator.

These four streams are combined and fed into a four-phase, phase shift keying (PSK) modulator as two parallel 32 Kbit/s streams, Fig. 1. To get four phases we simply divide a circle into four to give angles of 0, 90, 180 and 270 degrees. These correspond to the digital states 00, 01, 11, 10.

So if we clock each of the two phase modulators of Fig. 1 with quadrature components of a 46 MHZ carrier, the output from the adder will give one of the four states above. Then depending on the channel being transmitted, the 46 MHz PSK carrier is mixed with a frequency to give an IF for that channel which will be within the range 70±18 MHz.

In the receive direction, there are two down converters which translate the 4 GHz first into an IF centred on 70 MHz then to a band centred on 46 MHz. The automatic gain control has a range of 14 dB and uses the power of the system pilot as reference. The range of the automatic frequency control is ±40 kHz and once again centres on the system pilot.

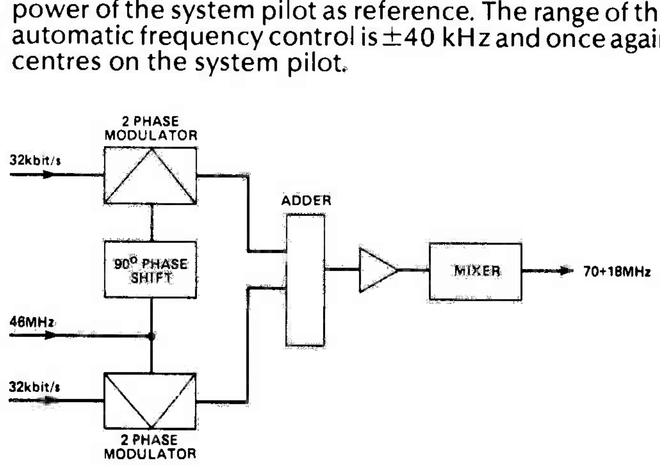


Fig. 1 PSK modulator block diagram.

With the increasing demand for international data links, SCPC is here to stay and whereas a Standard A type earth station with a 30m diameter aerial is required for FDM, a standard B earth station with a dish of only 12m diameter is needed for SCPC/PSK.

Dual Polarisation

The radio spectrum is very crowded, particularly in the L and C bands; for example, the 6/4 GHz satellite frequencies are also used for terrestrial radio. Any method of making better use of the available frequencies is worth trying. One such method is the use of opposite polarisations of the same carrier to carry different information.

Circular polarisation is used, rather than plane, because this is far less affected by attitude changes in the satellite or earth station, for obvious reasons. It is fairly easy to interconvert between plane and circular polarisations, and Fig. 2 shows one such device. There are devices for converting from circular to plane, and for splitting off different polarisations from each other. As a working minimum, a cross-talk of -30dB between different polarisations is acceptable.

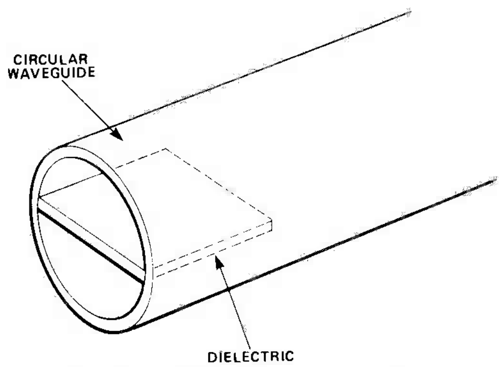


Fig. 2 Circular polariser in a waveguide.

There are several different aerial configurations in use. Figure 3a shows a front fed symmetrical reflector. This is a simple arrangement but the feed horn blocks the aperture so we can use the offset reflector of Fig. 3b. But in Fig. 3b the signal path length to one end of the reflector is not the same as the path length to the other end.

Aerials with two reflectors are called Cassegrain. Fig. 3c shows an open Cassegrain and Fig. 3d an offset

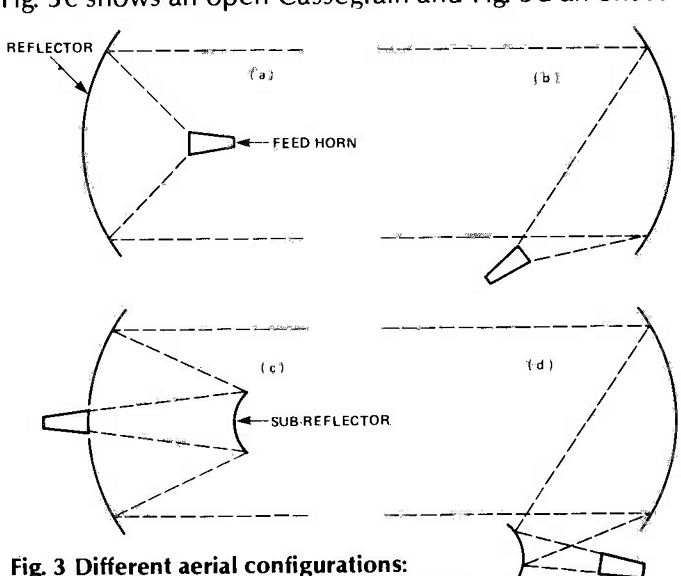


Fig. 3 Different aerial configurations: (a) front-fed symetrical; (b) off-set reflector; (c) open cassegrain; (d) off-set cassegrain.

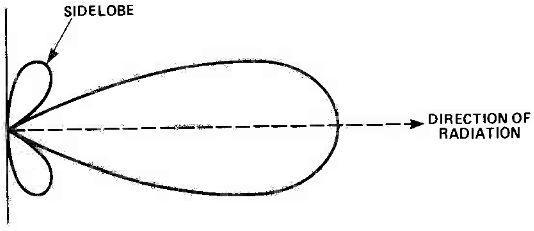
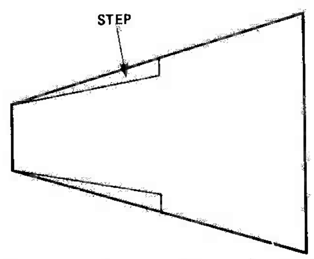


Fig. 4 Symmetrical beam.

Cassegrain. The main reflector is a parabola and the sub reflector a hyperbola which is thought to give a waveshape that is superior to that from a single reflector since distortions would cancel. The edges are also shaped to reduce spill over radiation and compensate for path length differences.

The object of a good aerial is to produce a symmetrical beam with low sidelobes (Fig. 4). In addition, if it is radiating waves of different polarisations, the cross polarisation (interference) must be low. There are two methods which will satisfy these requirements. One is to introduce a step in the aerial horn (Fig. 5). This has the effect of exciting a higher order mode of wave propagation in the wave guide which cancels the fundamental mode and gives good beam symmetry. The disadvantage is that this method limits the usable bandwidth of the antenna, which can be improved by further step discontinuities.



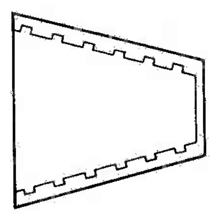


Fig. 5 (left) A step discontinuity in the feed horn. **Fig. 6 (right) A corrugated feed horn.**

Another method sometimes used is to line the walls of the aerial with dielectric or install corrugations (Fig. 6). The exact nature of the field distributions is beyond the scope of this article but briefly, the electric field parallel to the aerial axis enters the grooves but the circumferential field does not. The electric field is a combination of TE and TM modes which cannot propogate down smooth walls but need walls lined with dielectric or corrugations. The propagated frequency will depend on the depth and radius of the slots which in turn will control the field pattern. The penalty of course is that these aerials cost more and are heavier than conventional flat-walled dishes.

A development in recent years is to situate the feed horn on the ground and then convey the beam up to the main reflector by means of a wave guide which consists of four reflectors, Fig. 7. All this makes for a fairly complex tracking mechanism.

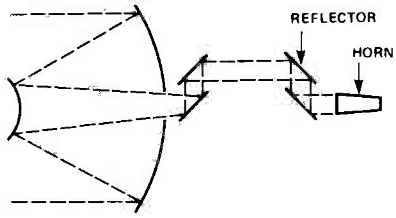


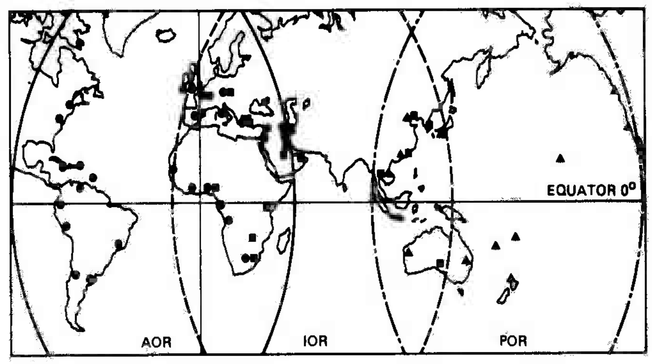
Fig. 7 Beam guided to main reflector.

Satellite Circuits

The UK's aerials have to serve satellites over the Atlantic and Indian ocean. The traffic paths are as follows: a primary and two secondary paths over the Atlantic Ocean Region (AOR) and a primary and one major path over the Indian Ocean Region (IOR). This means three satellites over the Atlantic Ocean and two over the Indian Ocean Region plus spares for each region.

On the AOR major paths, Britain works to the USA and Canada and on the primary path to Africa and the Middle East. Over the IOR major path we can communicate with Australia, Japan and Hong Kong and over the primary path with some of the industrially smaller countries.

The Pacific ocean has only one satellite, the Pacific Ocean satellite, but we are not geographically placed to do any business via that satellite.



● ATLANTIC OCEAN STATIONS
■ INDIAN OCEAN STATIONS
▲ PACIFIC OCEAN STATIONS

Fig. 8 The three satellite regions.

Band	HF	VHF	UHF	L	S	C
Frequency GHz	0.003-0.03	0.03-0.3	0.3-1	1-2	2-4	4-8
Wavelength	10-100m	1-10m	0.3-1m	150-300mm	75-150mm	37-75mm

Band	X	Ku	K	Ka	Millimetre
Frequency GHz	8-12	12-18	18-27	27-40	40-300
Wavelength	25-37mm	17-25mm	11-17mm	7-11mm	1-7mm

Table 1 Frequency Spectrum

ETI

INFRARED ALARM

In part two of this project, Frederick Howard gives details of the setting up and use.

The transmitter should be set up first so that it can be used to set-up the receiver. If you have an oscilloscope, connect it to the junction of IC2, pin 3 and R8 and then switch on the transmitter. A symmetrical square wave of 5 volts amplitude should be observed. If the circuit is not oscillating, try adjusting RV1. If you have a frequency counter, connect it in place of the oscilloscope and adjust RV1 until you get a reading of 50 kHz. If you do not have an oscilloscope or a frequency counter, set RV1 to its mid point. You will not be able to check that the circuit is oscillating, but if you have problems in setting up the receiver and suspect the transmitter to be at fault, you could either borrow the necessary test gear or devise a diode pump or frequency divider arrangement to make sure.

Before starting work on the receiver, set coils L1 and L2 so that their adjustable slugs are about one turn away from full insertion and, for reasons of personal comfort, temporarily disconnect the sounder. Point the oscillating transmitter directly at the receiver from a distance of one or two feet. The lens assembly can be left off of the receiver until after the setting-up operation if this is most convenient. Connect a high resistance voltmeter across C10, taking the positive lead to ground, and adjust L1 and L2 for maximum voltage reading. For fine adjustment, move the transmitter further away from the receiver.

Switch off the units, disconnect R5 on the transmitter from the positive rail and solder it into its correct position. Switch on again with the two units positioned as before and monitor the emitter of Q8 with an oscilloscope. A pulsed signal should be observed at an amplitude of about 3 volts. The sounder can now be re-connected and the system tested. If you do not have an oscilloscope you will not be able to test for a pulsed waveform at the emitter of Q8 so you will simply have to connect up the sounder and try out the system, hoping for the best.

In Use

The IR emitter diodes are very directional and must be pointed directly at the receiver in order to hold off the alarm. If more than one emitting diode is used the

PARTS LIST — RECEIVER

RESISTORS (all ¼W 5%)		C16,17,18	100n ceramic
R1, 26	56k	C19	15u 16V tantalum
R2,3,5,6,8,9,13,14, 17,18,19,24,27,28	10M		
R4,7,11,20	220k	**SEMICONDUCTORS**	
R10	1M0	IC1	4016
R12, 30	2k2	Q1,2,4,5,6,7,8,9	BC108
R15	82k	Q3	BF244
R16,21	8k2	Q10	BC478
R22	470R	Q11	VN10LK
R23	39k	D1-9	1N4148
R25	4M7	D10	1N4001
R29	270k	LD1	BP104 (Siemens)
R31	10k		
R32	12k	**MISCELLANEOUS**	
		L1,2	Toko coil, 3.5mH type 10PA CAN1A350EK
CAPACITORS			
C1,4,8,11	22u 16V tantalum	X1	Self-contained sounder or other audible warning device, 9V
C2,12	3n3 polycarbonate		
C3,7	10n ceramic		
C5,6,9,13	150p ceramic		
C10	4u7 16V tantalum	PCB; miniature switched jack socket and plug to suit; plastic case; PP3-type battery connector; lens assembly (see text); spacers, etc.	
C14,15	1n0 ceramic		

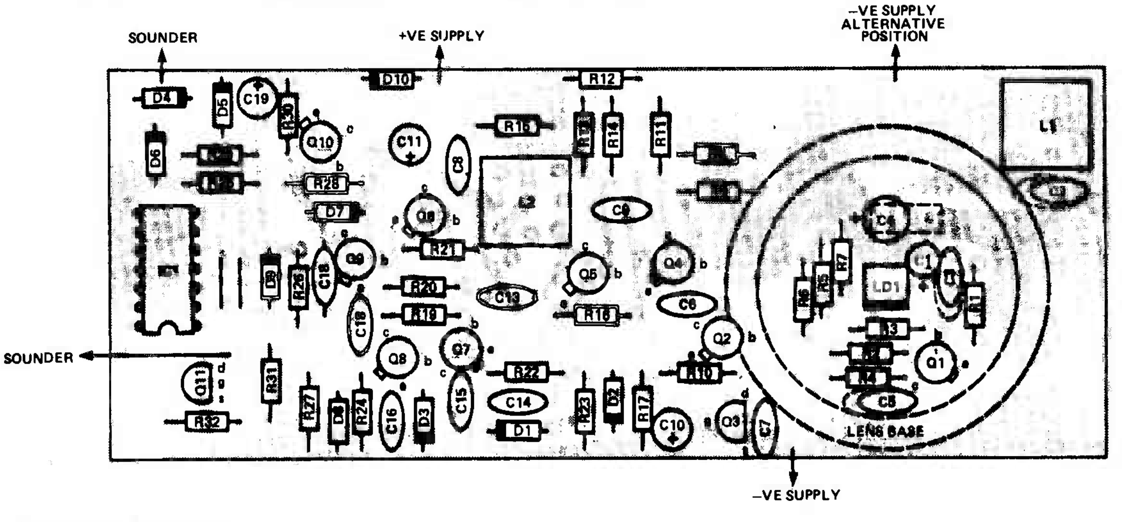
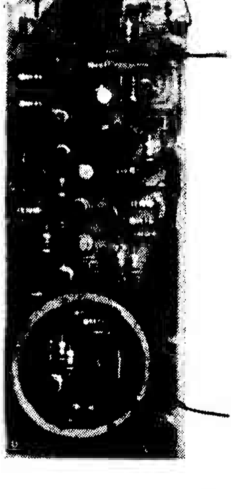
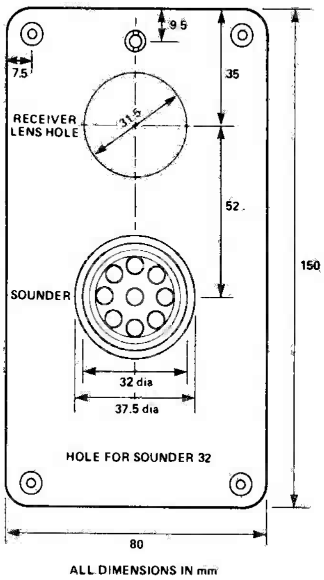


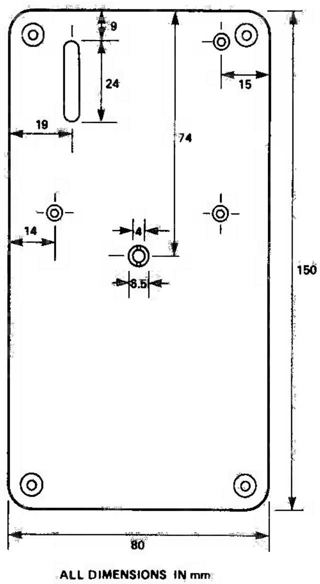
Fig. 5. Overlay of the receiver PCB.



beam will inevitably be slightly more divergent, if only because it is almost impossible to line up several diodes with sufficient accuracy to make it otherwise. A little experimenting may be in order here, particularly if you are planning to use the alarm over large distances. For short distances, up to about six feet, the two units may be placed side by side and the beam reflected from the opposite wall. For longer distances, up to a maximum of about 35 feet, the two units should be placed opposite one another and lined up carefully. Note that, for the reasons explained earlier, the receiver has a built-in delay of about twenty seconds after switch on during which time it will not detect any interruption of the beam.

ETI





Figs. 6 & 7. Drilling details of the receiver (left) and transmitter cases.

BUYLINES

The SFH100 and BP104 infrared diodes are available from Avionic Systems (Heathrow) Ltd, Viscount Way, Heathrow Airport, Hounslow, Middlesex TW6 2JW, as also are the VN10LK transistors. None of the other semiconductors should cause any problems, but note that BC178s can be used instead of BC478s — both are complementary to the BC108s used elsewhere in the circuit. Polycarbonate capacitors suitable for use as C2 and C12 in the receiver are available from Maplin (type WW25C), who can also supply suitable cases. Ambit stock a silver mica capacitor suitable for use as C3 in the transmitter (stock no. 04-22108) and can also supply the Toko coils (stock no. 35-03500). Almost any sounder which can operate from a 9V supply will be suitable, and various types are available from Cricklewood, Electrovalue, TK Electronics, Watford and others. The PCBs are available from us, see page 54.

READ/WRITE

Dear Sir,

The rather critical tone of your editorial note at the head of READ/WRITE in your May issue of Electronics Today, is, I suspect somewhat unjustified.

You imply that your readers do not care about Alan Todd's problem, because we have not come up with a solution to it.

I would suggest that his difficulty is in fact incapable of practical solution. A reasonably obvious solution viz. the use of solenoids, is, as Alan himself tells us, impractical.

The trouble is that the human body is an immensely complicated mechanism. Many people, deceived by 'The Six Million Dollar Man' believe that it is possible to duplicate its function as compactly as the original. But those of us who saw a television programme broadcast two or three years ago which went behind the myth (and which actually featured the man who survived the horrific crash sequence which was shown at the start of each $6,000,000 Man episode) will know how far away from the truth the series was.

This sort of problem is the subject of an immense amount of research effort, for the handicapped and disabled, but such machines as exist e.g. the Possum are limited and cumbersome.

Do you really expect one of your readers to come up with a solution for you to publish — at usual rates? It would make millions!

As I say, I doubt whether there is a way to let Alan play his guitar again. But maybe all is not lost. Given enough electronic knowledge, I expect one could build a synthesizer into a guitar body, with rows of micro switches between the frets to operate chords. Further switches would complete the circuits to 'pluck' the strongs. Depending on how much control Alan has over his right hand, one could perhaps add extra rows for vibrato or echo effects or what ever else might be required. One could also use foot controls if necessary for volume.

But I am no electronics expert, and I know nothing about guitars either. Maybe this whole idea is either (a) unworkable or (b) unacceptable in terms of the sound output possible. But I would like to think that with clever use of components you could build a subsititute for a stringed guitar that would be undetectable at normal audience distances. You could even paint strings on the neck of the machine!

As I said at the beginning, it's not that we don't care about Alan's problem, it's that we don't have the technical knowledge to provide any useful contribution. Probably many of your readers are like me — just about able to follow a circuit diagram to wire it up, but utterly lost if whatever it is doesn't work at the end. Never mind, burning your fingers and spilling hot solder on the cat is a better way than many of spending wet winter afternoons and just occasionally something does work.

Yours sincerely,
Henry Arnold
Huntingdon,
Cambridgeshire

Dear Sir,

Congratulations on your April issue, the subtleties of which escaped me 'till I read your May editorial.

Which shows I fell hook, line and sinker. It is a good thing to be made to laugh at oneself.

Yours sincerely,
Roger Hannis
Reading

Mr Hannis may be the only reader to have owned-up but we can assure him he wasn't the only one to be fooled.

Dear Sir,

Mr Porter's letter in the March 1984 issue introduces some useful features for the improvement of a loudspeaker and I wish to raise one point. By the introduction of an amplitude correction circuit, does this not at the same time result in a phase difference in the upper range of the bass signal, and I estimate this to be equivalent to a 2μs difference at the dividing frequency. This may be small in comparison with the main time delay but should it not be taken into account? A small change in the value of the capacitor will cope with this.

Yours sincerely
W.F. Harms
Bexhill,
East Sussex

Dear Sir,

In your April 1984 issue you published an article called Bass for Beginners. May I point out that some of the published calcuated values, particularly that for parameter C, were not entirely correct. Another problem arose in the calculation of R since, for the lower values f_n the terms under the square root function give a negative value and hence it follows that the absolute value must be taken before the square root is taken.

Yours sincerely,
Joel Morgan
Edinburgh

Barry Porter writes: Thanks for the opportunity to reply to the two letters — here goes . . . With regard to the point raised by W.F. Harms, as a general rule, any system that has a non-linear frequency response also suffers from phase shift. In simple terms, any network that is intended to correct the response inaccuracies will also counteract the phase shift. This appears to hold good for drive units, certainly to the limits of any measurements I have been able to make, so the acoustic output of the B200 does not contain any significant phase shift due to the equalisation network. What is present, and easily measurable, is phase shift caused by the natural HF roll-off of the bass unit, and by the LF roll-off and nearby resonance of the HF unit. Correction for these inaccuracies is possible, but quite difficult, and as no detectable improvement has been found, the extra complexity is not really justfied.

Mr Morgan raises a couple of points — he says that there is an inaccuracy for the 'C' value but fails to say what it is! There have been several sets of formulae for speaker response calculations in use for several years — they all differ slightly, yet the results are likely to be more accurate at low fre-

quencies than any anechoic or free-field measurement, so there is no absolute way of showing who is right. The formulae given in the article will allow calculated response curves that are accurate to about 1dB to be plotted, which is a lot better than I can measure at frequencies below 100Hz. Mr Morgan is correct with his second point — the bottom term should be bracketed.

Dear Sir,

As a sail plane, as opposed to hang glider, pilot I am very interested in your Vertical Speed Indicator design (variometer is a much neater name), and I shall be building at least one when time permits, but could the designer be prevailed upon to add a refinement known as Total Energy Compensation considered to be essential by sailplane pilots?

For non-gliding types, let me explain that to increase speed a sailplane (or hang glider) pilot has to lower the nose of the aircraft and dive; conversely, raising the nose slows the aircraft as it climbs. A variometer, being a very sensitive device, responds to very small control inputs even when the pilot thinks he is flying at constant speed. These climbs and descents involve only an interchange of potential and kinetic energy and any loss of height can be regained, within the constraints of the second law of thermodynamics, by reducing speed. The total energy of the glider remains essentially constant. The pilot therefore does not want these height changes to be indicated on his variometer, they confuse the important information whcih is the direction and speed of height variation caused by the air through which the glider is flying.

A total energy compensation system cancels out the unwanted signal, commonly by changing the volume of the capacity bottle in a flow measuring system by means of a diaphragm deflected by varying pilot pressure when speed changes occur. The pressure sensing system of the ETI design seems admirably suited to electronic compensation by means of a second pressure transducer in the pilot tube to provide an offset signal.

The design has caused considerable interest among sailplane pilots and a practical modification would be well received. Can you fix it?

A final word. I am not sure about open frame-work hang gliders, but if the variometer is to be fitted to a closed cockpit sailplane, the pressure sensor should be plumbed into the static vent pipework to prevent response to small pressure changes in the cockpit.

Yours faithfully,
Terence Jenvey,
Knole,
Somerset

Your points have been noted and passed to the author, who was last seen heading for his workshop: whether this was to get down to some serious prototyping or simply to hide from us, we do not know . . .

Dear Sir,

I have just finished filing the contents of ETI January 1983 to April 1984 inclusive and thought that you might be interested in the following observations.

It would greatly assist filing if the project/feature pages could be arranged so that they are i) totally separate, ie, not back-to-back with other articles and ii) not back-to-back with advert pages.

An analysis of projects over the above period breaks down as:–

Computing	*26*
Music	*5*
Audio	*9*
Test	*7*

Miscellaneous 19 (including everything not in the previous four categories).

Whilst I am fully aware that this is the age of the computer, there are magazines dedicated to this subject and I, for one, would welcome more high quality audio projects. I was particularly impressed with John Linsley Hood's Audio Design Series and would welcome more of the same.

Finally, a suggestion for a future feature article — how about an article on the design of PCBs, laying down the ground rules for component placement and input/output runs to minimise pickup, unwanted feedback, etc, etc?

I hope that you find the above of some interest; keep up the good work with one of the best electronics magazines around.

Yours faithfully,
A. G. Crane
Kings Lynn,
Norfolk

We are not sure that counting the number of projects is the best way of indicating what emphasis we are placing on particular fields. For instance, some of the longest projects we have published have been audio ones — for example, Barry Porter's Modular Preamplifier, and John Linsley Hood's 'Audio Design' amplifier (which may have to run to four parts rather than the three originally planned, due to the amount of material). Perhaps if the number of pages were counted, a quite different apparent balance would be arrived at.

That said, there is undoubtedly a very strong interest in using computers amongst our readers, and this shows in the numbers of contributions we get on the different subject areas. Whenever we are offered a project of sufficient merit, we do our best to use it, whatever its field.

Finally, the laying out of ETI pages is difficult enough as it is without trying to impose extra restrictions on us! Let it suffice to say that we do our best to produce a magazine that is, visually, easy to follow and attractive.

Dear Sir,

Thanks for a great mag; my only complaint is where are the follow-up articles/projects for the Cortex 16-bit computer? Your last article entitled "Cortex BASIC Part 1" (Feb. 1983) — what about part 2? And while I'm at it, how about a few circuits to add-on. A parallel in/out would do nicely for starters!

Yours faithfully
A Gibson
Edinburgh

It's been a long time coming, but the follow up on the Cortex does seem to be arriving! Firstly, we dropped the article on Cortex BASIC after the first part because we found that Powertran were sending out a manual to kit purchasers with exactly the same information as we were intending to print. Perhaps we could have explained our decision better at the time, though.

Hardware follow-ups depend on you, the readers. We are just completing one hardware add-on (the Centronics interface, the second part of which was delayed so that we could sort out a few problems with the PCB), and others are in the offing. However, what we print depends on what we get sent by you lot out there, so if you've built something for your Cortex, and you think it would be up to our standard, let us know about it! **ETI**

Please mention E.T.I. when replying to all adverts

SIMPLE CMOS TESTER

Here's a natty project to test the simpler CMOS ICs in up to 16-pin packages. Design and development by Peter Dooley.

When fault-finding on equipment which uses CMOS devices, it is not always easy to isolate the fault to one IC. One method of elimination is to substitute the suspect device with a new one, but this has the disadvantage of possible damage or destruction of the replacement part, should the fault be elsewhere. A more positive method would be to have some device for testing a suspect IC. The unit to be described will test most CMOS ICs (up to 16 pins), and can also be used for evaluation of unfamiliar devices.

Construction And Testing

Fit and solder all links, followed by test pins, IC sockets, resistors, capacitors, diodes (except D2), LEDs, DIL switches and the power socket. This last item is mounted on the foil side of the PCB, and is held in position by two screws. Note carefully the orientation of the DIL switches, this is such that they are closed when the sliders on them are towards the test socket.

D2 is soldered between the +ve terminal on the power socket and the appropriate track on the PCB; the 0V connection should be made using a short length of wire. Two flying leads are required, and for this we suggest using the specially flexible wire that you can sometimes get for test leads, otherwise you'll have to replace these fairly regularly. Note that the sockets on the flying leads should match the test pins.

Six stand-off pillars are used to support the PCB, two of them being mounted close to the test socket to add strength where it's needed.

After checking the PCB and wiring for obvious faults, insert the three ICs. With the power still off and both flying leads disconnected, all switch positions on SW1-16 should be set to off. Apply power and observe LED17 flashing. Adjusting RV1 should alter the speed. Apply the pulse probe to each of the 16 test points in turn and check that the corresponding

PARTS LIST

RESISTORS (all ¼ W 5%)

R1-16	47k (16 off)
R17-32, 34	1k0 (17 off)
R33	1M0

CAPACITORS

C1	330n polyester
C2	100n polyester
C3	100µ 16V PCB electrolytic

SEMICONDUCTORS

IC1-3	4049
D1	1N4148
D2	1N4001
LED1-17	0.1" red LEDs (17 off)

MISCELLANEOUS

SW1-8, 9-16	2 off 8 pole SPST DIL switches
SK1	16 pin ZIF socket (see Buylines)

16 off PCB test point connector pins, 2 off test point sockets to match; 3 off 16 pin IC sockets; mounting pillars (16 off); 2.1 mm power socket; PCB.

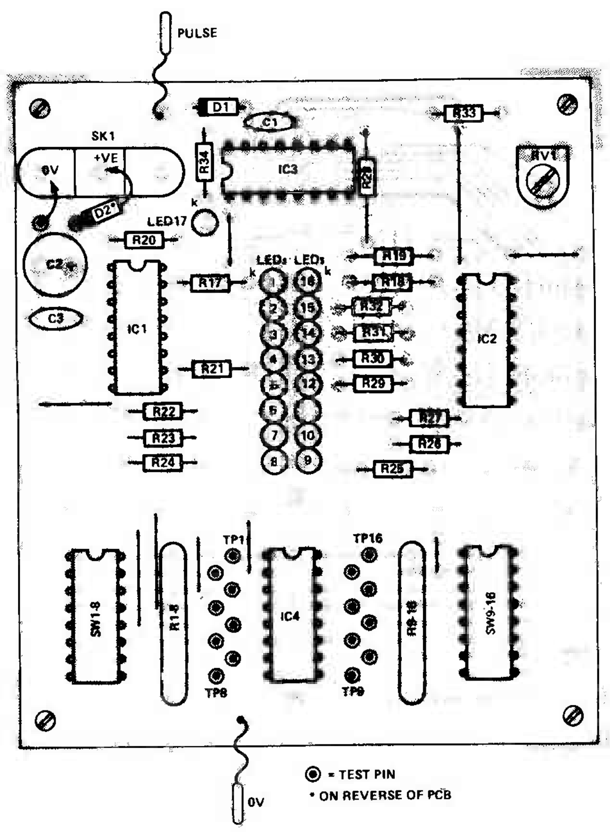


Fig. 1 Overlay diagram of PCB.

HOW IT WORKS

IC1, 2, 3 are 4049 CMOS hex inverting buffers, one buffer being connected to each pin of a 16-pin test socket. An LED monitors the output of each buffer. With all poles in DIL switches SW1-16 open, the pins and test points on the test socket are held low by resistors R1-16 and the LEDs, which are displayed in DIL formation, are off. If one or more switches are closed, applying the positive supply to the IC pins, or an output on the test IC goes high level, then the corresponding LED lights to indicate a high level. The 0V connection to the test IC is made using a flying lead which is connected directly to 0V.

IC3e and f together with C1, form a variable speed oscillator, with a frequency of approximately 1 Hz to 20 Hz. The output can be connected to any of the test points TP1-16, using a flying lead. Diode D1 is used to protect the oscillator components, should the output be inadvertently connected to a high level point. The output is monitored by LED17, which can be seen flashing at low speeds. The 9 volt DC supply can be obtained from a standard mains adaptor, or a 9V battery could be used. Diode D2 serves as a reverse polarity protector.

LED flashes. Operate SW1-16 in turn and check that the corresponding LEDs come on, and remain on until the switches are turned off. This concludes the test procedure.

In Use

Ensure that power is off before inserting the IC to be tested. Connect the 0V lead to the test point corresponding to the 0V pin on the IC and select the +V on the appropriate switch of SW1-16. Apply power and observe the output status of the IC on the display.

Select the input using the appropriate sections of SW1-16; care must be taken not to apply a high to any of the outputs of the IC, which will damage the IC under test, or to apply a high to the 0V power connection, which will risk damaging the PSU and D2. It should now be possible to work your way through the truth table of the IC under test, checking to see if all sections work.

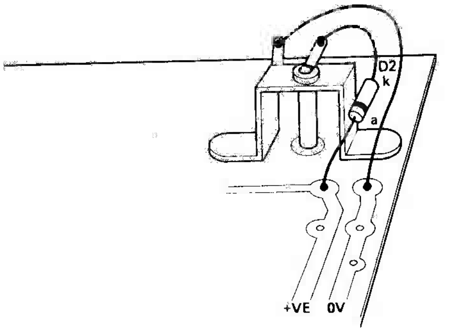


Fig. 3 Wiring of the power socket.

BUYLINES

The immediate problem we can see is the ZIF 16-pin socket SK1; here's a confession: we didn't use a ZIF socket, but, if you can find one (we couldn't) it is obviously the best thing to use here; otherwise, you'll just have to use an ordinary IC socket like we did. The other possible problems are the PCB connector pins and the test point sockets, which are RS Components part numbers 434-138 and 434-144 respectively (we haven't found a non-RS equivalent, so you may have to improvise). The PCB, as ever, is available from us.

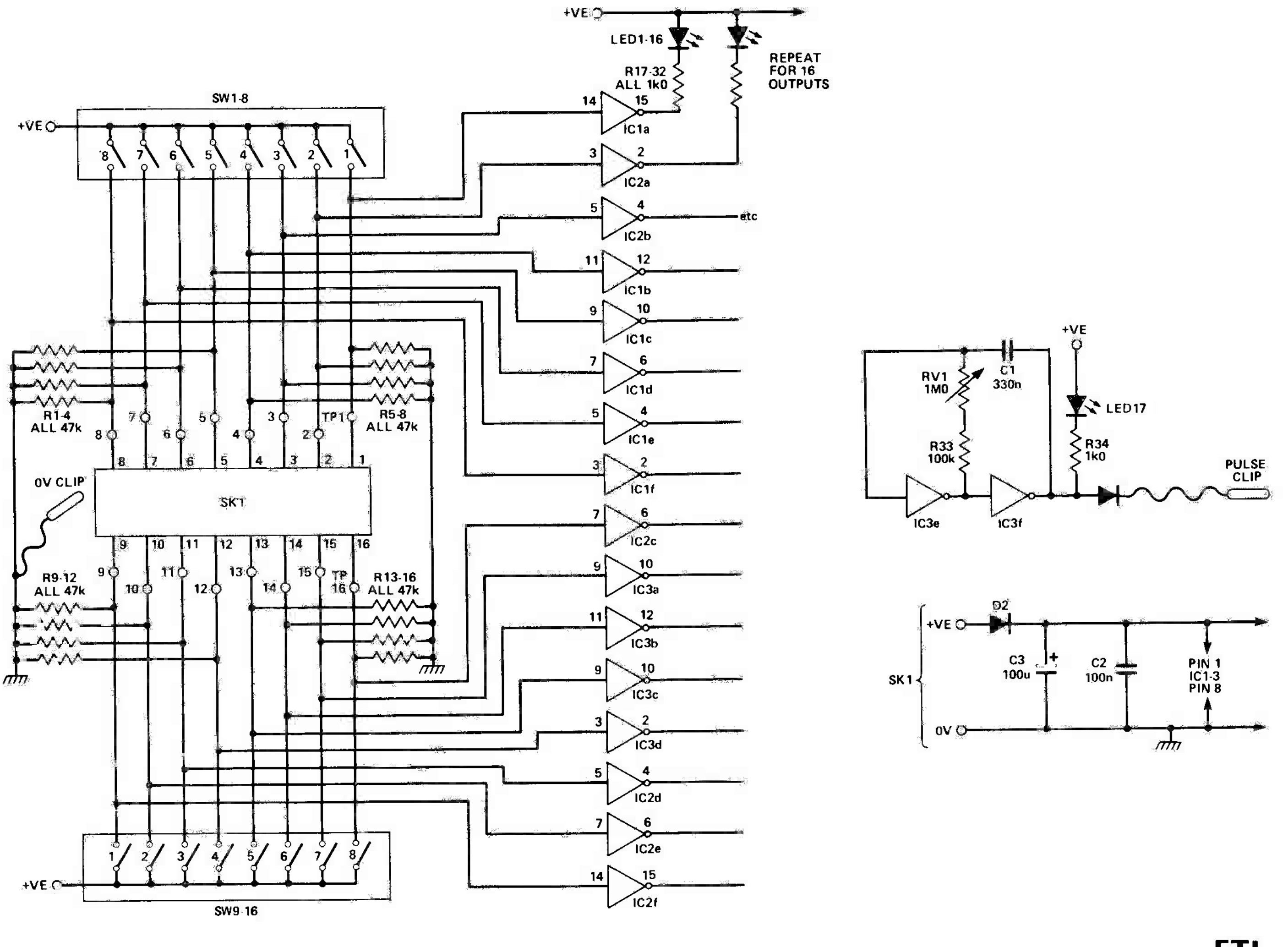


Fig. 2 Circuit Diagram of the CMOS tester.

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We receive a very large number of enquiries. Would prospective enquirers please note the following points:

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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).

We don't bother with the bureaucracy for Tech Tips — all you do is to send in your idea, stating clearly if you want an acknowledgement or receipt. If possible, please *type* your explanation of why the circuit is different, what it does and how it works, on a separate sheet from the circuit diagram; both sheets should carry your name, address and the circuit title. We'll let you know (within a month or so) if we want to use your Tech Tip.

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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.

Programmable Speech Board — Mini Mynah (February 1984)
The PCB for this project is double sided but only the underside pattern appears on the overlay drawing on page 26 and on the Foil Patterns page. The component side pattern appears on the PCB Foil Patterns page in the March'84 issue. The error does not affect PCBs supplied by our PCB service. There are also a number of errors in the circuit diagram on page 22. Pin 10 on IC11 should be connected to 0V along with pins 1 and 11, not pin 12 as shown; pin 12 should be left unconnected. On the same IC, pin 25 rather than pin 23 should be connected to pin 2 and R12/C4; pin 23 is Vcc and should be connected to the +5V supply. R5 has been missed off of the circuit diagram; it should be shown connecting IC4a pin 8 and IC5 pin 21 to the +5V supply. In each of the above cases the PCB and the overlay diagram are correct.

Adding Colour to the Ace (April 1984)
We renumbered the components in this article to make things easier for you (!) and ended up with utter confusion. In the third paragraph of the construction section on page 43, IC4 should read IC14. In the first column of the How It Works section on page 44, lines 3-4 should read "... via tri-state buffer *IC9...*". In the third column of the same section, the capacitor in the differentiator network (lines 13-14) is C6, not C9, and the line sync pulse mentioned at the start of the next paragraph is applied via IC1e, not R1d. In the first column of How it Works on page 45, C6/R15/R10 on line 9 should read C6/*R9*/R10, and the list of resistors given three lines further down should start with R29 not R21. In the second column on page 45, the colour modulator is IC14 not IC13 and the second phase shift network mentioned a few lines further down should be C16/*R32*, not C16/R17. On the circuit diagram on page 44, there are two C7s, the lower one of which should be C8 and have a value of 4n7, not 47n as stated in the parts list; C9 is listed as being 100n both on the circuit diagram and in the parts list but should actually be 1n. In the other half of the circuit diagram on page 45, C17 should be 33p not 10p and again the parts list is also wrong, and pin 16 of IC14 should be shown connected to pins 15 and 12, not to the +5V supply; the PCB overlay is correct. In the timing diagram at top left on page 45, read IC1 for IC13, IC5 for IC12, IC10 for IC9, IC11 for IC5, R14/C12 for R29/C19, and C9/R11 for C5/R6. In the timing diagram at top right on page 45, read IC5 for IC12 throughout, and in the regenerate clock signal diagram below it, read IC6b for IC2a, IC11 for IC5, and IC6c for IC2d. The same three ICs are mentioned in the delay timing diagram on the same page and should be similarly amended. In the setting up section on page 46, read RV1 for RV2 and vice versa, and in the software section read f0 for £0.

Midi Drum Synth (May 1984)
Two small links on the PCB went missing: between RV5(1) and upper (on PCB) RV4 connection, and between RV1-3 +VE and LED2 CATHODE take-off points. Also, the circuit diagram shows R13 going to −VE; it should go to earth (the PCB is OK).

Spectrum Joystick Interface (June 1984)
The PCB and the circuit diagram do not agree; the circuit diagram is correct, and all PCBs sent out by the PCB service should have been amended. IC3 is 74LS241, as correctly stated in the parts list but incorrectly given in the footnote to the circuit diagram.

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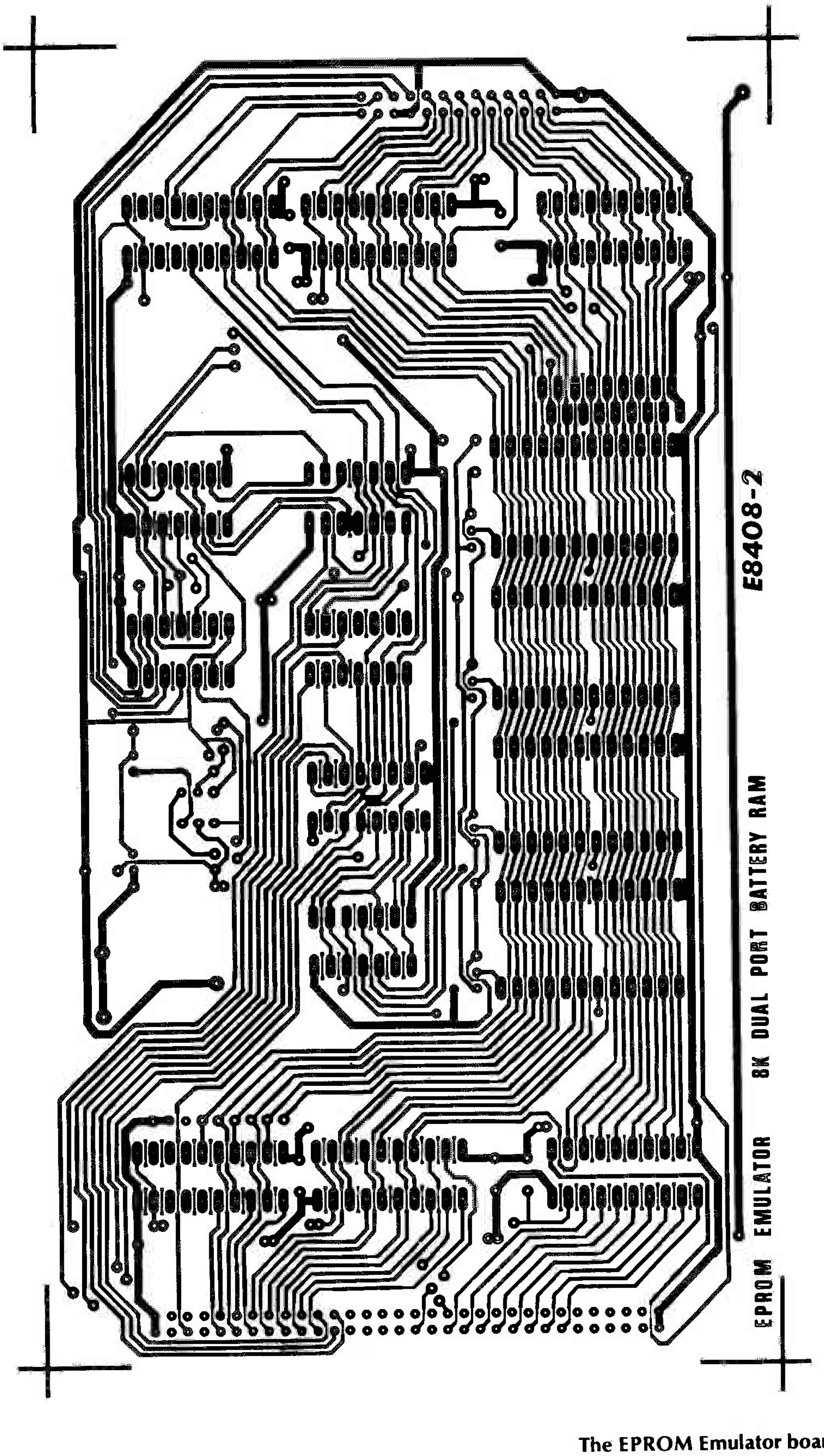

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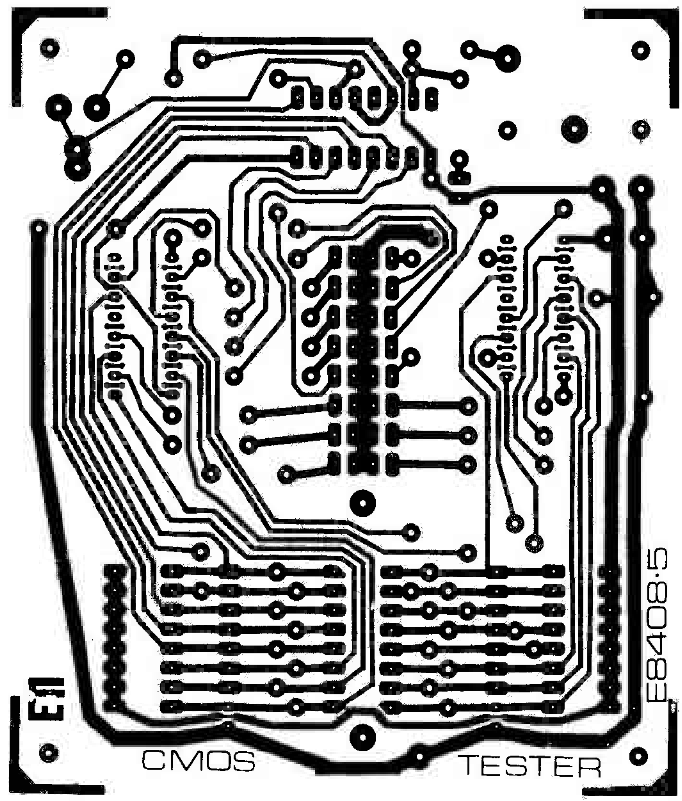

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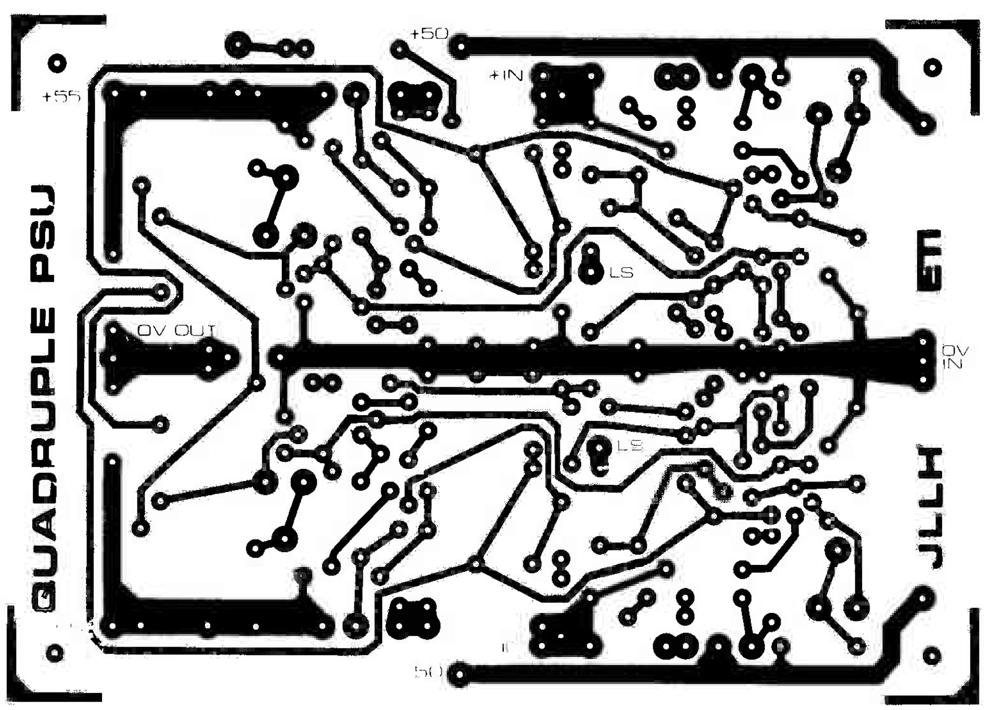

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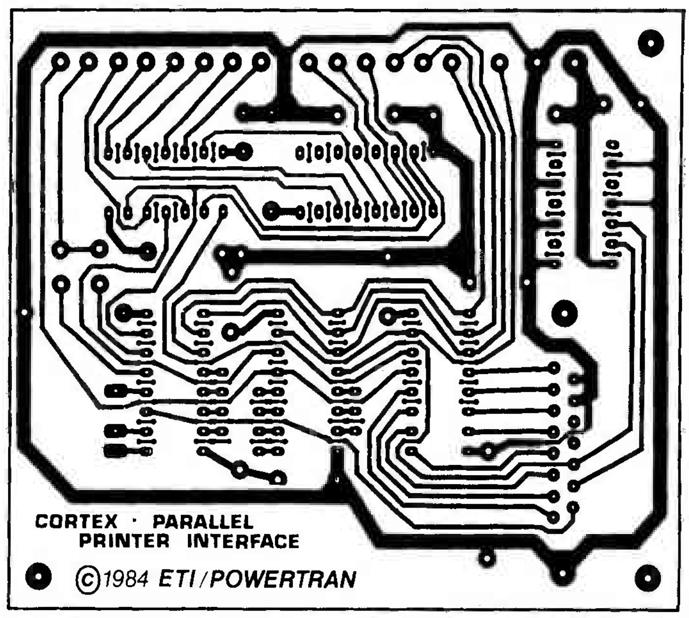

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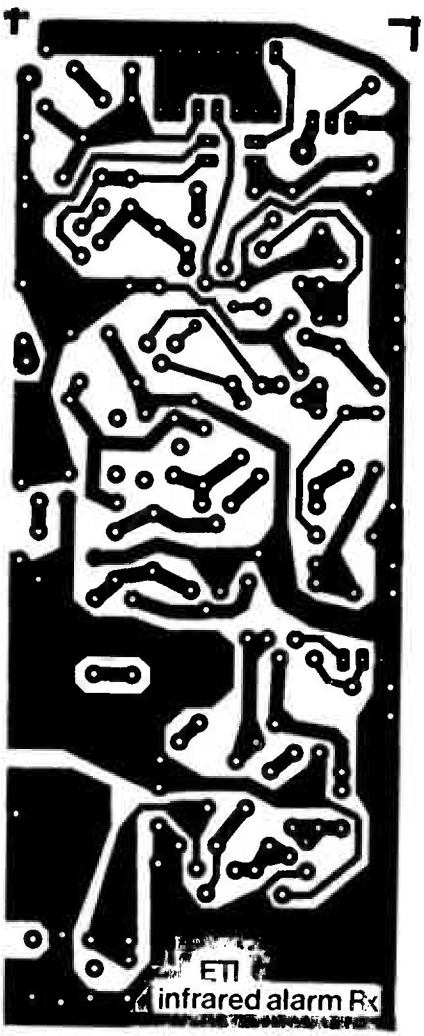

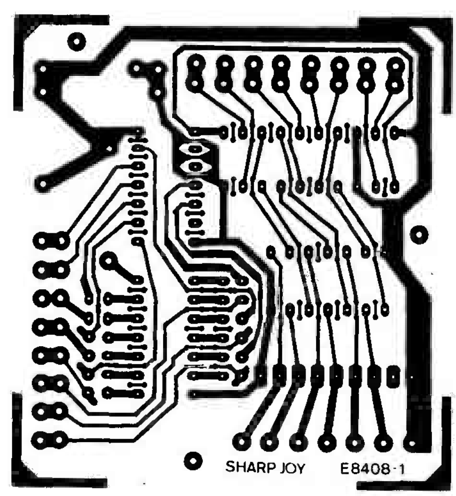

The Sharp Joystick Interface board.

The Infrared Alarm receiver board.

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BOOKS

PARAPHYSICS JOURNAL (Russian translation); psychotronics, kirlianography, heliphonic music, telekinetics. Computer software. S.A.E. 4 x 9", Paralab, Downton, Wiltshire.

SITUATIONS VACANT

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Madame Tussaud's are seeking to appoint an experienced Audio Visual Technican to work at their Royalty and Empire exhibition in Windsor. Applicants must have knowledge of electronics and computer programming. Experience of theatre lighting systems and sound recording studios would be an advantage. A driving licence and a certain amount of mobility are required.

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Mechanical/computing ability is required to assist with current projects (to be featured in Practical Electronics, September issue) and future generations of robots and robotic equipment.

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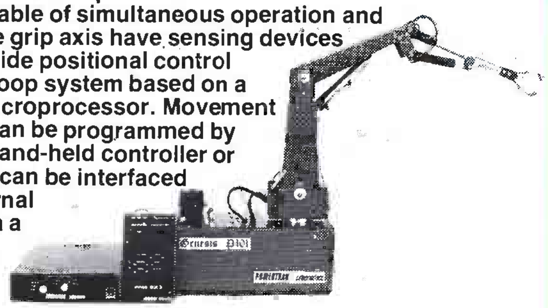

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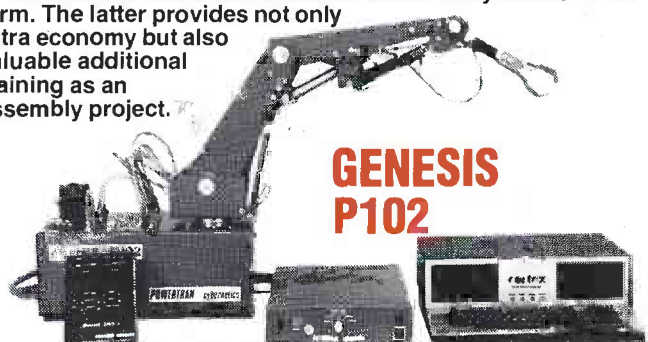

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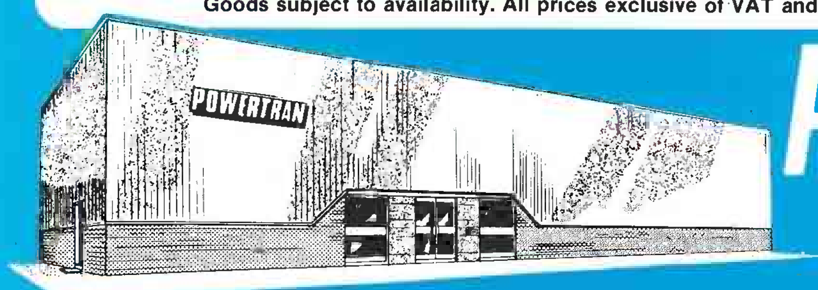

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