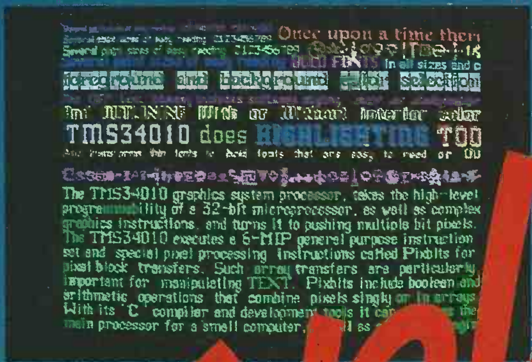
AN ARGUS SPECIALIST PUBLICATION

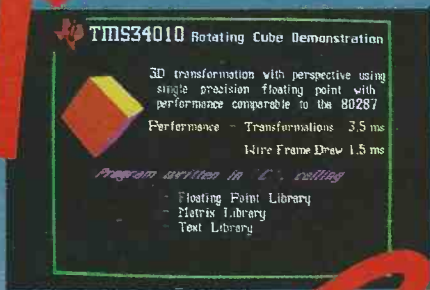
electronics today

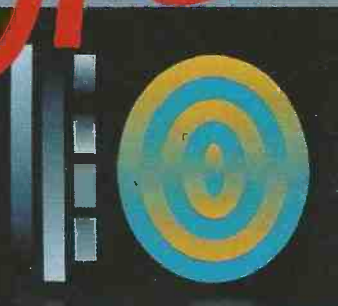
INTERNATIONAL APRIL 1987 £1.30

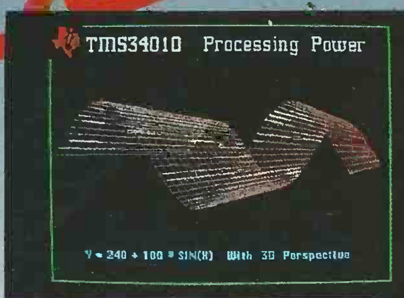
THE FUTURE OF COMPUTERS:

Graphics Processors









PLUS:
ROBOTICS CIRCUITS
BBC MICRO MIDI INTERFACE
24 hr SUNDIAL!

15 YEARS OLD
1972 | ESSENTIAL INDEX OF ALL ETI PROJECTS | 1987

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

electronics today
INTERNATIONAL APRIL 1987 VOL 16 NO. 4

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1 Golden Square, London W1R 3AB. Telephone 01-437 0626.
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Geoff Bains: Editor
Ian Pitt: Deputy Editor
Paul Chappell: Project Editor
Jerry Fowler: Technical Illustrator
Alisdair Chisholm: Ad. Manager
Nicola Baty:
Classified Sales Executive
Andrew Selwood: Copy Control
Dave Bradshaw: Group Editor
– Electronics

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FEATURES

PROJECTS

REGULARS

01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Micro Computer System

BBC Master Series
AMB15 BBC MASTER includes one free ROM cartridge .... **£385** (a)
AMB12 BBC MASTER Econet computer .... **£315** (a)
AMC06 Turbo (65C102) Expansion Module .... **£99** (b)
ADF13 Rom Cartridge .... **£13** (d)
ADF10 Econet Module .... **£41** (c)
ADJ22 Ref. Manual Part I .... **£14** (c)
ADJ23 Ref. Manual Part II .... **£14** (c)
ADJ24 Advanced Ref. Manual .... **£19.50** (c)

ACORN ADD-ON PRODUCTS
6502 2nd Processor .... **£173** (b)
TORCH ZEP 100 .... **£229** (a)
Muliform Z80 2nd Processor .... **£289** (b)
Acorn Teletext Adaptor .... **£95** (b)
Acorn IEEE Interface .... **£265** (a)

BBC Master Compact
SYSTEM 1
128K, Single 640K Drive & bundled software .... **£385** (a)
SYSTEM 2
System 1 with a 12" Med Res RGB Monitor .... **£469** (a)
SYSTEM 3
System 1 with a 14" Med Res RGB Monitor .... **£599** (a)

Second Drive Kit .... **£99** (c)

UPGRADE KITS
1770 DFS Upgrade for Model B **£43.50** (d)
Basic II ROM .... **£22.50** (d)
1.2 OS ROM .... **£15** (d)
DNFS ROM .... **£17.50** (d)
ADFS Rom (for B with 1770 DFS & B Plus) .... **£26** (d)

ECONET ACCESSORIES
Econet Starter kit .... **£85** (d)
Econet Socket Set .... **£29** (c)
Econet Bridge .... **£174** (b)
File Server Level II .... **£75** (d)
Printer Server Rom .... **£41** (d)
10 Station Lead set .... **£26** (c)
Adv. Econet User Guide .... **£10** (d)

COMMUNICATIONS ROMS
Termulator .... £25 (d)
Communicator .... £49 (d)
Commstar .... £28 (d)
DATABEEB .... £24 (d)

BBC FIRMWARE & SOFTWARE
Database Management Systems, Word Processors, Languages, Spreadsheets, Utilities
For full details on the wide range of above packages please write to us.

PRINTERS

EPSON
LX86NLQ (80 col) .... **£199** (a)
EX800 .... **£409** (a)
EX1000 .... **£579** (a)
EX1000 .... **£579** (a)
LQ800 (80 col) .... **£439** (a)
LQ1000 (136 col) .... **£589** (a)
JX80 4 colour .... **£229** (a)
FX800 .... **£319** (a)
FX1000 .... **£449** (a)
TAXAN KP815 (80 col) NLQ .... **£249** (a)
TAXAN KP915 (156 col) .... **£369** (a)
NATIONAL PANASONIC KXP1080 (80 col) .... **£149** (a)
STAR NL10 (IBM Interface) .... **£239** (a)
STAR Power Type (Daisy) .... **£229** (a)
JUKI 6100 Daisy Wheel .... **£259** (a)
BROTHER HR20 .... **£329** (a)
INTEGREX Multicolour .... **£525** (a)
HITACHI 672 A3 Plotter .... **£459** (a)

Paper:
2000 Sheets Fanfold:
9.5" x 11" .... **£13** (b)
14.5" x 11" .... **£18.50** (b)
Labels: (per 1000)
3.5" x 17/16" Single row .... **£5.25**(d)
27/16" x 17/16" Triple row .... **£5.00** (d)

ACCESSORIES

EPSON
FX plus sheet feeder .... **£129.00** (b)
LX80 Sheet feeder .... **£49.00** (b)
Paper Roll Holder .... **£17.00** (d)
Interfaces: 8143 RS232 .... **£28.00** (c)
8132 Apple II .... **£80.00** (c)
8165 IEEE + cable .... **£65.00** (c)
8177P NLO (FX80+/FX100+) . **£99** (d)
Serial & Parallel Interfaces with larger buffers available.
Ribbons: RX/FX 100/100+ .... **£7.00** (d)
RX/FX 80/80+ .... **£4.00** (d)
LX80 .... **£4.50** (d)
Spare pens for H180 .... **£7.50/set** (d)
FX80 Tractor Attachment (c)

TAXAN CANON
RS232 Interface + 2K Buffer .... **£63** (c)
Ribbon KP810/910/815/915 .... **£6.00** (d)

JUKI:
RS232 Interface .... **£65** (c)
Spare Daisy Wheel .... **£14.00** (d)
Ribbon .... **£12.00** (d)
Sheet Feeder .... **£182** (a)
Tractor Feed Attachment .... **£149** (a)

Sheet Feeder .... **£239** (a)
Tractor Feeder .... **£116** (a)
Ribbons Carbon or Nylon .... **£3.00** (d)
Red Correction Ribbon .... **£2.00** (d)

BBC Printer Lead:
Parallel (1.2m) .... **£6.00** (d)
Serial (1.2m) .... **£7.00** (d)
Printer Leads can be supplied to any length.

MODEMS

— All modems listed below are BT approved

MIRACLE 3000:
MIRACLE WS2000 V21/23 Manual .... **£95** (b)
MIRACLE WS4000 V21/23. (Hayes Compatible, Intelligent, Auto Dial/Auto Answer) .. **£149** (b)
MIRACLE WS3000 V21/V23 As WS4000 and with BELL standards and battery pack up for memory .... **£245** (b)
MIRACLE WS3000 V22 As WS3000 V21/V23 but with 1200 baud full duplex .... **£450** (a)
MIRACLE WS3000 V22 bis As V22 bis As V22
MIRACLE WS3000 V22 bis As V22 and 2400 baud full duplex .... **£595** (a)
MIRACLE WS3022 As WS3000 but with only 1200/1200 .... **£350** (a)
MIRACLE WS3024 As WS3000 but with only 2400/2400 .... **£450** (b)
DATA Cable from Ws series/PC or XT . **£7** (d)

DATATALK Comms Package "If purchased with any of the above modems" .... **£70** (c)
PACE Nightingale Modem V21/V23 Manual .... **£75** (b)

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

DISC DRIVES

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

PD800P (2 × 400K/2 × 640K 40/80T DS) with built in monitor stand .... **£249** (a)
PD800 (2 × 400K/2 × 640K 40/80T DS) .... **£229** (a)
TD800 (as PD800 but without psu) .... **£226** (a)
TS400 1 × 400K/1 × 640K 40/80T DS .... **£114** (b)
PS400 with psu 1 × 400K/1 × 640K 40/80T DS .... **£129** (b)

3.5" DRIVES
1 × 400K/1 × 640K 80T DS TS35 1 .... **£99** (b)
PS35 1 with psu .... **£119** (b)
2 × 400K/1 × 640K 80T DS TD35 2 .... **£170** (b)
PD35 2 with psu .... **£187** (b)

3M FLOPPY DISCS

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

5¼" DISCS		3½" DISCS
40T SS DD **£10.00 (d)**	40T DS DD **£12.00 (d)**	80T SS DD **£20.00 (d)**
80T SS DD **£14.50 (d)**	80T DS DD **£15.50 (d)**	80T DS DD **£25.00 (d)**

DISC ACCESSORIES

FLOPPICLENE Disc Head Cleaning Kit with 20 disposable cleaning discs ensures continued optimum performance of the drives .... 3½" **£16 (d)**, 5¼" **£14.50 (d)**
Single Disc Cable .... **£6** (d)
10 Disc Library Case .... **£1.80**(c)
40 Disc Lockable Box .... £8.50 (c)
Dual Disc Cable .... **£8.50** (d)
30 Disc Case .... **£6** (c)
100 Disc Lockable Box .... £13 (c)

MONITORS

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

MICROVITEC: 14" RGB
1431 Std Res .... **£179** (a)
1451 med Res .... **£225** (a)
1441 Hi Res .... **£365** (a)

14" RGB with PAL & Audio
1431 AP Std Res .... **£199** (a)
1451 AP Med Res .... **£259** (a)

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

20" RGB with PAL & Audio
2030CS Std Res .... **£380** (a)
2040CS Hi Res .... **£685** (a)
TAXAN SUPERVISION II 12" High Resolution .... **£279** (a)
TAXAN SUPERVISION III with amber/green option, BBC & IBM .. **£319** (a)
MITSUBISHI XC1404 14" RGB Med Res IBM & BBC Compatible .. **£219** (a)
PHILIPS 8501 RGB Std Res .... **£139** (a)

MONOCHROME MONITORS:
TAXAN KX1201G Hi Res 12" Etched Green Screen .... **£90** (a)
TAXAN KX1202G Hi Res 12" Long Persistence (P39) .... **£95** (a)
TAXAN KX1203A Hi Res 12" Etched Amber Screen .... **£95** (a)
PHILIPS BM7502 12" Hi Res Green Screen .... **£75** (a)
PHILIPS BM7522 12" Hi Res Amber Screen .... **£79** (a)

Swivel Base for Taxan Monochrome fitted with Digital Clock .... **£21** (c)

SPECIAL OFFER

2764-25 .... £2.50
27128-25 .... £2.75
6264LP-15 .... £2.80

ATTENTION

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

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

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

GANG OF EIGHT
INTELLIGENT FAST EPROM COPIER

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

SOFTY II

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

UV ERASERS

All erasers with built in safety switch and mains indicator.
UV1B erases up to 6 eproms at a time .... **£47(c)**
UV1T as above but with a timer .... **£59(c)**
UV140 erases up to 14 eproms at a time .... **£88 (b)**
UV141 as above but with a timer .... **£88 (b)**

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

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

D CONNECTORS

No of Ways

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

TEXTOOL ZIF

SOCKETS 24-pin **£7.50** 28-pin **£9.00** 40-pin **£12**

EDGE CONNECTORS

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

EURO CONNECTORS

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

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

MISC CONNS

21 pin Scart Connector **200p**
8 pin Video Connector **200p**

AMPHENOL CONNECTORS

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

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

GENDER CHANGERS
25 way D type

Male to Male **£10**
Male to Female **£10**
Female to Female **£10**

RS 232 JUMPERS

(25 way D)

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

4-way **90p** 6-way **105p**
8-way **120p** 10-way **140p**

RIBBON

(grey/metre)

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

DIL HEADERS

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

TECHNOLINE VIEWDATA SYSTEM

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

74 SERIES

7400	30p
7401	30p
7402	30p
7403	30p
7404	36p
7405	30p
7406	40p
7407	40p
7408	30p
7409	30p
7410	30p
7411	30p
7412	30p
7413	50p
7414	70p
7416	36p
7417	40p
7420	30p
7421	60p
7422	36p
7423	36p
7425	40p
7426	40p
7427	40p
7428	43p
7430	30p
7432	38p
7433	30p
7437	30p
7438	40p
7439	40p
7440	40p
7441	90p
7442A	70p
7443A	100p
7444	110p
7445	70p
7446A	100p
7447A	100p
7448	120p
7450	36p
7451	35p
7453	38p
7454	38p
7460	55p
7470	50p
7472	55p
7473	55p
7474	50p
7475	60p
7476	45p
7480	65p
7481	180p
7483A	105p
7484A	125p
7485	110p
7486	42p
7489	210p
7490A	55p
7491	70p
7492A	70p
7493A	55p
7494	110p
7495A	60p
7496	80p
7497	290p
74100	190p
74107	50p
74109	75p
74110	75p
74111	55p
74116	170p
74118	110p
74119	170p
74120	100p
74121	55p
74122	70p
74123	80p
74125	65p
74126	55p
74128	55p
74132	75p
74136	70p
74141	90p
74142	250p
74143	270p
74144	270p
74145	110p
74147	170p
74148	140p
74150	175p
74151A	70p
74153	80p
74154	140p
74155	80p
74156	100p
74157	80p
74159	225p
74160	110p
74161	80p
74162	110p
74163	110p
74164	120p
74165	110p
74166	140p
74167	400p
74170	200p
74172	420p
74173	140p
74174	110p
74175	105p
74176	100p
74178	150p
74179	150p
74180	100p
74181	340p
74182	140p
74184	180p
74185A	180p
74190	130p
74191	130p
74192	110p
74193	115p
74194	110p
74195	80p
74196	130p
74197	110p
74198	220p
74199	220p
74221	110p
74251	100p
74259	150p
74265	380p
74273	200p
74276	140p
74278	170p
74279	90p
74283	105p
74285	320p
74290	90p
74293	90p
74298	180p
74351	200p
74365A	80p
74366A	80p
7436A	80p
74367A	80p
74368A	70p
74376	160p
74390	110p
74393	112p
74490	140p

74LS SERIES

74LS00	24p
74LS01	24p
74LS02	24p
74LS03	24p
74LS04	24p
74LS05	24p
74LS08	24p
74LS09	24p
74LS10	24p
74LS11	24p
74LS12	24p
74LS13	34p
74LS14	50p
74LS15	24p
74LS20	24p
74LS21	24p
74LS22	24p
74LS24	50p
74LS26	24p
74LS27	24p
74LS28	24p
74LS30	24p
74LS32	24p
74LS33	24p
74LS37	24p
74LS38	24p
74LS40	24p
74LS42	50p
74LS43	150p
74LS47	80p
74LS48	90p
74LS49	100p
74LS51	24p
74LS54	24p
74LS55	24p
74LS73A	30p
74LS74A	35p
74LS75	45p
74LS76A	36p
74LS83A	70p
74LS85	75p
74LS86	35p
74LS90	48p
74LS91	90p
74LS92	55p
74LS93	54p
74LS95B	75p
74LS96	90p
74LS107	40p
74LS109	40p
74LS112	45p
74LS113	45p
74LS114	45p
74LS122	70p
74LS123	80p
74LS124/	629/140p
74LS125	50p
74LS126	50p
74LS132	65p
74LS133	50p
74LS136	45p
74LS138	55p
74LS139	55p
74LS145	95p
74LS147	175p
74LS148	140p
74LS151	65p
74LS152	200p
74LS153	65p
74LS154	160p
74LS155	65p
74LS156	65p
74LS157	50p
74LS158	65p
74LS160A	75p
74LS161A	75p
74LS162A	75p
74LS163A	75p
74LS164	75p
74LS165A	110p
74LS166A	150p
74LS168	130p
74LS169	100p
74LS170	140p
74LS173A	100p
74LS174	75p
74LS175	75p
74LS181	200p
74LS183	190p
74LS190	75p
74LS191	75p
74LS192	80p
74LS193	80p
74LS194A	75p
74LS195A	75p
74LS196	80p
74LS197	80p
74LS221	90p
74LS240	80p
74LS241	80p
74LS242	90p
74LS243	90p
74LS 244	70p
74LS 245	90p
74LS247	110p
74LS248	110p
74LS249	110p
74LS251	75p
74LS253	75p
74LS256	90p
74LS257A	70p
74LS258A	70p
74LS259	120p
74LS260	75p
74LS261	120p
74LS266	60p
74LS273	125p
74LS279	70p
74LS280	190p
74LS283	80p
74LS290	80p
74LS 292	£
74LS293	80p
74LS295	140p
74LS 297	£14
74LS298	100p
74LS299	220p
74LS321	370p
74LS323	300p
74LS324	320p
74LS348	200p
74LS352	120p
74LS353	120p
74LS356	210p
74LS363	180p
74LS364	180p
74LS365	50p
74LS366	50p
74LS367	50p
74LS368A	50p
74LS 373	70p
74LS 374	70p
74LS375	75p
74LS377	130p
74LS378	95p
74LS379	130p
74LS381	450p
74LS385	325p
74LS390	60p
74LS393	100p
74LS395A	100p
74LS399	140p
74LS445	180p
74LS465	120p
74LS467	120p
74LS490	150p
74LS540	100p
74LS541	100p
74LS608	700p
74LS 610	£25
74LS 612	£25
74LS624	350p
74LS626	225p
74LS628	225p
74LS629	125p
74LS640	200p
74LS640-1	300p
74LS641	150p
74LS642-1	300p
74LS643	250p
74LS643-1	300p
74LS644	350p
74LS645	200p
74LS645-1	400p
74LS668	90p
74LS669	90p
74LS670	170p
74LS682	250p
74LS684	350p
74LS687	350p
74LS688	350p
74LS 783	£16

74S SERIES

74S00	50p
74S02	50p
74S04	50p
74S05	50p
74S08	50p
74S10	50p
74S11	75p
74S20	50p
74S22	50p
74S30	50p
74S32	60p
74S37	60p
74S38	60p
74S40	50p
74S51	45p
74S64	45p
74S74	70p
74S 85	550p
74S86	100p
74S112	150p
74S113	120p
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4032	100p
4033	125p
4034	250p
4035	70p
4036	70p
4037	110p
4038	100p
4039	250p
4040	60p
4041	55p
4042	50p
4043	50p
4044	60p
4045	100p
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4096	90p
4097	270p
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75161	650p
75162	750p
75172	400p
75182	150p
75188	60p
75189	60p
75365	150p
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75451	50p
75452	50p
75453	70p
75454	70p
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5.000	150p
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17.734	200p
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8.00	150p
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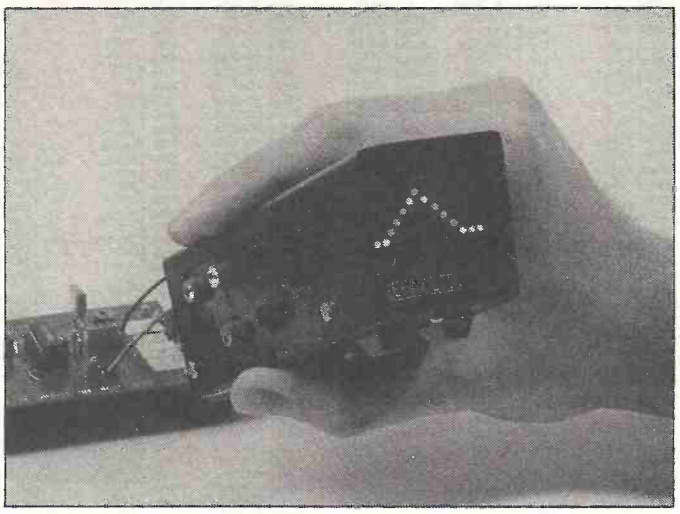
● *The Institution of Electrical Engineers will shortly begin to review the current (15th) edition of the Regulations for Electrical Installations, the standard work covering safety requirements for electrical equipment in buildings and elsewhere. The new 16th edition will generally follow the format used in preceding editions but will include an on-site guide to make it easier to find frequently-used material. A wide range of professional bodies will be consulted during the preparation of the new book and the IEE expects it to be ready sometime after 1990.*

● The new Verospeed catalogue lists almost 14,000 different product lines including components, cases, tools, software, computers and computer peripherals. Everything is despatched from stock and orders received before 3.00pm will go out the same day. Copies of the catalogue are free from Verospeed, Stanstead Road, Boyatt Wood Industrial Estate, Eastleigh, Hampshire SO5 4ZY. Tel (0703) 641 111.

● **The three highest-earning semiconductor suppliers in the world last year were all Japanese, according to business information company Dataquest. NEC took the first place with Hitachi and Toshiba close behind, forcing American companies out of the top three for the first time ever. Other companies making it into the top ten were, in order, Motorola, Texas Instruments, Philips-Signetics, Fujitsu, Matsushita, Mitsubishi and Intel.**

● Several new British Standards relating to home and car security have been published during the last year. They include BS4737: Intruder Alarm Systems In Buildings, BS6799: Code of Practice For Wire-Free Intruder Alarm Systems and BS6803, a code of practice for vehicle security systems fitted after vehicle manufacture. There is also a standard covering the installation of DIY home alarm systems, known as BS6707. For prices and details of other publications, contact the British Standards Institution, 2 Park Street, London W1A 2BS, Tel. 01-629 9000.



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A novel new instrument from Lefax Ltd offers the versatility of an oscilloscope in a handy, probe-type form.

Called the Scope-Probe, it uses an array of LEDs to display signal waveforms from 0-20kHz and can also indicate DC levels up to 20V.

The probe is similar in many respects to the ETI LEDscope featured in the January 1987 issue (for which Lefax supplies kits). it measures 46 x 46 x 120mm (1 13/16 x 1 13/16 x 4¾ ins) and is powerd form an internal alkaline battery which gives around twleve hours continuous use. The probe tip can be detached and replaced with a set of standard test leads, allowing the Scope-Probe to be used as a bench instrument.

Frequencies from 10Hz to 20kHz are covered in five switched ranges while DC voltage is handled in two ranges, 0-10V and 0-20V. The controls include fine sweep-frequency adjust, amplifier gain and Y-position and the input can be switched for AC or DC coupling. There is also a battery check facility.

The Scope-Probe costs £106.32 inclusive and is available to order from Lefax Ltd, Unit 6, Genesis Business Centre, Redkiln Way, Horsham, West Sussex RH13 5QH, Tel (0403) 54135.

Dialling-Up A PC Board

The Orator ISCM system turns any IBM-compatible personal computer into a versatile communications centre. Data can be updated or transferred automatically at pre-set times and when connected to a telephone handset the system can answer calls and record incoming messages.

Orator consists of a plug-in board plus a software operating system and uses digital signal processing techniques to store voice messages on computer discs. Different messages can be recorded for calls arriving at different times and calls can be diverted to other numbers during certain hours.

Orator will be available through selected computer dealers and is expected to cost around £800.00.

Lion Systems Developments Ltd, Oxford Road, Stokenchurch, High Wycombe, Buckinghamshire HP14 3SX, Tel (024 026) 3951.

BBC Music Keyboard

Hybrid Technology's Music 5000 synthesiser for the BBC micro has gained a keyboard.

Called the Music 4000, it has four octaves and is designed to rival professional equipment. 'This is not the cheap rubbish you buy for a Commodore 64' said Hybrid's Chris Jordan.

The keyboard plugs into the BBC micro's user port and comes complete with software which enables it to work with the Music 5000 system. The keyboard is always 'live' when the Apple programming language of the Music 5000 is in operation and it can be used for entering notes onto the editing staff or for playing in the same way as any other synthesiser keyboard.

The software is supplied on disc and allows the Music 4000/5000 combination to play eight voice polyphony with effects such as sound changing, echo and transposition. A 'multi-track recorder' section will store a performance from the keyboard for playback or transcription either into Apple's own internal music code or the conventional 'sticks and blobs'.

The Hybrid Music 4000 costs £140.00 plus VAT from Hybrid Technology, Unit 3, Robert Davies Court, Nuffield Road, Cambridge CB4 1TP, Tel (0223) 316 910.

A Reel Improvement

STC has announced the formation of Cablemaster, a new distribution service which can supply wire and cable for just about every possible application.

Cablemaster offers ex-stock delivery of a wide range of cable types, from heavy duty power distribution cables through to specialist products for computing, thermocouple and telephone applications. STC claims that Cablemaster is the first distributor to offer such a comprehensive range.

The Cablemaster catalogue gives detail specifications for the cable types available and the company provides a technical advice service. Orders can be placed by post or over the telephone and there are no postage and packing charges. Same-day despatch is guaranteed for all orders received before 5.30pm.

Catalogues and further information are available from Cablemaster, Edinburgh Way, Harlow, Essex CM20 2DF, Tel (0279) 639 639.

Computer-Controlled Broadcasting

The spinning turntables and banks of buttons in your local radio station could soon be a thing of the past.

A new system from America makes it possible for one person to control all the major functions of a radio station using a touch-sensitive computer screen.

Microphones can be switched in as required, taped sound effects can be selected from a menu and music tracks held in a remote-controlled multiple CD player can be brought into play by touching the screen. Telephone chat shows can also be controlled by the sytem and a text window on the screen allows news and other information to be flashed up in front of the presenter so that it can be read out.

The system is called Touchstone and consists of a software package for use on IBM PCs and a mechanical switching unit. The switch unit is controlled through the computer's RS232 port and can be used to operate tape machines and most other items of station equipment.

The CD player is a broadcast-quality unit which can hold 100 discs. Any one of 1000 tracks can be selected instantly by means of an external controller or computer such as the Touchstone system.

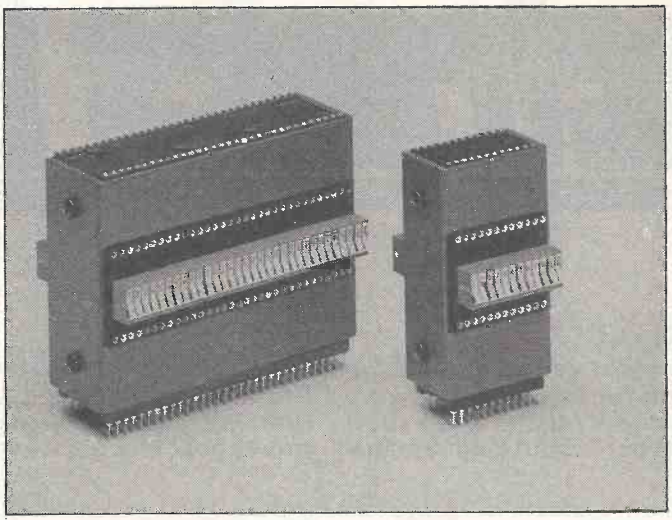
Touchstone is already in use in America. By enabling the presenter to take complete control, the system eliminates the need for a separate mixing desk operator and so reduces staffing costs.

Touchstone is distributed in the UK by Incomtel Ltd, 225 Goldhawk Road, London W12 8SB. Tel 01-743 5511.

Long Arm-Band Of The Law

Criminal Justice agencies in America are using electronic tracking devices to keep tabs on paroled convicts and people awaiting trial.

The system uses an arm or ankle band which is fitted to the person being monitored. Signals from the band are picked up by a local receiver so long as the transmitter is in range. If the signal ceases, the receiver informs a central computer which sounds an alert. About 45 such programmes are operating in 20 American states and the National Institute of Justice says they offer a significant improvement in supervision at moderate cost.



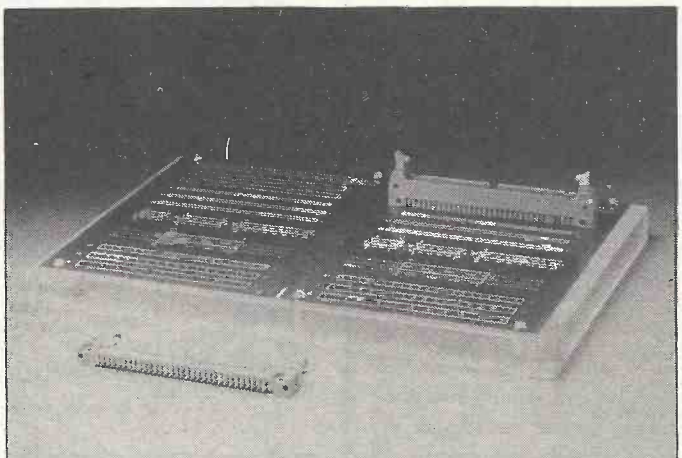
Patch Sockets for DIL ICs

Dau Components has introduced a range of adaptors which allow connections to be made between ICs and sockets with different pin-outs.

The adaptors are intended for use in test and development work and consist of a plug and socket at either end of a small aluminium case. Each pin on the plug is linked to the corresponding pin on the socket via a DIL switch, allowing the connection to be broken when not required. New connections are made using wire links between two rows of miniature sockets. In this way, any pin can quickly be connected to any other pin.

The adaptors are available in thirteen sizes from 14 to 64 pins and feature turned-pin socket contacts and gold-plated pin contacts. Prices range from around £25.00 plus VAT for the 14-pin version up to £95.00 plus VAT for the 64 pin adaptor. A complete set of thirteen adaptors will set you back around £350.00 plus VAT.

Dau Components Ltd, 70-74 Barnham Road, Barnham, West Sussex PO22 0ES, Tel (0243) 553 031.



Surface Mount Trial Board

The problems posed by surface-mounting components can be evaluated using a new trial board from OK Industries.

Designed in conjunction with British Aerospace, the board provides the correct tracking configurations for most currently-available surface-mount devices and can be worked using direct heat, hot gas or any of the other standard surface-mount soldering techniques. Component packages with up to eighty pins can be accomodated and the board features track spacings down to 0.032ins (0.812mm).

The surface-mount trial board costs £4.98 plus VAT. OK has plans to introduce a supporting kit which includes dummy versions of some of the more expensive types of surface mount-components.

OK Industries UK Ltd, Barton Farm Industrial Estate, Chickenhill Lane, Eastleigh, Hampshire SO5 5RR. Tel (0703) 619 841.

- **Bopla manufactures enclosures and accessories for electronic equipment including 19" rack systems, moulded terminal and keyboard housings and a variety of plastic cases in various sizes. The range is described in a 20-page A4 catalogue from West Hyde Developments Ltd, 9-10 Park Street Industrial Estate, Aylesbury, Buckinghamshire HP20 1ET, Tel (0296) 20441.**

- ACCumulator is the newsletter of the Amateur Computing Club and the latest issue includes articles on serial output expansion, baud rate conversion and using the Rugby Clock broadcasts. Membership of the club costs £6.00 and details can be obtained from Andy Leeder, Church Farm, Straton St. Michael, Norwich NR15 2QB.

- *AB Engineering now distributes the range of fasteners, spacers, ducting and other cable accessories manufactured by Japanese company Kitagawa Industries. Detailed information on Kitagawa's products is contained in a 40-page A4 illustrated catalogue which is available free-of-charge. Contact AB Engineering Company, Timber Lane, Woburn, Milton Keynes MK17, Tel (052 525) 322.*

- **A new club has recently started up in the Manchester area for electronics and computer enthusiasts. It meets on the second and fourth Tuesday of each month at a local school and aims to provide information and guidance on various aspects of the hobby. For details contact Mike Darlington at 18 Somerset Road, Failsworth, Manchester M35 0WA, Tel 061-682 0274.**

- The latest edition of the Data Converters and Reference ICs handbook from Ferranti contains information on both new and established ADCs, DACs and voltage reference devices. Application notes are included and there is a new section on interfacing ADCs and DACs with the Z80 and 6500 families of microprocessors. For a free copy contact Ferranti Electronics Ltd, Fields New Road, Chadderton, Oldham, Lancashire OL9 8NP, Tel 061-624 0515.

- **Chris Curry's Red Boxes (see ETI December 1986) are now available for use with the Amstrad 464, 6128 and 6256 computers. They can be used to relay information from security devices and other sensors or to control mains-operated appliances, all using the existing mains wiring as a signal carrier. Contact Electronic Fulfilment Services Ltd, Chesterton Mill, French's Road, Cambridge CB4 3NP.**

NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

MIDI MASTER KEYBOARD

At last! A musical instrument that cannot produce a single sound! MIDI instruments can be controlled by an external keyboard and that is just what this top-spec beast is built for. Eat your heart out Roland (and Yamaha and Casio, and . . .).

MORE MUSIC

The May issue of ETI is positively bristling with goodies for the budding (or even more than budding) musician. Not only the MIDI keyboard but the start of a new regular column on musical equipment and the business and a Tech Tips special of musical circuits.

THE TRUTH ABOUT HI-FI

The real truth is we promised this one for this issue. However, this time we mean it! All you really wanted to know about hi-fi but were afraid to make up.

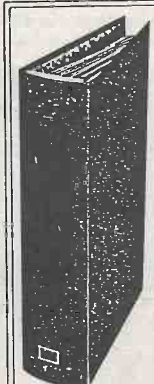
PLUS . . .

There's the most up-to-date news tor tne electronics enthusiast, the most informed and opinionated columns, the most objective reviews, the most vigorous of letters, the free-est of readers' ads, and all the rest that each month make ETI the one worth waiting for.

THE MAY ISSUE OF ETI — ON SALE 3rd APRIL

GO FOR IT!

All the articles listed above are at an advanced stage of preparation, but circumstances beyond our control may prevent publication.



● The new Electrovalue catalogue is said to be their biggest yet at sixty pages. It lists a wide range of components, tools, test equipment, computer accessories and books and features an extensive selection of Siemens capacitors and other products. Prices are guaranteed for the four-month life of the catalogue. Copies are available free-of-charge from Electrovalue Ltd, Freepost, 28 St. Judes Road, Englefield Green, Egham, Surrey TW20 8BR, Tel (0784) 33603. Note the Freepost address, which means that you don't need a stamp on your envelope.

● *Many, many apologies to the poor people whose telephone number we gave at the end of our 1986 index in the January 1987 issue. The number was included for the benefit of those who wished to obtain backnumbers. The correct number is (0442) 48432 — only one digit different — which gets you through to Infonet in Hemel Hempstead. They will be happy to help with all enquiries regarding backnumbers.*

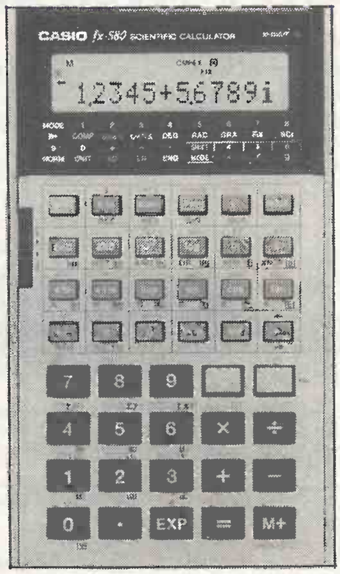
Beating The Dread Noughts

Tired of entering strings of noughts into your calculator when dealing with electrical quantities?

The new FX580 calculator from Casio handles multipliers such as micro and kilo directly and gives the result in the most appropriate units. It is also pre-programmed to handle equations involving most common electrical units and can correctly distinguish between the real and imaginary parts of calculations involving complex numbers.

The FX580 has a 10-digit liquid crystal display and haldes 180 scientific functions. It accepts all multipliers from pico to Giga plus the less-familiar femto, atto, Tera, Peta and Exa and understand the relationships between watts, volts, amps, ohms, farads, coulombs and seconds. Power is supplied by two lithium batteries and each set should last for around 16 weeks.

The FX580 will be available from Casio dealers at a recommended retail price of £27.95.



Casio Electronics Company Ltd, Unit 6, 1000 North Circular Road, London NW2 7JD, Tel 01-450 9131.

Blind Mice?

Researchers at IBM have developed a hand-held device which enables blind people to read from a computer screen.

It is similar in most respects to a conventional computer mouse but has a matrix of tiny pistons on its upper surface. The mouse is moved around to select areas of the screen and the pistons move in and out to form characters which can be felt.

The device has been developed from existing equipment which has been in use for many years. The advantage is that the new system uses standard parts and will be relatively cheap to manufacture, unlike the old system which cost around £6,000 per unit. It is also far faster, more convenient and less bulky.

The mouse has been developed specifically for use with IBM computers but the engineers who designed it say there should be no problems adapting it to work with other computers.

DIARY:DIARY:DIARY:DIARY:DIARY:DIARY:DIARY:DIARY:DIARY

The International Open Systems Conference — March 3-6th
London. For details contact Online at the address below.

Wind Power — March 11th
White Horse Hotel, Dorking, Surrey. Lecture organised by the IEEIE. Contact M.P. Lott on 01-921 1129.

Energy In The World — March 12th
The IEE, London. Lecture by Sir Hermann Bondi of Cambridge University. Contact the South East Centre Honorary Secretary on (0462) 53331 ext. 292.

CADCAM '87 — March 14-16th
Metropole Hotel and NEC, Birmingham. See March '87 ETI or contact Christine Smith on 01-608 1161.

The Code-Breaking Computers Of 1944 — March 26th
The IEE, London, 2.15pm followed by lecture in the evening. See March '87 ETI or contact the IEE at the address below.

Digitally implemented Radios — April 1st
The IEE, London. Colloquium. Contact The IEE at the address below.

Fibre Optics In Communications — April 2nd
University of Cambridge, 7.00pm. Lecture organised by the IEEIE. For details 'phone 01-863 3357.

The Role of Alternatives In The World Energy Scene — April 7-9th
University of Reading. See March '87 ETI or contact the IEE at the address below.

Frequency Control And Synthesis — April 8-10th
University of Surrey. Conference. Contact the IERE on 01-388 3071.

Reliability '87 — April 14-16th
Birmingham. Conference and exhibition organised in conjunction with the IEE. Contact the Institute of Quality Assurance on 01-584 9026.

Electricity And The Body — Friend Or Foe? — April 23rd
The IEE, London. Lecture by Dr. A. T. Baker of the Royal Hallamshire Hospital. Contact the IEE at the address below.

The Electronic Data Interchange Conference — April 28/29th
The Barbican Centre, London. See February '87 ETI or contact Online at the address below.

Cellular & Mobile Communications '87 — April 28/29th
London. For details contact Online at the address below.

British Electronics Week 1987 — April 28-30th
Olympia Exhibition Centre, London. See February '87 ETI or contact the Evan Steadman Communications Group on (0799) 26699.

Digital Audio Tape Recording — April 30th
The IEE, London. See March '87 ETI or contact the IEE at the address below.

Tool Kits And Sneaky Tricks — May 15th
The IEE, London, 2.00pm. Discussion meeting. Contact the IEE at the address below.

TV Displays: The Next Ten Years — May 20th
The IEE, London, 2.00pm. Discussion meeting. Contact the IEE at the address below.

Computer North — May 27-29th
G-Mex Complex, Manchester. Business computer show. Contact Cahners on 01-891 5051.

International ISDN Conference — June 15-18th
London. Conference on the Integrated Services Digital Network. Contact Online at the address below.

Networks '87 — June 16-18th
London. For details contact Online at the address below.

CableSat '87 — June 2-4th
Metropole Hotel, Brighton. Exhibition and conference. Contact Online at the address below.

UK Telecommunications Networks: Present & Future — June 2-4th
IEE, London. Conference. Contact the IEE at the address below.

IDEX '87 — September 21-23rd
Metropole Exhibition Halls, Brighton. International Defence Electronics Exposition — conference and exhibition. Contact Nutwood Exhibitions on (04848) 25891.

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

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

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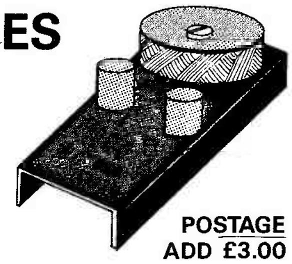

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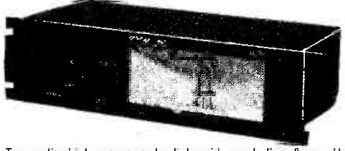

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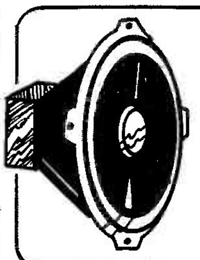

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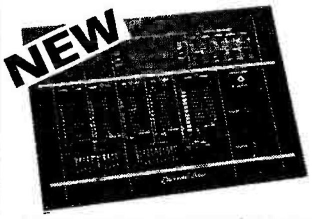

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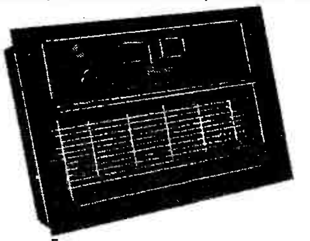

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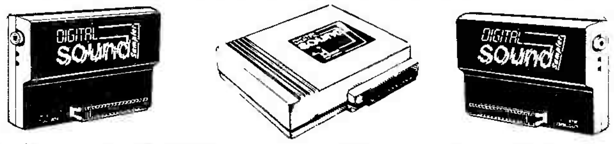

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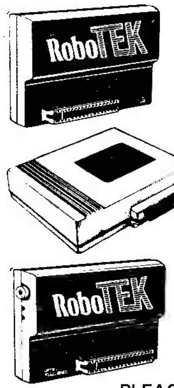

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READ/WRITE

The Cortex Caper

Some Years ago I bought a Powertran Cortex kit and recently I discovered that the firm Powertran has disappeared.

I know there was a newsletter service for the Cortex but I did not join it, so I lost track of it. Today I would like to join the service but I am unable to find the name and address of the administrator.

I would further like to buy some hardware add-ons, like the RGB interface, but I do not know if there is anybody selling Cortex add-ons.

I hope that you can provide the right addresses so I can get started again.

Magne Ertresang
Nesttun, Norway.

I am writing in the hope you can help a Cortex owner.

Some time ago I built a Cortex computer from a kit supplied by Powertran Cybemetics. Due to carelessness on my part I have succeeded in destroying the entire EPROM set.

I obviously require replacements but it appears that Powertran has ceased trading. Can you tell me of anywhere I can obtain them or, if Powertran has simply moved, its new address.

Dr. S.F. Butler
Littlehampton, Sussex.

Powertran has indeed ceased trading. Unfortunately ETI knows of no company actively supporting the Cortex. The newsletter is no longer available and spare parts and add-ons for this excellent project can only be bought on the second hand market.

The best course of action for anyone wanting help or parts for the Cortex is to advertise in the ETI Free Readers' Ads.

Amp Thoughts

When John Linsley Hood has completed his series on FM receivers he will have published designs for the core of an audio system which approaches the state of the art.

I am sure that I am not alone in wishing this was available as a *matching* kit containing the ETI Audio Design amps, the Synchrodyne AM receiver described in Wireless World, and the ETI FM receiver.

The lack of a kit from a reliable supplier may not concern the dedicated hobbyist but undoubtedly deters the occasional constructor and inhibits the growth of interest in electronics.

The disadvantages of kits are that the supplier will choose components on the basis of cost rather than quality and that the kits will be designed around cases which are too small to allow upgrading. However, these problems only arise if the supplier assumes kits are primarily of interest to those who cannot afford an 'ordinary' brand amplifier/tuner.

The days have passed when it was possible to build more cheaply than buy except at the upper end of the market. Nowadays kits are more likely to attract customers who are weary of being told that X is best without any plausible reason being given, and who would like to put these opinions to the test and have more control over the sound than the ability to sign a cheque.

Hart Electronic Kits at present offer two JLH amps: a 30 watt integrated and a 100 watt power amp. The former is housed in a small box about 430 x 300mm and 1-2U in height. The latter is in a larger box about 3U in height. These boxes will stack together quite neatly and are attractive and unobtrusive.

Could Hart be persuaded to increase the range?

One item which could complete the JLH/ETI range would be a small integrated amp to replace the 30 watt mentioned above.

This is a good design but is now rather out of date and I am sure could be improved upon. For the last 6 years I have used two of the 30 watt amps and, good as they are, I cannot help feeling inside there is an even better amp trying to get out. However, they have always given me a great deal of pleasure and have been chosen by a number of friends in preference to more expensive commercial designs of impeccable pedigree.

Since it is now over two years since you published the 'Audio Design' amps and as yet no kit is readily available perhaps it is a good time to ask JLH if he has had any further thoughts on the design, whether a lower power version would be possible, the advantages and disadvantages of different PSU configurations, the advantages of dual mono construction, which components in the circuits are most likely to influence sound quality and benefit most from upgrading, whether it is better to mount PCBs horizontally or vertically, etc.

D.W. Macdonald.
Truro, Cornwall.

Great minds, it seems do indeed think alike. JLH has already suggested to us some improvements very much along the lines you mention.

In the reasonably near future we hope to publish an improved version of the Audio Design amp, complete with a kit from Hart, and a totally re-worked lower power design offering similar high quality to replace the old 30W amp and also available from Hart in kit form.

Pull the Other One

After many years of furious use, the controls on my guitar have finally (and inevitably) started to crackle beyond even my level of tolerance. I have tried everywhere to find replacements without any luck.

The problem is that I need a rotary pot with an on/off switch built-in and operated by pushing and pulling the pot knob — not the usual rotary switch.

Can you help me with a source of these pots. The only possibility I have been offered so far is a special order (probably all the way from the guitar factory in the States) and far too costly.

Colin Harris,
Cottingham, Humberside.

Potentiometers with integral push/pull switches are indeed difficult to find. Fortunately, Cirkit has recently started to stock these devices. They are available in 5k, 10k, 20/25k and 100k log and 10k, 20/25k and 100k lin versions, all with DPST switch and costing £1.60 each. Cirkit is on (0992) 444111.

ETI welcomes letters from readers on any topic. If you disagree with our learned contributors or just think it's time for a general election, don't sit there and seeth in silence. Write and tell us all about it. Write to:
Electronics Today International,
1 Golden Square,
London, W1R 3AB. **ETI**

FIFTEEN YEARS OF ETI

Wallow in a little nostalgia as ETI checks out its un-chequered history.

Way back in 1970 a new electronics magazine was launched in Australia. It was called Electronics Today International and it quickly became very popular indeed.

It proved so successful that the owners decided to try their luck with an overseas edition.

Thus it was that in April 1972 a British version of ETI appeared. It was based on the format established by its Australian predecessor and proved just as popular, quickly finding its place among the leading British electronics journals. Within a few years ETI had built up a large and devoted readership and gained a reputation for its topical features, strong project articles and of course, its off-beat sense of humour.

In The Beginning

So what was this exciting new magazine like, and how did it differ from the present-day ETI?

One noticeable difference is that the early ETI was aimed less at hard-bitten electronics enthusiasts and more at the general reader. The editorial page in the launch issue — boldly headed 'Tomorrow Starts Today' — spoke of the ever-increasing impact of electronics on our daily lives. In a world where the daily pinta was electronically checked and the morning mail electronically sorted, it argued, everone had an interest in electronics and would need up-to-date information. ETI set out to provide it.

Accordingly, the early issues had far more feature articles than is normal today and correspondingly fewer projects. The first ETI contained fourteen features and product tests plus news, reviews and a suppliers guide. Many of the articles were very short, some of them no more than a page. However, the topics chosen covered a very wide field and there was plenty to interest both the intelligent general reader and the more dedicated hobbyist.

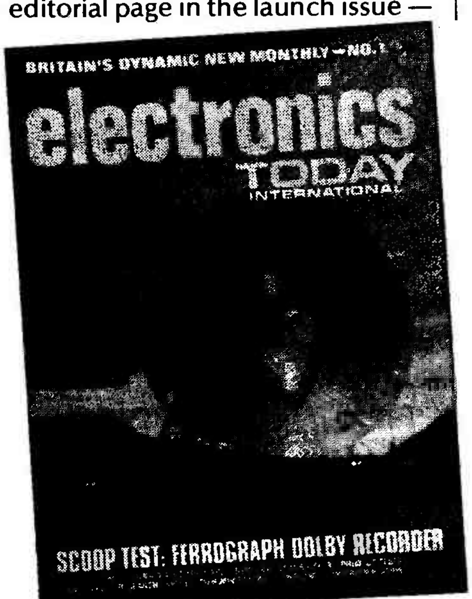
The book reviews in particular covered a surprisingly broad range. In addition to the dictionaries of electronics, constructors guides and data books the first few issues carried reviews of *The Population Bomb* by Paul Ehrlich, *Beyond Freedom And Dignity* by the psychologist B.F. Skinner and Charles Reich's controversial book on the organisation of society in a technological age, *The Greening of America*.

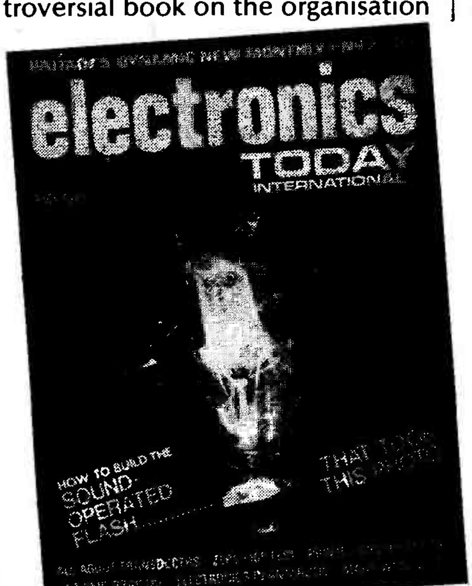
The launch issue included articles on space tracking stations, triacs and room acoustics and there was also an early look at a topic which has occupied our attention more recently — bio-feedback. Tech Tips was there right from the start (although the first circuits were taken from manufacturers' data sheets rather than being sent in by readers) and by issue three the editors had received enough correspondence to start a regular letters page (called 'Input Gate' — anyone remember than?).

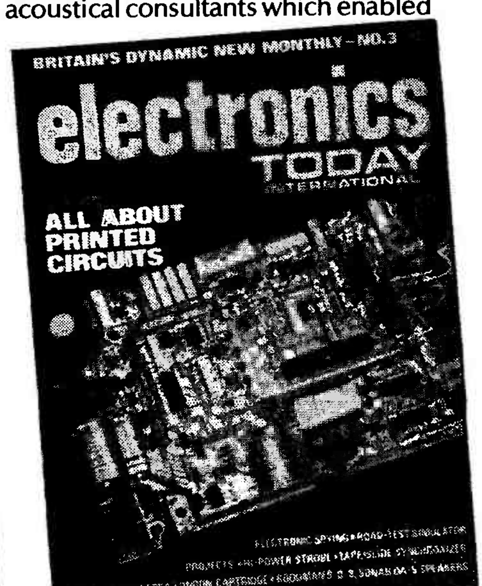
Sound Start

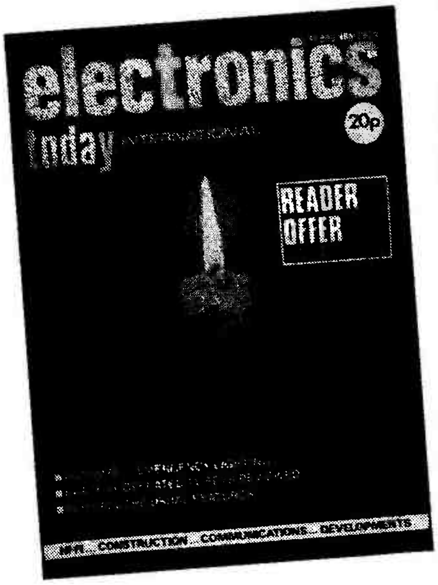
Another big difference between ETI then and now is the amount of space devoted to different aspects of electronics. In 1972 computers hadn't reached the home construction market and audio was the in thing. There were specialist hi-fi magazines around but few of them covered the electronics side of audio in any depth.

ETI responded to this challenge with a wealth of articles, backed up by a special agreement with a firm of acoustical consultants which enabled









Power cuts hit Britain in 1974, but ETI readers weren't left in the dark.

us to offer comprehensive and authoritative advice on almost all audio matters.

The first issue included a review of the newly-launched Dolby noise reduction system and a 'scoop' review of the first reel-to-reel tape recorder with built-in Dolby — the Ferrograph Model 7HD.

The magazine also included record reviews in those days, around three to four pages each month being taken up with a look at the latest jazz, classical and pop releases. The review section was among the first of the regular features to be dropped but it says much about the supposed readership of the magazine that the editors felt it worth retaining the classical record reviews long after pop and jazz had gone.

Computing The Changes

Much has changed since those first few issues, and arguably the greatest change has been in the field of computing. ETI was the first electronics magazine in this country to describe a DIY computer design for the home constructor, presenting first the System 68 modules in 1977 and then the Triton single-board computer in 1978.

We also launched one of the first specialist computing magazines available in this country, Computing Today. It appeared as a pull-out supplement in the November 1978 issue of ETI and was published as a separate magazine from March 1979 onwards.

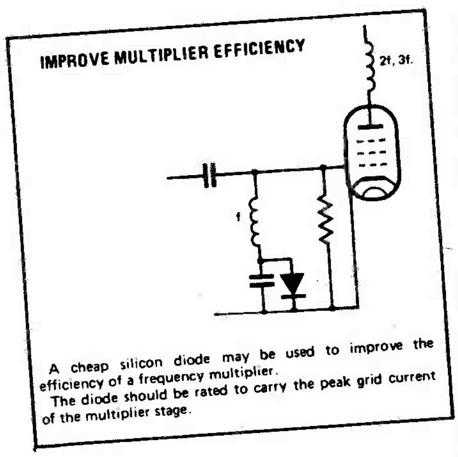
Sadly, CT is no longer around. Like many other non-trade, non-machine-specific computer magazines it lost out in the fierce circulation wars a year or so back and ceased publication. Nonetheless it will be remembered with affection by many past readers.

There have also been some interesting changes behind the scenes over the last fifteen years. ETI's original owner was an Australian called Colin Ryrie who also published the professional music magazine Sonics and a number of other audio and technical magazines. Tragically, Colin was killed in a boating accident whilst returning home one night across Sydney harbour. Control of the company passed to his son Kim who ran it successfully for some years.

In 1979 Kim Ryrie and a close friend came up with an idea for a futuristic musical instrument. In order to develop the idea they needed a large sum of money fairly quickly so Kim sold off his magazine holdings. He achieved the best price by selling the Australian and British interests separately. Thus ETI acquired British owners and the world gained a new musical instrument, named after the suburb of Sydney where Ryrie lived. It was called The Fairlight.

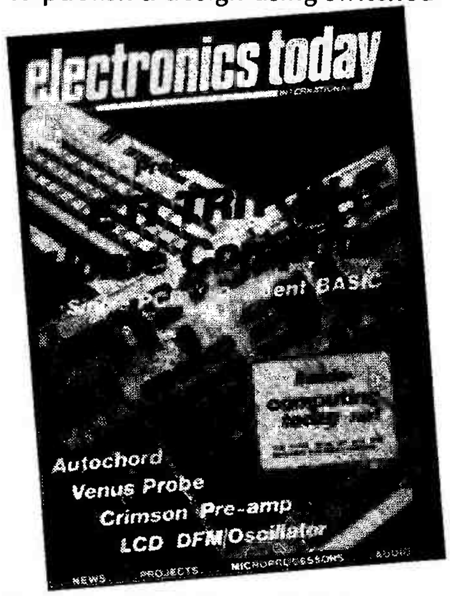
Changes in the world of electronics have also been faithfully reflected in our pages. The December 1972 issue introduced that marvellous device, the light emitting diode, while readers of the December 1974 issue were treated to some advice on how to handle the newly-introduced and very delicate CMOS ICs. MOSFETs and gallium arsenide are among the other new developments charted in our pages and the list of new techniques and applications we have covered is far too long to go into here.

Some other developments have stood the test of time less well. Bubble memories were all the rage for a long time but somehow never made it commercially. Quadrophonic audio was another idea which generated a lot of interest at the time, and who now remembers the Elcassette?



Times change: in 1972 we published Tech Tips with valves in them.

Our projects too have frequently broken new ground. Aside from the computers mentioned earlier, we were the first electronics magazine to publish a design using switched capacitor filters. Some of our audio projects in particular have set new standards in their fields and it was pleasing to see a music magazine recently recommending the ETI/Powertran Vocoder to its readers, even though the design is now over six-years old.



November 1978: ETI presents the Triton single board computer and the first issue of Computing Today.

Very Interesting, But . . .

And of course, ETI wouldn't have been complete without a few silly articles. Among our personal favourites were the guide to Murphy's Law (October 1972, repeated in September 1977), Phil Walker's Super Selective Music Filter (April 1984) and the Adzap (April 1986). We also produced one or two items which were perfectly functional even if the function was a little odd. In this category we recall the UFO detector (which certainly detected something even if it wasn't UFOs) and are happy to carry on the tradition with the 24-hour Sundial in this issue.

And so, we hope, it will go on. The changes over the past fifteen years have been enormous and we can reasonably expect just as much to change in the next fifteen years. But whatever happens in electronics, so long as their are enthusiasts around who need to be informed and entertained, we hope ETI will be there to do it.

See you in 2002. **ETI**

ETI NEEDS YOU!

This copy of ETI is your magazine — in more ways than one. You bought it (and thank you for that!) but it is ETI readers like you who provide most of the contents. Staff and regular contributors fill some ETI pages but we still have a constant need for good features, projects and circuits. We'll even pay you for them!

If, like most ETI readers, you build electronic devices of your own design we want to hear from you. You may have just finished the hi-est of fi amplifier, or a microprocessor-controlled Sellotape dispenser, or just a great gadget to impress your friends. Whatever your project, if it will appeal to other readers it can earn you fame and fortune in ETI into the bargain.

If you don't want to take your idea to a working prototype, novel circuits and improvements to existing ETI projects are always welcome for the ever-popular Tech Tips pages.

From experts in their fields we want features. ETI has a reputation for presenting interesting, informative and wide-ranging features. If you know something the rest of us don't, tell us all through the pages of ETI.

Whatever you can contribute to ETI we want to hear from you soon. Write in with a brief description of your idea. Include a circuit diagram for projects and a brief synopsis of features.

Write to: **The Editor, Electronics Today International, 1 Golden Square, London, W1R 3AB.**

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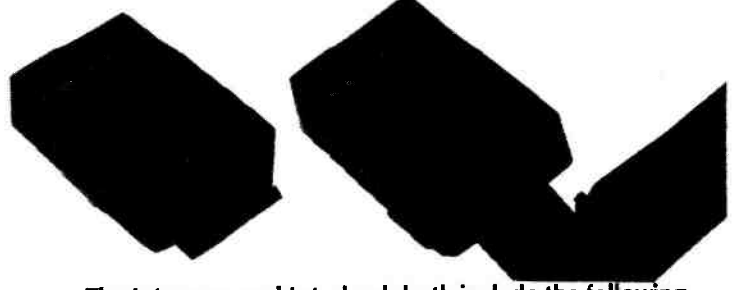

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The Interspec and Interbeeb both include the following features:

- **8-bit input port**
- **8-bit output port**
- **four switch sensor inputs**
- **four relays switching 12V 1A outputs**
- **8-channel multiplexed analogue-to-digital converter**
- **15-way expansion bus**

All parts are I/O-mapped (including the expansion bus) and have been designed for maximum compatibility with existing peripherals. In addition to the above facilities, the Interbeeb includes a separate power supply (the Interspec takes its power from the Spectrum edge-connector) and a precision 2.5V voltage reference in the ADC (the Interspec uses a simple zener diode reference). The ADC is based on the 0809 device and has a stated conversion time of 1ms and an accuracy of 1LSB.

These units are extremely easy to use and are supplied, built and tested, with all the documentation necessary to get you up and interfacing.

GRAPHICS PROCESSORS

Ian Sherlock looks into his high-res, bit mapped crystal ball and find the graphical future of computers is not that far away.

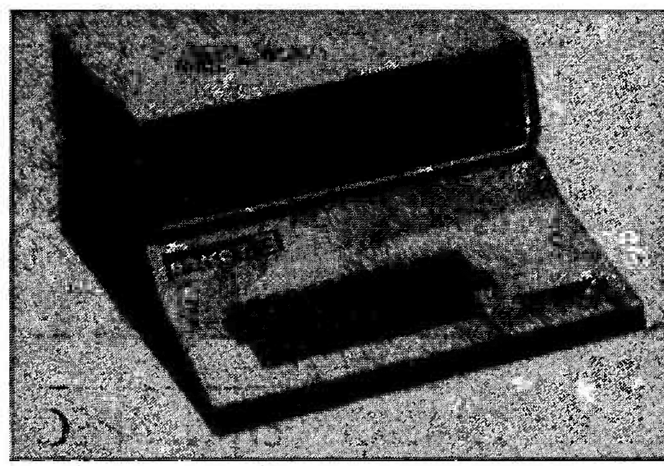
The ability to present graphical information is one of the most important features of any computer system. This applies not only to the large (and horrendously expensive) engineering workstations at the top end of the market but right down to the humble home micro.

There has been a trend recently to incorporate graphics based operating systems in business computers and even in some of the more domestic aimed machines (the Apple Mackintosh and Atari ST micros).

The graphical power of micros has steadily increased since their introduction some 10–15 years years ago (Table 1). However, the abilities of the conventional methods of handling computer graphics have just about reached their peak. To go further a new approach is required. This is provided by the 'graphics processor'.

Screen Resolution	Number of Colours	Bit-map Size	Approx. 'Dot Frequency'
256 x 200 (low)	16	25K	5.4MHz
640 x 480 (medium)	256	307K	22MHz
1280 x 1024 (high)	64k	2621K	100MHz

Table 2 Bit-map memory usage of different displays



The Nascom 3 micro — an early character generator-based computer.

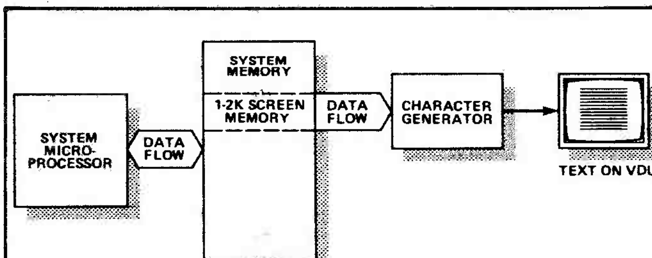


Fig. 1 Character generation in early micros.

Development Of Graphics

To appreciate the importance of graphics processors we need to look at the recent history of microcomputer graphics systems.

Graphics systems have developed significantly since small computers first appeared in the early seventies. Figure 1 shows the simplified system design of an early micro-computer such as the Nascom or UK101. The microprocessor has access to all system memory, and that area of memory dedicated to the screen can also be accessed by a character generator. The character generator scans through screen memory recognising character codes and then putting the appropriate dot sequence on the screen. Such a character generator can only produce a very limited display of text and so-called 'chunky' graphics.

The next system to emerge, and that used widely today, replaced the character generator with a graphics controller chip accessing screen memory configured as a bit-map. Such a system is used by the BBC micro and is shown in Fig. 2.

The bit-map differs from the arrangement of memory used with a character generator in that each bit in the bit-map corresponds directly to information displayed on the screen. In a very simple black and white system there might be one bit in memory mapped directly to each screen pixel (ie one = pixel on, zero = pixel off).

This scheme allows the microprocessor to display absolutely any picture within the system's resolution limits by changing the pattern of ones and zeros in the bit-map by means of the graphics controller.

The graphics controller relieves the host microprocessor of some of the work involved in managing the bit-map. For example, in some systems the host microprocessor can send simple instructions to the controller of the form:

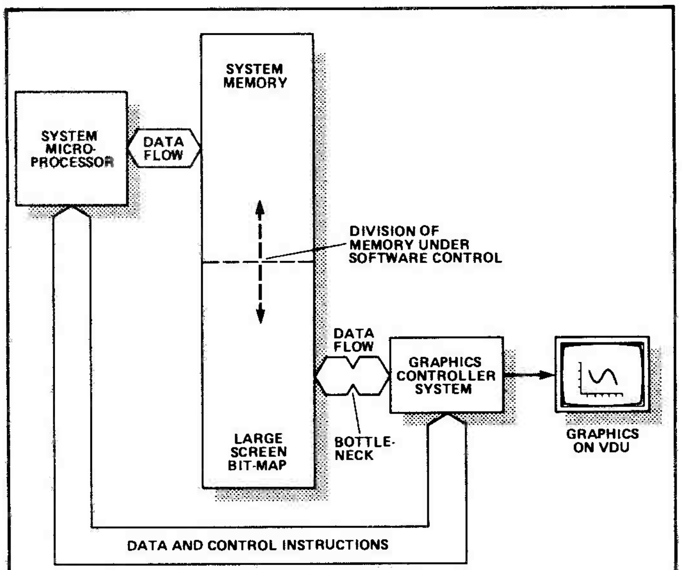


Fig. 2 Modern micro design with a graphics controller and DRAM bit-map.

Draw a line from point (0,0) to (100,100).
Draw a circle radius 20 centred at (60,80).
Draw a filled rectangle on the diagonal between (10,10) and (70,30).

The controller interprets these instructions and sets up the bit-map accordingly. If the user requires an unusual pattern to be drawn the host microprocessor has to intervene directly to alter the bit-map. Such intervention draws heavily on the host's processing power and slows the system unacceptably.

The simple bit-map and controller arrangement described has certain obvious disadvantages:

- In its simplest form it does not allow for colour or grey scale displays.
- It will not handle text efficiently.
- It is slow.
- It is limited by any pre-defined functions designed into the graphics controller.

To an extent, these problems can already be solved but the development of a graphics processor still provides a big leap forward in performance.

Providing colour for a bit-map display is quite easy and can be achieved by mapping several bits in memory to each pixel on the screen. For example mapping four bits per pixel would allow either 16 different colours or perhaps 16 different intensities of one colour to be displayed on a screen.

To achieve the resolution required for, say, the electronic publishing of a colour magazine would require a bit-map holding at least 25 bits per pixel — 8 bits or 16 intensities for each of the three primary colours.

It is fairly clear that a bit-map of any size will eat up large chunks of memory. Some examples are shown in Table 2.

It is for reasons of economy of memory and speed of operation that even graphics controller based systems tend to handle text in the same way as character generators. A word processor displaying 25 lines of 80 character text would require about 2k of memory if it used a character generator.

Producing the same display from a black and white bit-map would require about 12 times more memory, and considerably more than that if a colour bit-map were used. In addition to the need for more memory the bit-map display of text would be much slower in operation than the character generator display since moving a character about would entail shifting several bytes of information, not just a single byte character code.

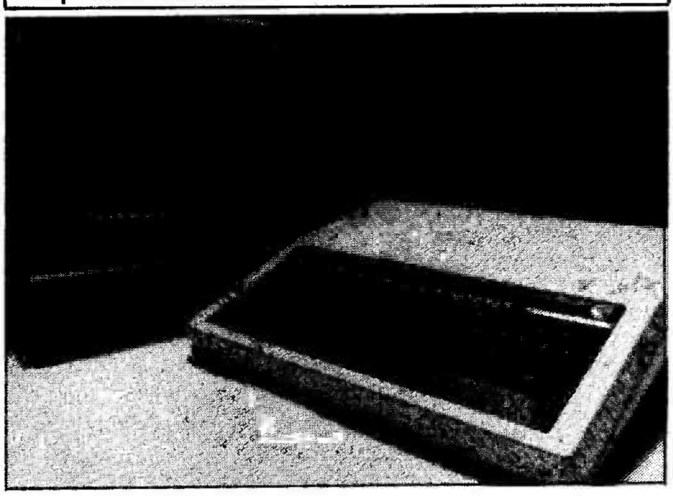
Clearly there is a trade off in design. A graphics controller displaying text in the same way as a character generator, uses little memory and is quick. However, mixing chunks of text and graphics can pose difficulties which stem from the different ways in which the two entities are stored in memory.

But now ...

It would seem then that the problems of bit-mapped graphics driven by a controller can be eased but not mitigated completely. We shall see later that the first graphics processors now becoming available are suffi-

System	Approx. Cost	Date	Typical Best Graphics	Typical System Memory
Nascom	£300	1977	80 x 48 1 colour	64K
BBC micro	£400	1981	640 x 256 1 colour	64K
IBM PC	£2,000	1982	640 x 400 16 colours	640K
Work Station	£10,000	1986	1024 x 800 16 colours	4096K

Table 1 Cost and graphics performance of a selection of computers.



The BBC micro — a typical graphics controller-based micro

MSX computers contain a forerunner of the graphics processor.

ciently quick in operation to allow text and graphics to be handled in the same way in the bit-map, while at the same time overcoming the problems of the limited instruction set of the graphics controller. Using a graphics processor, an electronics engineer can now put together a low cost system with the following features.

- Full colour, variable intensity, bit-mapped display.
- Text from a variety of fonts mixed with complex graphics.
- Very high speed number crunching for 3D animation.
- A graphics system which is totally programmable and can even operate without intervention from the host microprocessor.

A useful analogy can be drawn between a graphics system and a hand held calculator. A graphics controller provides fixed graphical functions in the same way that a calculator provides fixed mathematical functions. In contrast a graphics processor can be programmed to execute a series of instructions giving it much the same flexibility and sophistication that sets a programmable calculator apart from a simple hand operated machine.

Having taken a brief look at the development of graphics systems the following question arises: Why has it taken so long for manufacturers to devote funds to the production of a properly optimised graphics processor? The answer to this question lies largely in the realms of memory development. Until recently the DRAM chips available for graphics bit-maps have imposed an unacceptable constraint on the performance of any graphics system, no matter how efficiently the driving processor or controller. This memory problem has recently been solved, opening the way for the design of very powerful systems.

VRAM

The system shown in Fig. 2 hints at the memory problem which is associated with bit-map bandwidth and stems from the need to update the screen continuously from memory.

A typical computer display can spend 90% of its time updating the screen with the other 10% of its time taken by the blanked electron beam retracing its scan path. During the screen update period information has to be read from the bit-map.

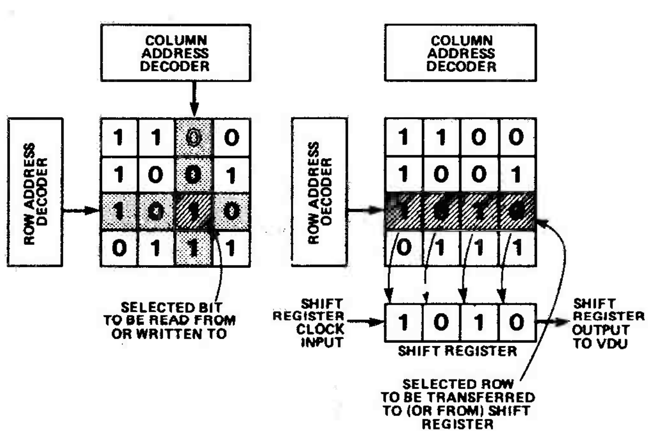


Fig. 3 (a) Dynamic RAM showing ordinary access. (b) Video RAM showing shift register transfer.

Using conventional DRAMS it is not possible to read out data sequentially to the screen while updating other areas of memory at the same time. So the graphics system is limited to making alterations to the computer display during the 10% of time when the screen is blanked.

This is an unacceptable communications bottleneck. To appreciate how it has been overcome we first need to look at the operation of a DRAM in greater detail.

Figure 3(a) shows a simplified diagram of a single Dynamic RAM chip. The DRAM is accessed in the normal way by providing a row address signal (which the DRAM latches to select a row of information) followed by a column address signal (which the DRAM latches so that one bit in the selected row can be identified). The condition of the DRAM Read/Write line then determines whether the selected bit is read from or written to.

If a bit-map were to be made entirely from DRAM then, as explained, severe limitations would be imposed on the performance of the graphics system.

One solution to the problem involves using two port video RAMs or VRAMs, devices which first became available commercially in 1984. A single VRAM is shown schematically in Fig. 3(b).

Shift Registers

VRAM looks like a DRAM with a shift register attached and indeed VRAM supports the normal DRAM read and write accesses. However, VRAM will also accept a row address followed by a special transfer strobe which signals the device to copy the selected row to the shift register. When the transfer has been completed an external shift clock can be applied to shift the row data out of the VRAM. During shifting the VRAM is free to be updated.

Of course in reality DRAMS and VRAMs are much larger than indicated in Fig. 3(b), typically they might be built as 256x256 bit arrays rather than the 4x4 bit array shown.

A VRAM bit-map is able to update its display by transferring rows to the shift register to be clocked out to

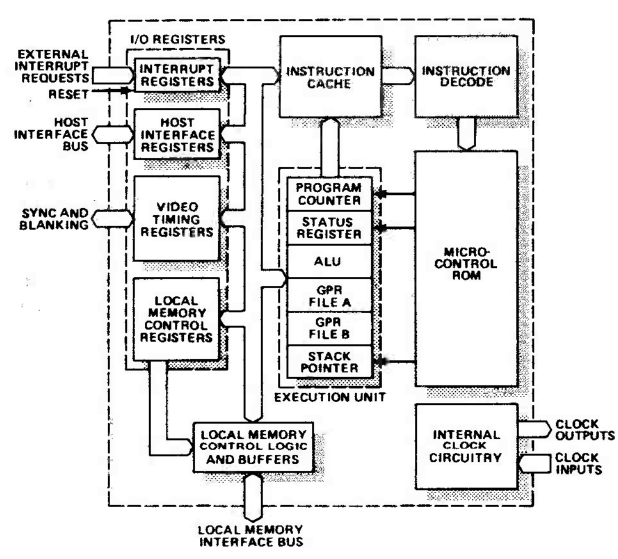


Fig. 4 The internal architecture of the TMS34010.

the screen driver. From the moment of transfer the VRAM would be free to be modified. For a typical screen display the VRAM would be busy for only 5% of the time. This compares favourably with the 90% busy figure for the DRAM bit-map. In the future the vast majority of high performance graphics systems will have to rely on the VRAM as the bit-map memory component.

The TMS34010

The availability of VRAM has made the development of graphics processors a worthwhile activity. The first device to reach the market is the Texas Instruments TMS34010. A 1.8 micron CMOS device made up of over 200,000 transistors, the TMS34010 is a complete 32 bit microprocessor in its own right but with certain features added to optimise its graphics performance.

The chip was designed in England and is currently avail able in sample quantities costing roughly £230 each. However, as production steps up over the next few years that price should fall below £20 per device at which point add-on boards will start to become available for personal computers, bringing work station quality graphics to the home micro.

The internal architecture of the TMS34010 is shown in Fig. 4. The central processing unit functions are located in the middle of the diagram. These include 30 32 bit general purpose registers which are all available to the user. There is also a 256 byte instruction cache built into the TMS34010, shown in Fig. 4 above the CPU. The cache holds a copy of a small region of processor memory. As the TMS34010 executes code it looks in the cache for the next instruction. If the instruction is present in the cache it can be fetched with virtually no delay, saving time which would otherwise be lost accessing extended memory.

Graphics code commonly contains large numbers of short machine code loops used, for example, to draw lines and circles. The cache has been designed to accommodate these short loops and can execute them very quickly, making few external memory accesses.

Running down the left of Fig. 4 are a series of dedicated I/O registers. Seven registers control the way in which the processor responds to an interrupt and the way in which the processor interacts with the system host processor (assuming there is one).

There are a further 15 registers dedicated to video timing. These can be programmed by the user to set the length of the horizontal and vertical sync and blanking signals. One processor can be used to produce signals compatible with a whole range of video standards. The generation of video signals can also be disabled and the chip locked to an external picture source to allow the mixing of different video signals.

The last set of six I/O registers control the local memory interface. The processor's local memory can be made up of VRAMs for the bit-map, DRAMS to hold program data and even EPROMs to hold boot-up code for a system in which the TMS34010 does not have a host.

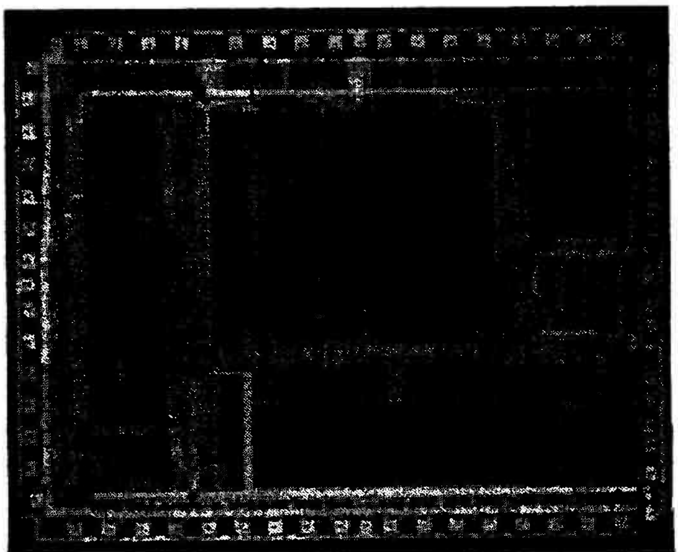
All the local memory control logic is resident in the processor so VRAM and DRAM chips can be connected directly to the processor with a minimum of glue logic and no dedicated memory controller is required. The TMS34010 is also exceptional in that its address space extends over 128 Mbytes to accommodate the biggest VRAM bit-maps.

The largest area of Fig. 4 and the largest area on the silicon chip is taken up with the microcontrol ROM which orchestrates the movement of data within the chip as it executes each machine code instruction. The size of the control ROM is a reflection of the large number of optimised instructions built into the TMS34010. These instructions allow the programmer to refer to the bit-map directly using an X,Y co-ordinate address mode, leaving the chip to compute the absolute memory address itself.

Another strong graphics feature hinges on the ability of the processor to move large amounts of data about in memory very quickly. The processor also has the ability to look at data not just at bytes and words but also as pixel groups whose bit size can be preset by the user. So it is possible to effect pixel block transfers ('pixblts') easily from machine code, particularly if use is made of the x,y addressing mode.

The pixblt operations enable 2D bit arrays to be moved around in memory at high speed and are especially useful for moving graphical entities about within the bit-map. For example, characters from a text font can be treated as 2D arrays of pixels and pixblt operations may be used on them to achieve smooth scrolling effects.

Pixel blocks can also be combined with each other arithmetically before displaying them on the screen so transparency masks can be set up to protect certain parts of the display or to protect certain colours.



The IC mask of the Texas TMS 34010 graphics processor.

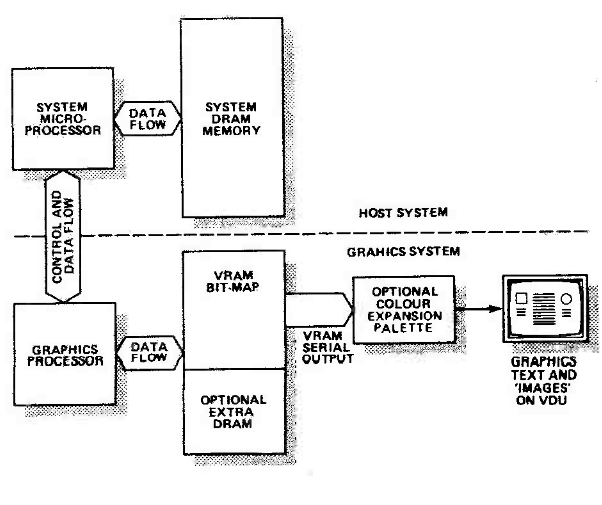
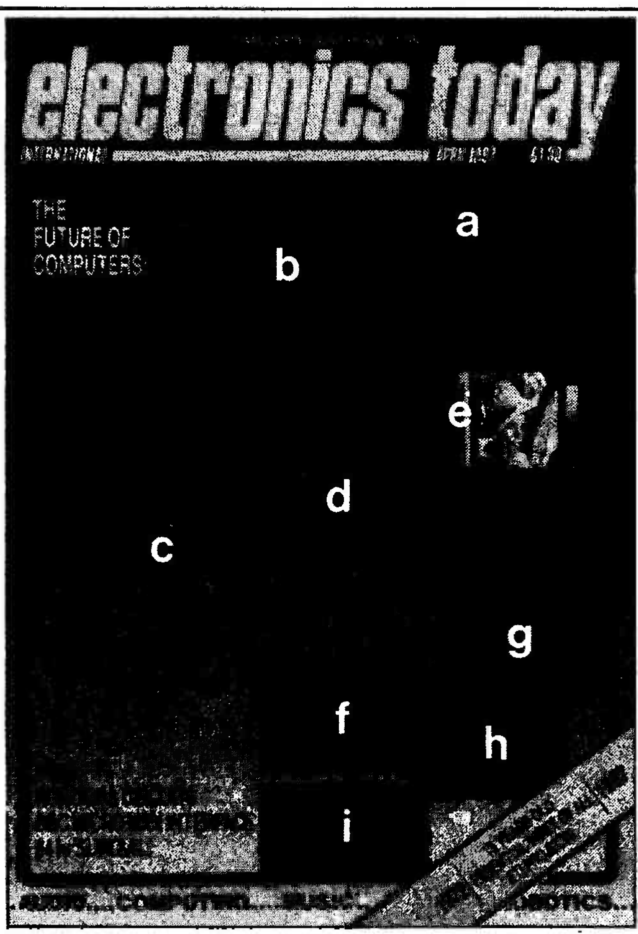


Fig. 5 Outline architecture of future computers.



This month's cover shows TM34010 demos. (a) two rotating cubes in a wire frame tunnel demonstrating real time 3D animation. (b) a screen full of text with an inset of scrolling text, all performed by the graphics processor. (c) high speed pattern-fill demos. (d) solid cube rotated in real time with salient measurements. (e) video image processing — zoom. (f) perspective projection of a surface. (g) colour blend demo with only four bits per pixel. (h) ETI in the numerous fonts supported by the TMS34010. (i) simulated ECG display — the traces move!

Typical System

Figure 5 shows a typical system incorporating a TMS34010 in a configuration that could set the norms for personal computers of the future. Such a system could be designed to provide a display of resolution 1024x1024 using perhaps 4 bits per pixel. The colour palette shown in Fig. 5 acts as a look up table such that the 4 bits per pixel can define any 16 colours from a palette of 4096. The 16 selected colours can also be changed at the end of each displayed line by reloading the palette control registers.

It should be remembered that the TMS34010 is designed as a general purpose 32 bit processor optimised for graphics work so micro designers looking to cut costs could dispense with the host section of the architecture altogether!

The resulting system, built entirely around a TMS34010 would retain the graphics performance of the personal computer while being cheaper and simpler to manufacture, a system ideally suited to the home micro market.

With a machine cycle time of 160ns the graphics processor is capable of drawing lines at the rate of 1.25 Mpixels per second and placing bit-map text at 43k characters per second. The number crunching capacity of the chip also enables it to cope with the real time

These four screen shots show a black and white video image captured with the graphics processor and then manipulated in memory. Top: the original picture. Upper middle: The effect of a low fass filter with loss of sharp edges. Lower middle: historgram equalisation of the image. Bottom: Demonstration of a zoom.

animation of 3D graphics. Rotating wire frame diagrams poses no great problem and the programming effort can be minimised by providing the user with high level language procedures to apply three dimensional perspective and rotational transformations. The programmer simply has to dump the co-ordinates of his 3D object into an array, apply the transform and perspective procedures and let the chip do the rest.

There are obvious applications for graphics processors in displaying computer graphics on VDUs but these processors are also able to control laser printers. A laser printer operates by dumping information to be printed into a memory bit-map. The contents of the bit-map can then be scanned out to a laser which writes on a spinning photosensitive drum.

The drum becomes electrostatically charged according to the scan pattern of the laser and attracts powdered ink. The inked drum can then print to paper in the same way a photocopier prints to paper. Laser printers offer exceptionally high speed and high resolution printing. To achieve their full potential the information in the bit-maps has to be managed efficiently and graphics processors can provide the necessary management functions.

Future

The graphics processor is now being designed into the next generation of personal computers as a standard feature. In two or three years time when the cost of the device has fallen even further it will begin to look very attractive to the manufacturers of micro-computers. The graphics processor could appear as an add-on board transforming the performance of an existing micro or alternatively it could be placed at the heart of a custom designed machine.

The appearance of these advanced micros will pose a challenge to the writers of software who will be able to produce real-time animated 3D graphic displays of outstanding quality. Games software will become considerably more sophisticated to utilise the more powerful hardware. Micro operating systems will also tend to imitate those of the bigger office machines in that there will be a move towards the control of computers through mouse and VDU rather than through the keyboard.

Image Processing

One of the most intriguing applications of future micros may lie in the area of image processing. It so happens that the VRAMS which make up the bit-map can be made to work in reverse so that a digitised bit stream from a camera can be fed into the shift register and dumped to the memory array. Once captured an image could be processed for enhancement or special effects purposes before being redumped to a screen.

The emergence of the graphics processor will stimulate several exciting developments over the next few years. Although the current price puts these devices outside the range of most ETI pockets we shall all surely be seeing a lot more of the graphics processor in the future.

ETI

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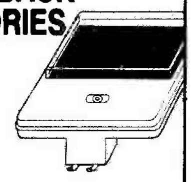

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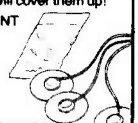

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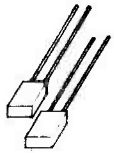

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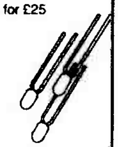

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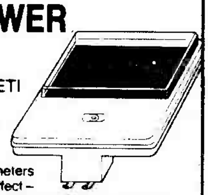

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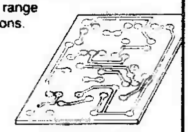

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FEATURED IN ETI JANUARY 1987

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You are driving along the road one day when the sound of a horn makes you look behind. The driver of a milk float is cursing you for driving so slowly. A while later, an invalid carriage overtakes you, and just as you turn into your drive you hear a tractor driver mutter 'At last I can get out of first gear!'

Do you:

a) Fit a £500 Pie-in-ear in-car stereo with digital flexi-woofers and 24-band ramification?
b) Buy a set of fluffy dice and sticker saying 'My other car is a Macaroni'?
c) Give your car in part exchange for a milk float/ invalid carriage/ tractor?
d) Tune your engine.

The combined tachometer and dwell meter parts set contains: case with battery compartments; printed circuit board; all components; switches; plug, socket and test leads; battery connector; full instructions. The answer to the quiz, by the way, is: e) Buy a bright red Lotus Esprit.

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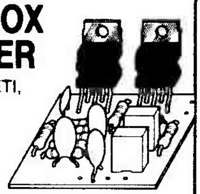

FEATURED IN ETI, APRIL 1986

No ordinary amplifiers, these. When our first customers took an interest, it was for the diminutive size (both modules will fit in a matchbox!), the total disregard for power supplies and speaker impedances, and the impressive power output from these little amplifiers. When they re-ordered, it was for the sound quality.

Two amplifier modules were described, both based on the powerful L165V IC. The single IC version will deliver over 20 Watts with a suitable speaker and power supply. The bridge version can provide up to 50W! Although the specified supply voltage and speaker impedance must be used to achieve maximum power, both modules are quite happy to work from any voltage between 12V and 32V, and will accommodate any type of speaker. The bridge version is ideal for giving a boost to car Hi-Fi systems, driving two 4 Ohm speakers in parallel on each channel for best effect.

Both designer-approved parts sets consist of a roller tinned printed circuit board and all components. The L165V ICs are also available individually, with a free mini data sheet giving specifications and suggested circuits.

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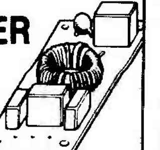

FEATURED IN ETI, SEPTEMBER 1986

It is astonishing how many people buy or build top-flight hi-fi equipment, and then connect it to a noisy, spiky mains supply. Rather like buying a Ferrari and trying to run it on paraffin, you might think. Expecting crystal clear sound, the poor music enthusiast ends up with a muddy, confused mush, and feels that he has somehow been cheated. 'Is this hi-fi? My music centre sounded just as good!'

The domestic mains supply is riddled with RF interference, noise, transient spikes, and goodness knows what else. Computers crash, radios pop and crackle, tape recordings are spoiled and hi-fi sounds 'not quite right'. Why put up with it when the solution is so simple? The ETI mains conditioner is the lowest cost upgrade you will ever buy, and probably the most effective!

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ETI MAINS CONDITIONER PARTS SET ONLY £4.60!

*Note: the toroid and VDR supplied are superior to the types specified in the article.

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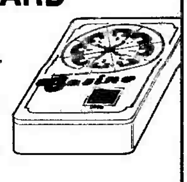

FEATURED IN ETI, MARCH 1987

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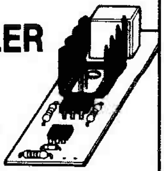

FEATURED IN ETI, JANUARY 1987

Have you ever wondered what people do with all those computer interfaces? 'Put your computer in control,' say the ads. 'The Spectrabeeb has eight TTL outputs.' What on earth can you control with a TTL output? A torch bulb?

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FEATURED IN ETI, JULY 1986

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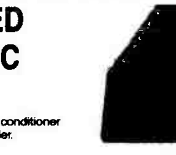

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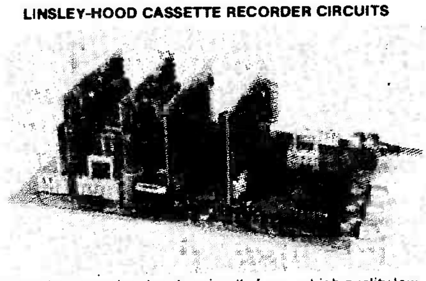

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74LS14	35	74LS86	30	74LS155	45	74LS221	57	74LS348	200
74LS15	24	74LS90	45	74LS156	55	74LS240	65	74LS353	120
74LS20	21	74LS92	40	74LS157	30	74LS241	65	74LS363	180
74LS21	21	74LS93	40	74LS158	39	74LS242	65	74LS366	48
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HARDWARE DESIGN CONCEPTS

Mike Barwise continues his pulse generator design. This month he looks at criteria for designing the PCB and adds a range expander to the system.

We have now reached the final, practical stage of our pulse generator design. I have chosen to distribute the generator across several PCBs. It would otherwise be difficult to find a convenient case for it and anyway the various functions are better kept separate for performance reasons.

This modularity also allows potential future upgrades. Using the industry standard extended single Eurocard (100mm x 220mm), a half width (8.5in) Eurocase will accommodate our design, which will consist of four boards in the first instance.

The common connector between boards is a DIN41612 C indirect with 96 ways. This allows the A and B rows to be used for the pin-intensive programming register bus (44 bits) and clocks, leaving the C row for use by the control microprocessor. When dealing with such a large pin count, confusion between pin names is likely to arise, so all microprocessor signals will be prefixed 'PRO...'.

Increasing Generator Range

Referring back to the February 1987 issue, we see that the basic 1000:1 range of the pulse generator can be increased by the addition of a decade programmable clock divider. This is the board we will build this month. It provides four decade ranges for each of the parameters of the pulse — period, delay and width. This divider is a lot simpler than the pulse generator, as the counters are allowed to free run.

In order to create decade ranges, the 74F168 decade counter is used. This is a direct plug-in replacement for the 74F169 used elsewhere in this design.

The circuit (Fig. 1) consists of a master clock oscillator, a four decade synchronous divider chain and a four to one multiplexer for each of the three outputs required. One multiplexer is obligatory (pulse period), the delay and width multiplexers being optional but highly recommended as they allow much greater control. The cost of two extra multiplexers (about £5) is well worth it.

The multiplexer outputs are buffered by a 74F244 to allow sufficient drive for the pulse generator board. If you want to go cheapskate and use only one multiplexer then the three signal lines are paralleled just before the buffer inputs by fitting LK1 and LK2.

There are a couple of unusual points about this circuit. First, the use of a proprietary oscillator is recommended, as the construction of stable high speed crystal oscillators is not to be taken on without experience.

Secondly, referring back to our previous discussion of cascaded counters, we find that the outputs are normally short 'ticks' from the RCO pins and it is worth mentioning that there can be unwanted glitches at these pins.

This glitch hazard is covered by the logical AND combination used in the pulse generator proper but it is obvious that for both these reasons an individual RCO output is unsuitable here as a clock signal (which should be a clean square wave).

The solution is to double the speed of the input clock and then use the Q0 (divide by two) output of each counter. The output is then a good 50/50 mark–space ratio square wave at half the effective rate of each counter.

So the first stage effective rate is the input clock rate (say 20MHz) yielding an output of 10MHz, the second stage effective rate is 2MHz (divide by ten) yielding an output of 1MHz and so on.

Resolution And Clock Rate

A couple of readers have told me I did not make my comments on pulse generator resolution quite clear enough, so here goes with some further clarification.

The programmable counters are clocked at the input clock rate selected by the range board. It is not possible, however, to program a counter to divide by *one*. The lowest functional modulo is in fact *two*. This means the shortest period programmable is twice the clock period.

However, it is possible to program the period to all other multiples of the clock period up to maximum. So the programmable increment in period (the resolution) is equal to the clock period with a minimum of two clock periods. With a 10MHz clock you can program pulses of 200ns, 300ns and so on, and with a 20MHz clock, 100ns, 150ns, 200ns etc.

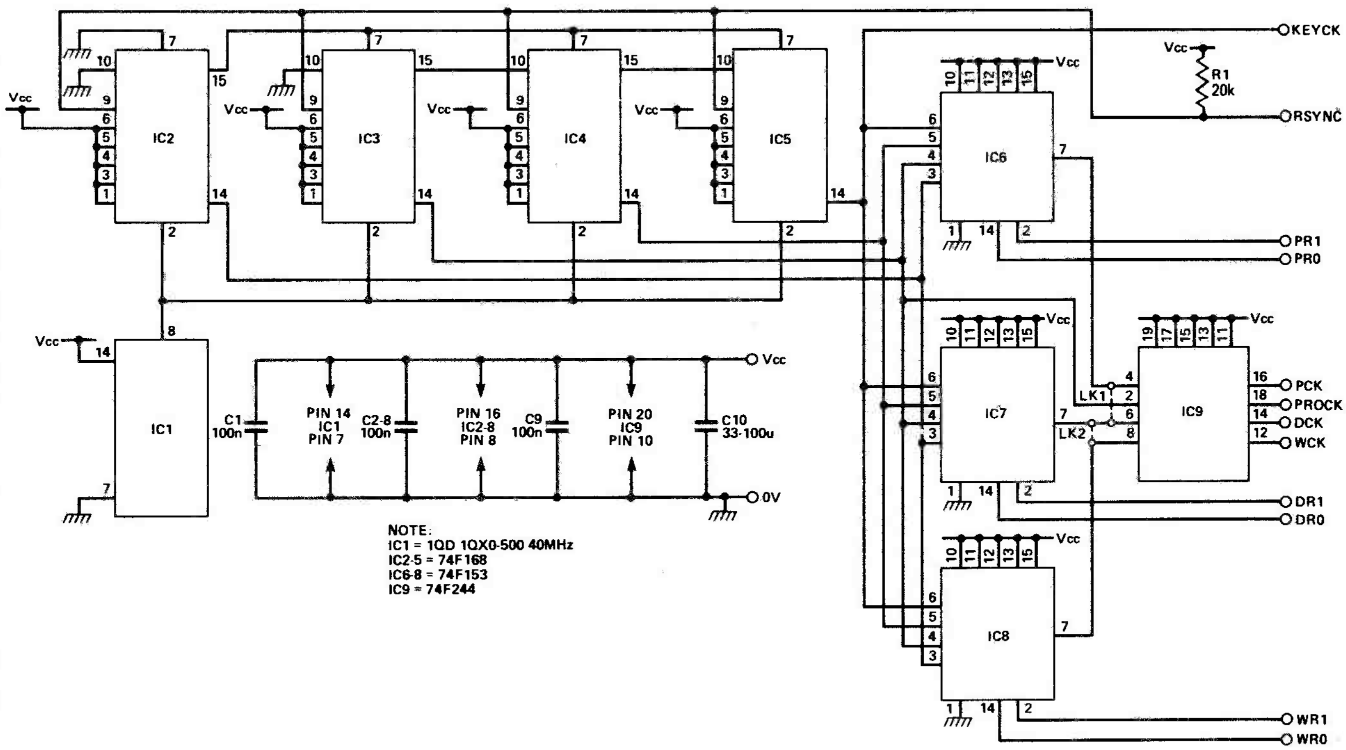


Fig. 1 The circuit diagram of the range board.

Once we use our counters to create a pulse generator this minimum period of two clock periods must be taken into account for each counter. It is apparent that when both delay and width are programmed to their minima of 200ns (10MHz clock), the overall period must be programmed to 400ns or greater, yielding a maximum frequency of 2.5MHz. Even though 100ns increments generally provide adequate resolution for our pulse generator, the use of a 20MHz clock giving 50ns resolution to each counter doubles f_{max} to 5MHz.

The final circuit of the generator board (coming next month!) will allow a zero delay option to permit working to around 10MHz depending on the oscillator selected.

I am standardising on the 40MHz crystal (20MHz clock) for the moment (the software depends on it to some extent) so I would recommend it all round.

I hope this dispels any confusion about resolution.

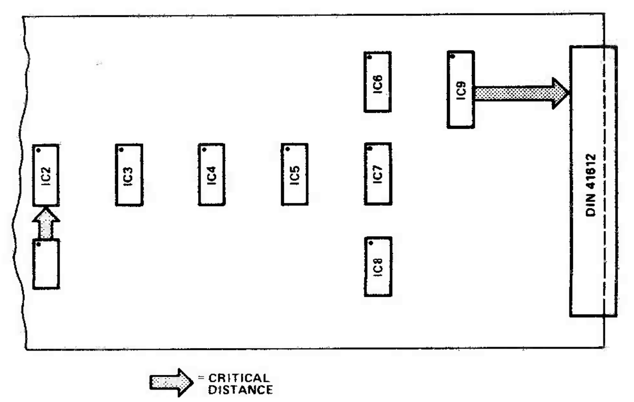


Fig. 2 The suggested layout for the range board.

The pulse generator as a whole has about half the resolution of a single programmable counter, due to the cascaded delay and width stages.

The PCB

I have already mentioned how the 74AS and 74F series TTL required for the 20MHz version of the pulse generator require special consideration when laying out the PCB.

If normal 74LS series TTL is used (for a 10MHz pulse generator) the PCB layout is not critical. However, assuming that we are using the 74F or 74AS high speed TTL chips, the bulk of the handling precautions are accomplished by a board topside consisting entirely of Vcc and ground planes. This is shown in Fig. 4.

Note that the IC packages should be well spaced apart but that interconnections should generally be no more than two inches or so long.

The topside foil has been designed for use with both the pulse generator board and the range board so more pilot holes for the IC pins are given than necessary for this particular circuit. For many pins in these positions the holes in the foil should be widened with a countersink drill bit (as they are at the backplane connector) to give clearance from the ground and Vcc planes as required by the circuit.

The PCB tracking on the underside should be as fine as possible, ideally in the region of 0.02in, and the track density should be no greater than 0.05in. Each track should be of consistent width.

Tracks which vary in width cause problems when it comes to predicting their dynamic characteristics (impedance, resonance and so on) at high speeds. Of course, tracks which carry heavy currents (eg output tracking from the driver/buffers) should be thicker, but not much more than say 0.05in, and the track to gap width ratio should be kept to about 50%.

PARTS LIST

RESISTORS

R1	20k

CAPACITORS

C1–9	100n ceramic
C10	33-100n ceramic

SEMICONDUCTORS

IC1	IQD IDX0–500 40MHz
IC2–5	74F168
IC6–8	74F153
IC9	74F244

MISCELLANEOUS

PCB; DIN 46112 C 96/96 connector.

BUYLINES

All the parts for the range board are available from usual suppliers (such as Electromail and Vero) except the oscillator IQX0–500 40MHz. This is available direct from IQDM North Street, Crewkerne, Somerset TA18 7AR. Tel: (0460) 74433.

Pin	A	B	C
1	+5V	+5V	+5V
2	KEYCK	PROCK	—
3	WCK	—	—
4	DCK	—	—
5	PCK	—	—
6	—	—	—
7	—	—	—
8	—	—	—
9	—	—	—
10	—	—	—
11	—	—	—
12	—	—	—
13	—	—	—
14	—	—	—
15	—	—	—
16	—	—	—
17	—	—	—
18	—	—	—
19	—	—	—
20	—	—	—
21	—	—	—
22	—	—	—
23	—	—	—
24	—	—	—
25	—	—	—
26	—	—	—
27	—	—	—
28	RSYNC	—	—
29	WR0	WR1	—
30	DR0	DR1	—
31	PR0	PR1	—
32	GND	GND	GND

— not used for the range board.

Fig. 3 The backplane connector pinout used by the range board.

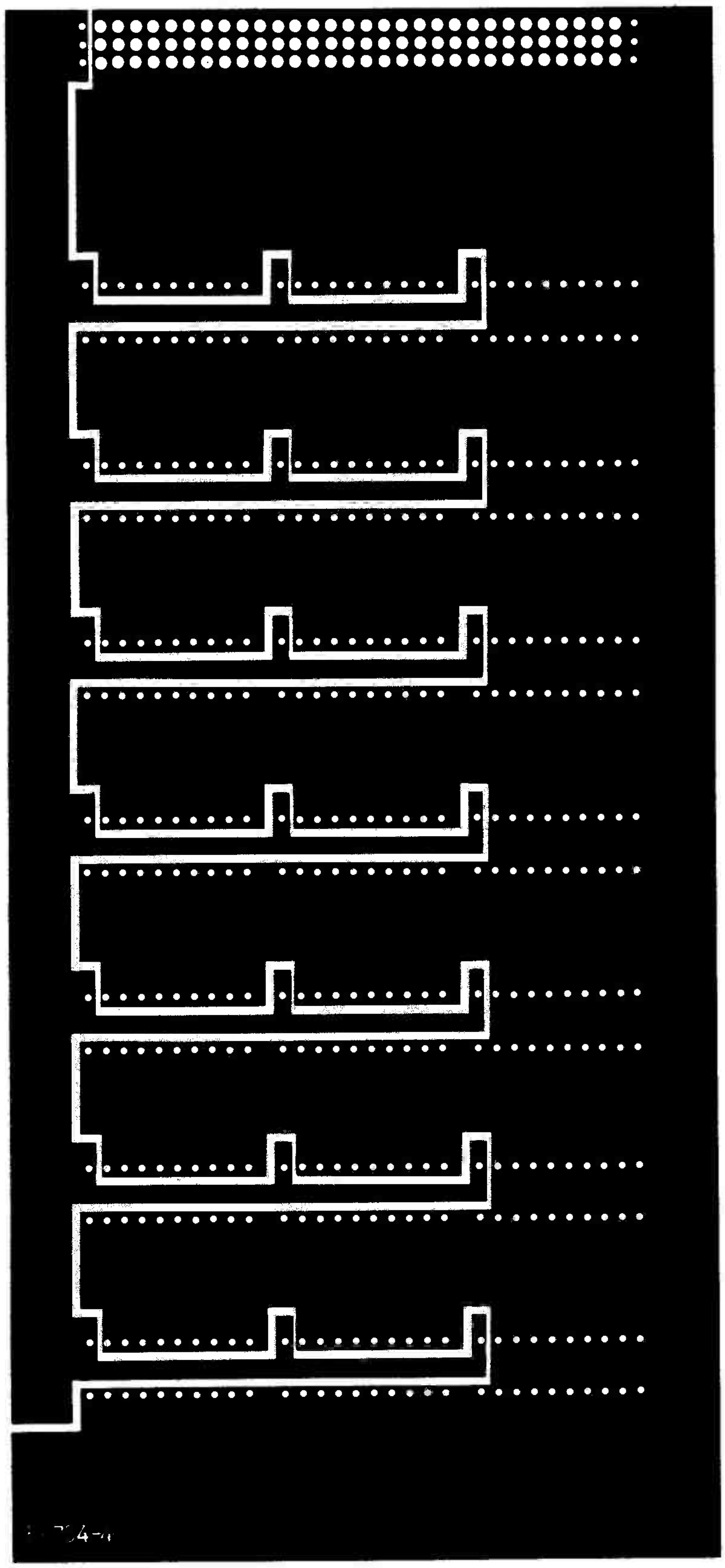


Fig. 4 The topside foil for the general purpose high speed TTL board.

These specifications represent a good rule of thumb for minimal crosstalk (spurious interaction) between adjacent TTL digital signals at up to about 50MHz. Tracks thinner than 0.02in are difficult to etch (although boards using 0.01in tracking prove excellent for small signal logic — if you can make them reliably). With tracks wider than about 0.05in, track capacitance starts to become significant in the 20MHz region.

The track/gap width ratio is mainly responsible for controlling the track to track crosstalk, and the (constant) spacing with respect to the ground plane on the topside is the primary factor controlling the characteristic impedance of the track.

Tracking should be straight line/angular rather than 'soft curve', but corners should (ideally) be turned in 45 degree increments rather than 90 degree. More acute junctions than 45 degree are *never* permitted. Not only can these radiate at high frequencies but they pose considerable etching and soldering problems.

Construction

The only safe approach when using a 20MHz or faster system is to use a PCB. Remember that your master clock oscillator is running at 40MHz. Sockets should be used for all components, including the oscillator, as this allows easy servicing and upgrade. Only good quality low profile turned pin sockets should be used. If these look a little expensive, Augat produce a very good coined contact alternative which is available from various sources, but standard Vero sockets are ideal.

Turned pin sockets have integral stand-offs on the pins. Where ground and Vcc connections are needed, these should be soldered direct to the supply planes on the topside. Pins not grounded or connected to Vcc should pass through clearance holes in the ground plane.

If you have to countersink these holes yourself, it is quite important to leave some copper between adjacent pins to screen them from each other. However, it doesn't take much so don't risk pins shorting to ground by being too cautious with the countersink. Note that a spot face cutter is *not* suitable. Its nose angle is too obtuse so it will be very difficult to get the cutouts centred about the holes in the PCB.

Of course any links on the topside of the board must be insulated. It pays to form the links tidily with a pair of pliers. The best stuff is 22 SWG or 24 SWG tinned copper wire and 0.7mm bore PTFE (heatproof) sleeving (both available from RS).

Though neatness is a lot of trouble, the results will well repay the effort. At the speeds we are talking about, neatness almost equates to reliability.

For decoupling, try to get multi-layer miniature ceramic capacitors. The ordinary single layer discs are too big for comfort. The aim is to keep the board profile as low as possible, in any case not more than 0.6in total including the lead projection on the solder side. This is not very difficult to achieve in practice, but it is important, as the boards will have to be mounted together on a 0.8in pitch.

Despite these contstraints, the only component that you won't be able to get from normal chip shops will be the oscillator. This is available from IQD, North Street, Crewkerne, Somerset TA18 7AR. Tel: (0460) 74433).

Next month I shall give the recommended PCB underside foil pattern. Meanwhile you are welcome to try your hand at designing your own.

Next month I shall also look at the design of the main pulse generator board.

ETI

CIRCUIT THEORY

Paul Chappell starts a new series looking at the theory behind circuit design.

The fact that simple circuits behave in complicated ways was illustrated by last month's article on snubber networks. When faced with a problem like misbehaving snubbers, trial and error may eventually lead to a working circuit but you can never be sure that the component values selected in this way are the best ones for the job. There may be some problem which will only make itself known when the circuit catches fire a week later or if you make up another circuit with the same component values and slight variations in their characteristics cause it to fail. The only way to be sure is to analyse the circuit.

Analysis is one side to the circuit theory coin. The other is synthesis. Suppose that you come to the conclusion that a new music processor you are designing needs a network with certain phase and frequency response characteristics. How do you go about making one?

The techniques of circuit theory aim to make the analysis and synthesis of circuits as simple as possible. It may seem otherwise when the ideas are unfamiliar to you but as every student of Zen knows — the road may be hard and painful, but the eventual enlightenment will make it all worthwhile! I'll begin by taking some of the main playing pieces out of the box to see what kind of moves they make.

Linear Circuits

Every electronics enthusiast has an intuitive idea of the meaning of a linear circuit. If pressed to give a definition, I imagine most would come up with something like: 'A circuit in which the output is proportional to the input'. This is a good description of a special class of linear circuits (often called 'DC circuits') but it's not the full story.

To qualify for the title 'linear', a circuit must have two properties. The first is that the output must vary in proportion to the input, but *needn't be the same shape*. (If it *is* the same shape, we have the special class of DC networks — amplifiers, attenuators and suchlike).

This is known as the principle of *proportionality* (what else?), and stated formally it looks like this:

If an input $e(t)$ produces an output $r(t)$, then an input $Ke(t)$ must produce an output $Kr(t)$.

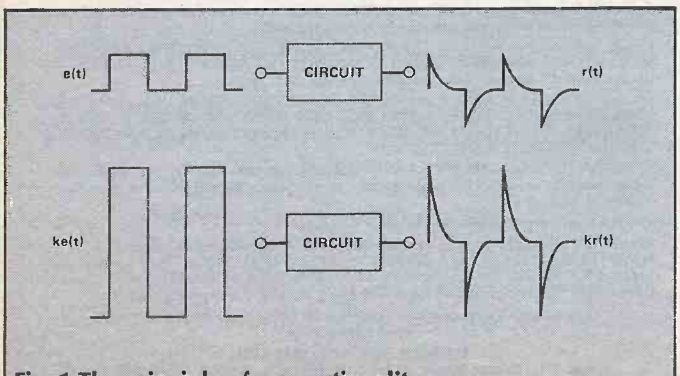


Fig. 1 The principle of proportionality.

An illustration of proportionality is shown in Fig. 1. The circuit is shown with a square wave input, but to qualify for proportionality this property must hold for any input whatsoever.

The second property is this: if you know the output produced by one waveform and you also know the output produced by another then the output caused by the two waveforms added together must be equal to the two individual outputs added together. It's a bit of a mouthful, but I hope that Fig. 2 will make it clear. This is known as the principle of superposition. Stated formally it is:

If an input $e_1(t)$ produces an output $r_1(t)$ and an input $e_2(t)$ produces an output $r_2(t)$, then an input $e_1(t)+e_2(t)$ must produce an output $r_1(t)+r_2(t)$.

Once again, this must hold for any pair of inputs whatsoever. The reason for using e for the input, by the way, is that if we want to be pedantic about it, it is called the *excitation* (or stimulus, so I suppose we could equally well use s). Also, i(t) suggests that the input must be a current. It can be, but it needn't. The output is formally called the *response* — hence the r.

The reason that linear circuits are dear to the hearts of electronics engineers is that they are so well behaved and easy to analyse.

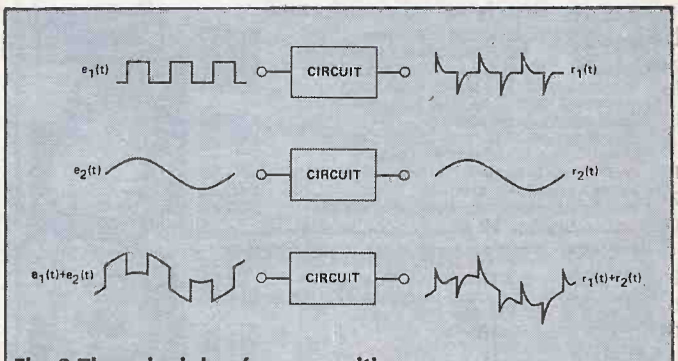


Fig. 2 The principle of superposition.

Superposition is a great blessing because it means that if you are faced with the problem of deciding the output produced by a complicated waveform, it can be split into parts and each part can be dealt with individually. The response to the complicated waveform is then obtained by adding the simple parts together.

You've probably done this yourself on numerous occasions without even being aware of it! Whenever you arrange the DC conditions for an op-amp, for example, you make the implicit assumption that the DC level and the AC signal can be dealt with independently. This is a special case of superposition in which one of the inputs is a fixed voltage.

There is another application of superposition that is so deeply ingrained in the thought processes of any electronics person that it seems an unquestionable eternal truth. I'll come on to it next month, but in the meantime you might care to fathom out what it is.

Figure 3 shows some linear and non-linear circuits. Before reading any further you might like to try deciding which are which. If they pass the proportionality test *and* the superposition test then they are linear. If they fail either one, they are not.

Figure 3a is an inverting amplifier. I don't think I need to say too much to convince you that this is linear. Amplifiers belong to the special class of linear DC circuits which have the property that the output is equal to the input multiplied by a constant.

As an exercise, you might care to try proving that all such circuits must exhibit proportionality and superposition. It's not difficult and will give you a chance to flex your mathematical muscles a little.

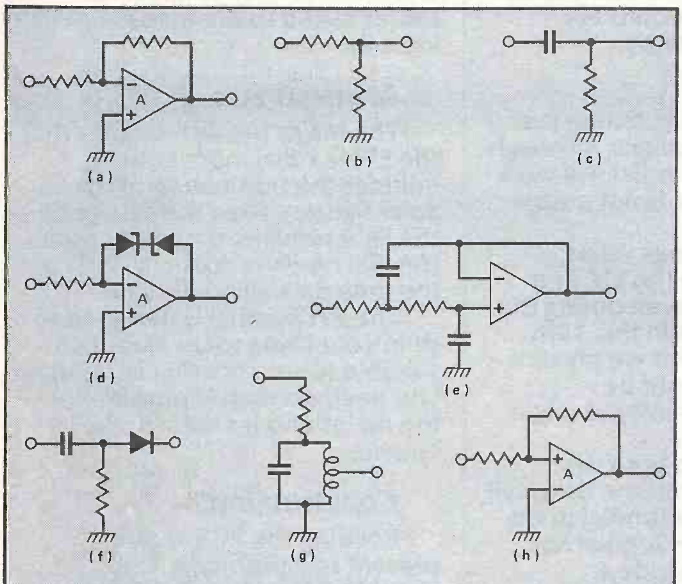


Fig. 3 Linear and not so linear circuits.

Figure 3b is a simple resistor attenuator and belongs to the same class of linear circuits as the amplifier. In fact, any resistor network whatsoever is linear and will produce an output equal to the input multiplied by a constant.

Figure 3c is clearly not a DC network — the response to any constant voltage level will always be zero. However, it is linear, and could very well be the circuit inside the box of Figs. 1 and 2.

Figure 3d is a comparator. It fails the proportionality test immediately. Any input will either produce a switch from one voltage level to another or no output at all. That is not linear!

Figure 3e is a Sallen and Key low pass filter implementation (common or garden variety) and is linear.

Figure 3f passes the proportionality test for any old waveform but fails on superposition. A pair of inputs that would catch it out on superposition would be two square waves 180° out of phase.

Figure 3g is linear. In fact, to give the game away, any combination consisting only of resistors, capacitors, inductors and amplifiers will be linear.

Respect

The only limitation I can think of is that inputs and outputs must be respected. That is to say no two amplifiers should have their outputs connected together, the input to a network should not feed directly into the output of an amplifier, and so on. A formal proof would be tedious and unenlightening but rests on the fact that resistors, capacitors and inductors are themselves linear, so any combination of them will also be linear.

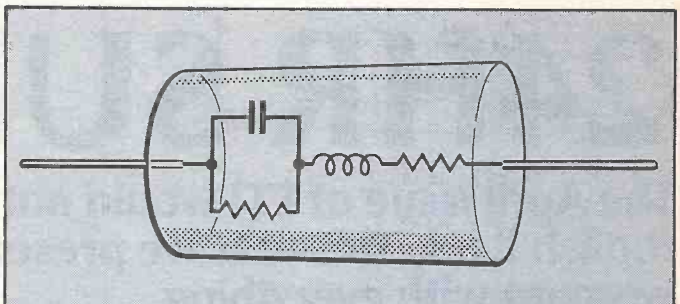


Fig. 4 A real life capacitor composed of ideal elements.

Figure 3h. What can I say about this one? Anybody can recognise it at a glance as a comparator with hysteresis, so it seems to contradict my previous statement. Or does it? The reason it works as a comparator is that the output of the op-amp bangs up against one or other of the supply rails. In other words, it works because of the practical limitations of real-life op-amps. Strictly speaking, the circuit is an amplifier with infinite gain!

Circuit theory does not recognise any practical limitations on components. All resistors obey Ohm's law to the letter. Capacitors don't leak, inductors don't saturate and amplifiers aren't restricted by supply voltages.This may seem like pedantic nonsense but there's a good reason for it.

Imagine that your TV set suddenly goes on the blink. You could reasonably claim that any method of analysis which did not predict that on the 12th of March at 10.15pm your picture would go wonky is in some way flawed. If it happened in the middle of the Dirty Dan show, you might express that very opinion to the repair man in rather ruder terms.

Ideal Components

There are two approaches we could take to make the analysis more realistic. We could draw a circuit and label it like this: R1 is a low grade resistor that's likely to fail at any moment, L1 is a coil with a loose core, C1 does peculiar things when it gets hot, and so on. If you want to analyse a circuit like that, good luck to you!

The other approach is to pretend that all components are ideal, and to add in more ideal components to represent the deficiencies. You've all seen circuit models similar to Fig. 4, where the ideal capacitor is made a good deal less ideal by the addition of resistors to represent leakage and effective series resistance, and an inductor to represent the inductance of the internal foils (and to a much smaller degree the inductance of the leads). The advantage of this approach is that you can see exactly what's causing the problem. Since all the individual components are ideal they are nice and well behaved when you come to write equations about them.

Let's face it, there's no such thing as an op-amp in real life. What you can buy are devices which behave enough like op-amps over a very limited range of voltages and frequencies to be allowed the name.

Resistors are well behaved over a limited range. Too much current and the nice Ohm's law line begins to sag. Much more current and they burn.

Capacitors are much less well behaved. Certain types of ceramic things are so unlike capacitors in their behaviour that I'm surprised the consumer organisations allow them to be sold under that name! Probably they've never studied circuit theory.

Well, Zen students, that's quite enough for you to meditate on for this month. Ommm, Ommm, Ommm . . .

ETI

24HR SUNDIAL

The April issue of ETI would not be the same without at least one foolish item. This year we present the project for the man (or woman) with everything.

The humble sundial is the oldest accurate timepiece. Once early scientists had sorted out what was happening in the heavens above they soon found a sundial provided a reading of the passage of time as accurate as could be expected in those days.

The conventional sundial works on a very simple principle. The Sun, as any informed 16th century astronomer will tell you, moves around the Earth in a pretty predictable manner.

So it casts a shadow from a stationary edge that will move across a scale and mark out the passage of the elusive time.

In the UK the conventional sundial suffers from a few problems. First, it requires a suitably exposed stretch of garden to put it in. With 50-odd million people now crammed into this country, suitable gardens are getting hard to come by.

Sunlight

More importantly, during the night there is no sunlight. Although the conventional sundial will work with moonlight, this is not a very effective solution.

Just to make things worse, sundials situated in the UK find very little sunlight even during the day! It is only fitting in this 15th anniversary issue that we present a project that would not be necessary in the country of origin of ETI — Australia!

Sunlight, then, is both the crucial ingredient and the downfall of the conventional sundial in the UK. So the ETI 24hr Sundial has been created to provide a timepiece with all the simplicity and charm of the original but better suited to the modern British lifestyle.

Artificial Sun

The major breakthrough is that the ETI Sundial more closely imitates the true nature of the Solar System. Now the source of the light remains stationary and the dial revolves round to indicate the time on a suitable scale.

The ETI Sundial is designed to sit in your living room close to a suitable source of artificial light. All you need do then is plug it into the mains and let nature take its course.

Construction

Building the PCB should present few problems. Care should be taken to insert all the capacitors the correct way around as shown in Fig. 2.

The wiring of the stepper motor will depend on the model used. For the RS motor used in the prototype the wiring is as shown.

The link should be fitted from pad A to *either* pad B or C. This determines the direction of rotation of the dial. This may have to be altered to suit the stepper motor used.

The secondary of the mains transformer should be connected to the pads shown and the primary connected to a mains lead via a 1A fuse. The mains earth should be connected to the PCB earth as shown for safety.

The operation of the stepper motor and its correct direction of rotation can now be checked.

The gearbox specified simply bolts onto the stepper motor after a small sprocket (supplied) is glued onto the motor spindle. The whole motor assembly is then bolted to the underside of the top of the case using countersunk bolts with the final drive spindle protruding through a hole.

The dial itself should be drawn onto a piece of stiff card or the design given here (Fig. 3) photocopied and stuck onto a suitable base. This should then be

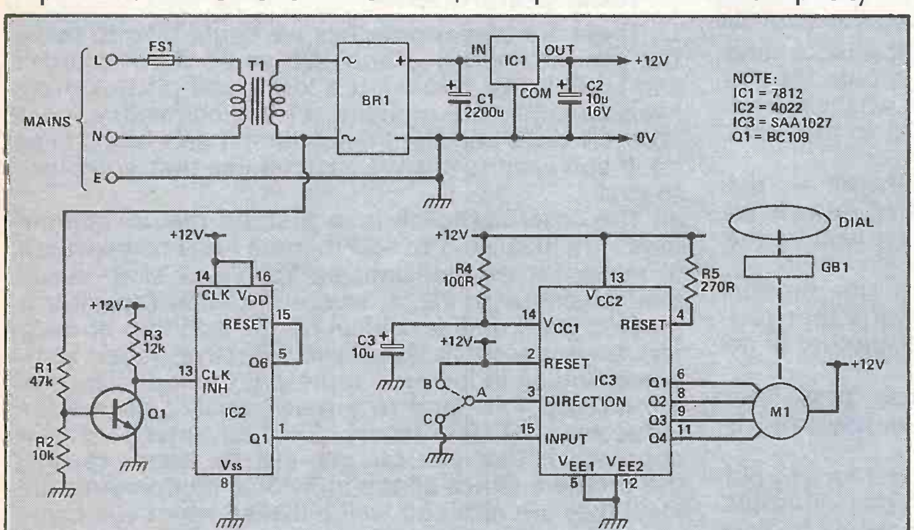


Fig. 1 The circuit diagram of the 24hr Sundial.

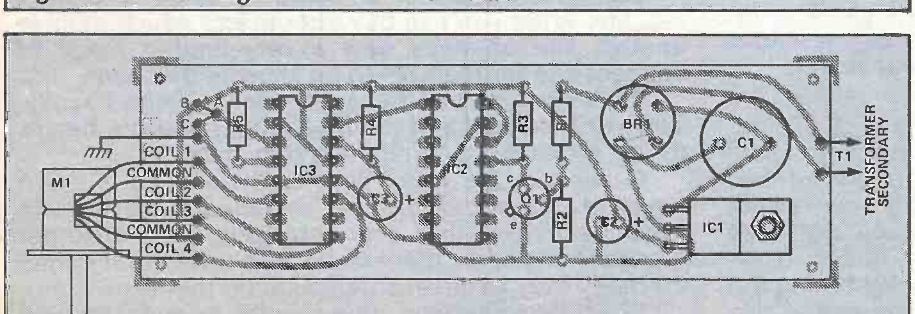
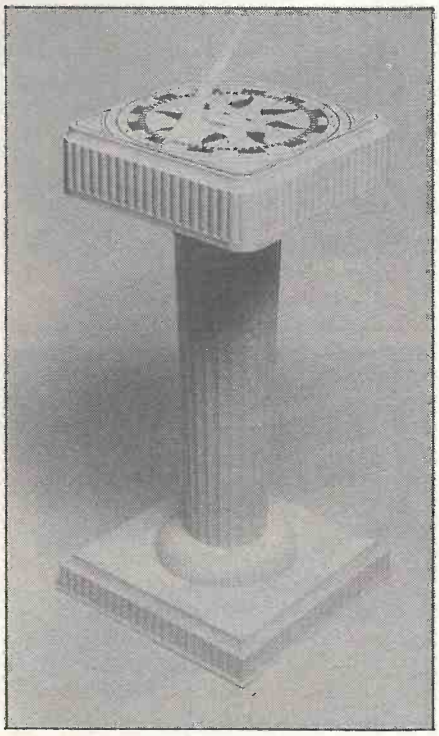


Fig. 2 The component layout for the 24hr Sundial PCB.



stuck onto the gearbox spindle. A small plastic gear was used on the prototype to form a mounting for the dial.

The shadow caster can be anything from a simple rod stuck on top of the spindle to the more elegant swept triangular shape fixed to a (stationary) piece of clear plastic mounted above the dial as shown in Fig. 4.

For the correct baroque effect it is essential the sundial is mounted on a suitable pillar. These are available moulded in genuine 16th century plastic from your local garden centre.

The clear elegance and practicality of this project is perhaps best summed up by the comments of one member of the ETI staff (who shall remain nameless to protect his employment and his kneecaps).

He suggested the gearbox should be fitted back to front, the dial replaced by rotors so the whole circuit then doubles as a helicopter!

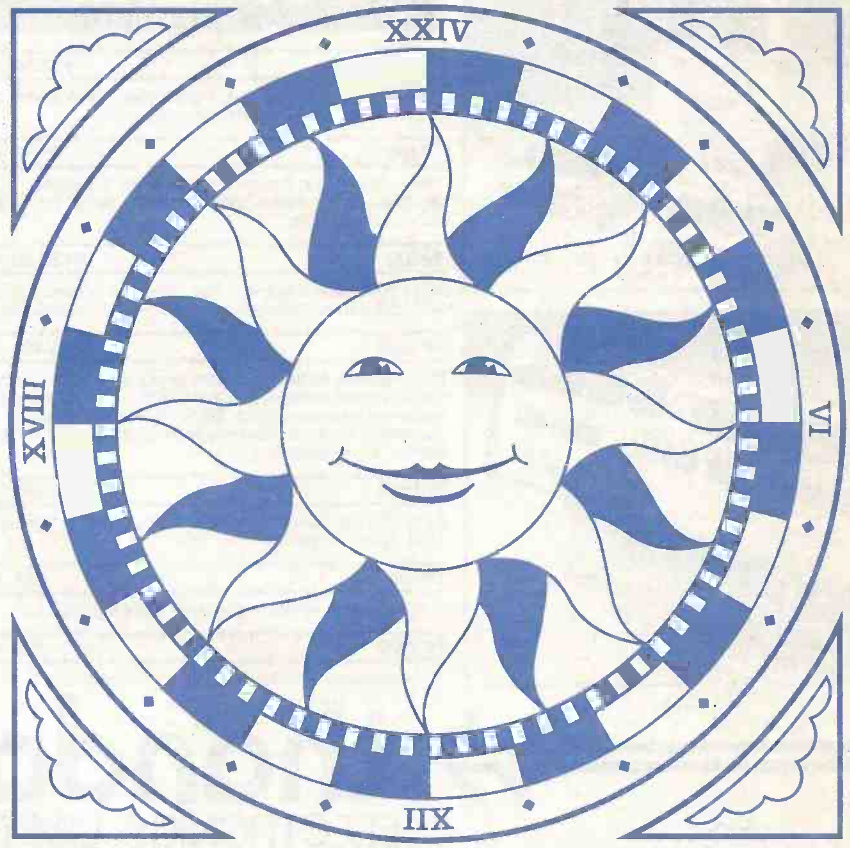


Fig. 3 A suitable dial for the 24hr Sundial.

HOW IT WORKS

The circuit is simple enough, based as it is on the SAA1027 stepper motor driver chip (IC3).

A 50Hz signal is obtained from the transformer secondary and inverted by Q1 to give 50 pulses per second.

IC2 is an octal counter with the sixth output connected to the reset to give a divide by six action and 500 pulses per minute at the number one output (pin 1).

This is used to clock the motor driver chip (IC3) and provide a rotation of 625 revs an hour. The gearbox has a gear ratio of 15,000:1 and reduces this to one revolution per 24 hours.

BUYLINES

All the parts of the ETI 24hr Sundial are easily available with the exception of the stepper motor and gearbox. These are available from Electromail (Tel: (0536) 204555) as type numbers 332-947 and 336-400 respectively.

PARTS LIST

RESISTORS all ¼w except where indicated	
R1	**47k**
R2	**10k**
R3	**12k**
R4	**100R**
R5	**270R ½w**
CAPACITORS	
C1	**220μ 25V radial electrolytic**
C2, 3	**10μ 25V radial electrolytic**
SEMICONDUCTORS	
IC1	**7812**
IC2	**4022**
IC3	**SAA1027**
Q1	**BC109**
BR1	**W005**
MISCELLANEOUS	
T1	**12V 1A transformer**
M1	**7.5° stepper motor**
GB1	**15,000:1 gearbox**

PCB; fuse and fuseholder; case; pillar; dial; card; acrylic plastic; nuts and bolts.

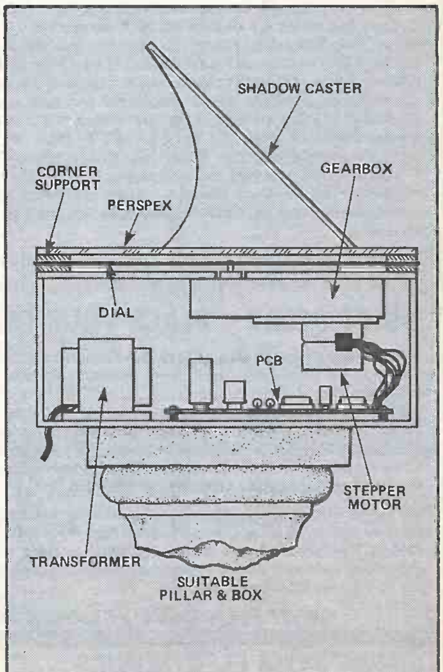


Fig. 4 Construction of the Sundial.

ETI

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Dual 400K drive, as above	£180.00

CASED/UNCASED FLOPPY DISC DRIVES

5.25" FLOPPY DISC DRIVES

	Price (Ex VAT)	P and P
500K 48 TPI D/S 40T	£90.00	£2.00
IMB 96 TPI D/S 80T	£90.00	£2.00
• 500K 40 T 48 TPI Cased with PSU & Leads	£110.00	£3.00
• 1MB 80 T 96 TPI Cased with PSU & Leads	£110.00	£3.00

3.50" FLOPPY DISC DRIVES

250K SS/DD 40T	£35.00	£1.50
1MB 135 TPI D/S Slimline	£75.00	£1.50
• 1MB 80 T 135 TPI Cased with PSU & Leads	£90.00	£3.00
• Twin 1MB 80 T 135 TPI Cased with PSU & Leads	£165.00	£5.00

DISC DRIVE ACCESSORIES

DISKETTES

5.25" Double Sided/Double Density	£0.90	
3.50" Double Sided/Double Density	£2.50	
3" CF2	£3.99	
3" CF2DD	£5.00	
Regulated PSU (state 5.25" or 3.50")	£8.50	£1.50
5.25" Drive Case Takes 1 5.25" H/Height Drive	£9.00	£2.00
3.50" Drive Case Takes 2 3.50" Drives	£15.00	£2.00
Drive Interface Cable – Single	£5.00	£0.50
Drive Interface Cable – Double	£7.00	£0.50
5.25" Drive Case and PSU assembled – Takes 1 H/H Drive	£20.00	£3.00
3.50" Drive Case and PSU assembled – Takes 2 Drives	£20.00	£3.00

• Available in 110 & 220V Versions

MONO/COLOUR MONITORS

PHILIPS

	Price (Ex VAT)
High-res Green screen monitor. Model No:BM7502	£72.50
High-res Amber screen monitor. Model No:BM7522	£77.50
IBM compatible (Green) with Leads. Model No:BM7513	£95.00
Dark glass, White screen monitor. Model No:BM7542	£77.50

MITSUBISHI - Colour

Med. Res. BBC Compatible Model 1404	£232.00
Med. Res. IBM Compatible Model 1404E	£264.00
Med. Res. IBM Compatible + Colour Card Model 1404EC	£391.00

HANTAREX

Boxer – 12" High-Res Green screen monitor	£80.00
CT 9000 14" colour RGB, RGBI –	£179.95
4 × 12 mono green	£63.95

MODEMS

Nightingale plus Comstar software	£120.00
Answer call mini modem MD101, V21	£73.00
Miracle Technology WS2000 V21,V23	£95.00
Miracle Technology WS3000 V21,V23 AA AD	£275.00
Miracle Technology WS3000 V22,V21,V22 AA AD	£471.00
Miracle Technology WS3000 V22BIS,V22,V21,V23 AA AD	£595.00

NB: Please add £3.00 P and P per Single Drive, and £5.00 P and P per Dual Drive
Please add £7.00 delivery on Monitors, £3.00 on Modems

SPECIAL OFFER

MEMOTECH TWIN 500K DISC CP/M COMPUTER

Includes NewWord Word Processor, Supercalc, BASIC, and Utilities **£399.00** inc VAT & P+P

D type CONNECTORS

PLUGS way	9	15	25	37
SOLDER	0.42	0.57	0.81	1.15
PCB	0.44	0.60	0.85	
PCB R/A	0.85	1.27	2.01	
SOCKETS				
SOLDER	0.63	0.86	1.14	1.94
PCB	0.71	1.07	1.60	
PCB R/A	1.20	1.88	2.94	
COVERS	0.58	0.61	0.68	0.78
IDC PLUG	3.05	3.77	4.94	
SOCKET	3.25	3.90	5.27	

RIBBON CABLE

per metre	Grey	Colour
10 way	0.40	0.70
16 way	0.65	1.10
20 way	0.80	1.30
26 way	1.00	1.70
34 way	1.35	2.30
40 way	1.65	2.60
50 way	1.95	3.30
64 way	2.80	4.20

CENTRONICS CONNECTORS

36 w IDC Plug 4.55 Skt 4.55
36 way Plug Solder 2.01

IDC CONNECTORS

	SKT	PCB Plug	R/A Plug	EDGE Plug
10 way	0.61	0.72	0.72	
16 way	0.75	1.00	1.00	
20 way	0.88	1.24	1.24	
26 way	0.98	1.34	1.34	
34 way	1.40	1.69	1.69	2.27
40 way	1.62	1.88	1.88	
50 way	2.08	2.93	2.93	

PRINTER LEADS

Memotech	8.50	QL	6.85
Amstrad	8.80	Dragon	7.95
		BBC	7.40

MODULATORS

UM1286	2.00
UM1233	3.00

HEADER PLUGS DIL IDC

14 PIN	0.72	28 PIN	1.43
16 PIN	0.78	40 PIN	1.63
24 PIN	1.04		

DIL SWITCHES

4 way	0.64	8 way	0.85
6 way	0.80	10 way	1.25

74LS & 74

		74LS175	0.40	74LS367	0.35	74F14	0.75
		74LS181	1.80	74LS368	0.35	74F74	0.40
74LS374	0.50	74LS182	2.00	74LS37	0.18	74F85	1.95
74LS00	0.17	74LS183	1.50	74LS373	0.50	74F125	1.05
74LS02	0.18	74LS190	0.55	74LS378	0.75	74F138	1.05
74LS03	0.18	74LS191	0.50	74LS38	0.18	74F161	2.95
74LS04	0.17	74LS192	0.50	74LS390	0.50	More available	
74LS08	0.18	74LS193	0.50	74LS393	0.50		
74LS09	0.18	74LS194A	0.60	74LS395A	0.90		
74LS10	0.18	74LS196	0.60	74LS40	0.18		
74LS107	0.30	74LS197	0.60	74LS42	0.30		
74LS109	0.30	74LS20	0.18	74LS47	0.50		
74LS11	0.18	74LS21	0.18	74LS48	0.60		
74LS112	0.30	74LS22	0.18	74LS49	0.85		
74LS113	0.30	74LS240	0.60	74LS51	0.20		
74LS114	0.30	74LS241	0.55	74LS54	0.20		
74LS122	0.35	74LS242	0.55	74LS541	0.90		
74LS123	0.40	74LS245	0.70	74LS55	0.20		
74LS125	0.30	74LS244	0.50	74LS640	1.20		
74LS126	0.30	74LS245	0.50	74LS641	1.20		
74LS12	0.18	74LS247	0.55	74LS642	1.20		
74LS132	0.35	74LS248	0.90	74LS643	1.20		
74LS133	0.35	74LS249	0.90	74LS644	1.20		
74LS136	0.28	74LS251	0.40	74LS645	1.20		
74LS137	0.70	74LS253	0.60	74LS668	0.80		
74LS138	0.30	74LS256	0.80	74LS669	0.80		
74LS139	0.30	74LS257	0.40	74LS670	1.00		
74LS13	0.30	74LS258	0.50	74LS673	5.00		
74LS14	0.30	74LS259	0.65	74LS674	5.00		
74LS145	0.80	74LS26	0.18	74LS682	2.10		
74LS147	1.10	74LS260	0.65	74LS684	2.75		
74LS148	1.00	74LS266	0.30	74LS685	2.75		
74LS15	0.18	74LS27	0.18	74LS686	5.00		
74LS151	0.30	74LS273	0.50	74LS687	2.75		
74LS153	0.50	74LS279	0.50	74LS689	2.75		
74LS155	0.40	74LS280	1.50	74LS73	0.30		
74LS156	0.40	74LS283	0.50	74LS74AN	0.22		
74LS157	0.30	74LS290	0.70	74LS75	0.27		
74LS158	0.30	74LS293	0.70	74LS76	0.27		
74LS160	0.50	74LS295	1.00	74LS78	0.27		
74LS161	0.50	74LS298	0.95	74LS83	0.40		
74LS162	0.55	74LS299	2.00	74LS85	0.45		
74LS163	0.50	74LS30	0.18	74LS86	0.20		
74LS164	0.50	74LS32	0.18	74LS90	0.22		
74LS165	0.75	74LS322	3.00	74LS92	0.30		
74LS166	0.75	74LS323	2.50	74LS93	0.27		
74LS168	1.10	74LS33	0.25	74LS95B	0.45		
74LS169	0.80	74LS352	1.00	74LS96	0.65		
74LS170	0.90	74LS353	0.80	74F00	0.38		
74LS173	0.40	74LS365	0.35	74F02	0.38		
74LS174	0.35	74LS366	0.35	74F10	0.38		

7430	0.20	7446	0.90	7486	0.40
74367	0.65	7448	0.90	7490A	0.50
7438	0.35	7450	0.22	7491	0.60
7440	0.22	7470	0.38	7492	0.50
7441	0.60	7474	0.35	7493	0.48
7442	0.60	7475	0.45	7494	0.85
7443	0.80	7476 + 7485	0.90	7496	0.65

TTL74

7400	0.20
7401	0.20
7402	0.22
7404	0.25
7406	0.35
7407	0.35
7408	0.22
7409	0.22
7410	0.22
74100	1.90
74114	0.20
7412	0.22
74121	0.40
74123	0.60
7413	0.30
7414	0.45
74141	0.60
74147	1.25
74153	0.45
74155	0.70
74157	0.70
74159	1.50
74160	0.60
74161	0.80
74163	0.80
74165	0.85
7417	0.30
74170	1.50
74173	0.95
74174	0.90
74180	0.80
74181	1.20
74182	0.80
74184	1.55
74188	2.10
74190	1.00
74191	1.00
74193	1.00
7420	0.22
7422	0.28
74251	0.85
74284	2.25

TRANSISTORS

AC128	0.25	BF200	0.35	MPSA55	0.20
AC142	0.33	BF244	0.30	MPSU05	0.80
AC176	0.22	BF256B	0.45	TIP29A	0.35
AC187/8	0.23	BF257/8	0.32	TIP29C	0.38
AD149	0.75	BF259	0.30	TIP2955	0.65
AD161	0.40	BF324	0.25	TIP30	0.30
AD162	0.40	BF336	0.30	TIP30C	0.35
AF124-127	0.50	BF337	0.35	TIP3055	0.65
AF139	0.38	BF421-423	0.22	TIP31A	0.35
AF239	0.50	BF469-472	0.40	TIP31C	0.40
BC107B-110	0.11	BF870-872	0.30	TIP32A	0.45
BC114	0.15	BFR41	0.22	TIP32C	0.40
BC140	0.27	BFR51	0.20	TIP33C	0.65
BC147-159B	0.12	BFR90	0.60	TIP34A	0.75
BC170	0.06	BFR91	0.75	TIP34C	0.90
BC182-239C	0.09	BFR94	5.88	TIP36	1.25
BC256A	0.20	BFX29	0.28	TIP41A	0.45
BC307B-338	0.12	BFX84	0.33	TIP41B	0.50
BC441/461	0.33	BFX85	0.31	TIP42A	0.50
BC477	0.20	BFX87/88	0.33	TIP42B	0.50
BC516/7	0.30	BFY17	0.30	TIP42C	0.40
BC547B-559	0.11	BFY41	0.30	TIS90	0.20
BD124P	1.00	BFY50	0.30	TIS91	0.30
BD131	0.50	BFY51	0.30	2N2219A	0.27
BD132	0.50	BFY52	0.30	2N2221A	0.27
BD133	0.48	BFY90	0.76	2N2368	0.24
BD135	0.40	BSX20/21	0.25	2N2369A	0.23
BD136-140	0.30	BSX26	0.30	2N2483	0.45
BD245B	0.55	BSX29	0.32	2N2648	0.65
BD517	0.70	BU104	1.70	2N2904A	0.25
BF115	0.40	BU105	1.50	2N2906/7	0.20
BF154	0.20	BSY95	0.30	2N2926	0.18
BF167	0.33	BUY69	2.10	2N3053	0.30
BF177	0.30	MJE2955	0.78	2N3054	0.70
BF178	0.35	MJE3055	0.70	2N3055	0.48
BF181	0.25	MJE340	0.48	2N3819	0.40
BF184	0.30	MJE370	0.90	2N3904	0.15
BF185	0.30	MJE520	0.45	2N3905/3906	0.12
BF196	0.12	MJ2955	0.65	3N128	1.60
BF197	0.18	MJSA05	0.20		
BF198/9	0.15	MPSA12	0.25		

LINEAR ICs

710	0.40
748	0.30
AY-3-1014A	2.75
AY-3-1015D	2.75
AY-3-8470	2.00
AY-3-8475	3.00
AY-3-9710	3.15
AY-3-9725	4.00
CA3011	1.10
CA3018	0.75
CA3028A	1.00
CA3046	0.60
CA3052	1.90
CA3054	1.00
CA3065	2.00
CA3080A	2.00
CA3080E	0.55
CA3085	1.30
CA3088	0.50
CA3088E	2.00
CA3089Q	2.00
CA3090AQ	2.30
CA3100S	2.00
CA3130E	0.75
CA3140T	0.70
CA3161E	1.50
CA3162E	5.00
CA3189E	1.70
CA3183E	1.50
CA3240E	0.90
CA3260E	2.50
CA3290E	1.10
HA1366W	1.70
LA3300	1.90
LA4032P	2.45
LA4400	3.00
LA4420	2.25
LA4422	2.80
LA4461	3.50
LC7120	3.00
LC7130	3.00
LC7131	3.00
LM1889N	2.50
M51513L	2.00
M51515L	3.00
MB3712	1.80
MC1315P	2.90
MC1330P	1.90
MC1349P	1.50
MC1460G	2.90
MC1463R	4.80
MC1469R	3.00
MFC6040	0.70
ML237B	2.50
ML238B	4.50
NE535T	1.10
NE5501N	0.90
NE5534N	1.00
SAB3209	3.75
SN76008N	2.25
SN76110N	1.20
SN76115AN	1.60
SN76131N	1.70
SN76396N	1.65
SN76600P	1.40
SN76660N	0.80
SN76707N	2.10
SN76708N	3.00
TA7204P	1.30
TA7205AP	0.85
TA7208P	1.30
TA7222P	1.30
TA7310P	1.15
CA3020	1.50
HA1388	2.50
LM1357P	1.95
LM301AN	0.30
LM310N	2.40
LM311	0.40
LM319	1.50
LM324N	0.35
LM339N	0.35
LM348N	0.55
LM358N	0.45
LM380N-14	0.80
LM381	1.70
LM3900	0.70
LM558	1.50
LM710CN	0.90
LM711CN	0.90
LM741	0.50
LM747CN	0.80
MB3756	3.50
NE555	0.20
NE556	0.55
NE566	1.30
TBA120S	0.60
TBA920	1.75
TDA1011	2.00
TDA1022	4.00
TDA2006	2.75
TDA2190	2.40
TDA2591	2.75
TDA2670	1.50
TL071CP	0.40
TL072CP	0.60
TL074CN	1.00
TL081CP	0.30
TL082CP	0.50
TL084CN	0.90
TBA990Q	2.75
TC9100	7.50
TC9109P	7.50
TCA270SB	3.00
TCA650	3.50
TCA660B	3.50
TCA740	2.50
TCA900	1.90
TCA910	1.90
TDA1003A	1.90
TDA1035T	2.50
TDA2002	2.75
TDA2010	3.00
TDA2030	1.80
TDA2522	2.50
UPC1025H	3.25
UPC1156H	2.50
UPC1182H3	3.25
UPC1366C	1.75
ZN425E8	3.50
ZN426E8	3.50
ZN427E	6.00
ZN428E8	4.50
ZN447E	8.75
ZN449E	2.90
ZN435E	5.00

COMPUTER ICs

AM8228PC	5.50
D8755AD	15.00
HD6802P	2.60
MC8T26P	1.15
MC8T97P	1.15
MC8T98P	1.15
M5L8035LP	3.00
M5L8085AP	2.70
M5L8155P	3.00
M5L8156P	3.20
M5L8212P	1.45
M5L8216P	1.45
M5L8251AP-5	2.95
M5L8253P-5	2.70
M5L8255AP-5	2.55
M5L8279P-5	3.50
UP88284AD	4.00
UPD8156C-2	3.50
UPD8243C	2.30
UPD8748HD	16.00
6821P	1.40
6850P	1.15
808G	17.00
8088	9.50
8228	3.00
8748D	13.00
7201	6.90
Z80ACTC	1.50
Z80ACPU	1.50
TMS9929	5.00
TMS9928	5.00
76489AN	2.50
MC6845SP	5.00
Z80ADART	6.50
Z80ADMA	7.00
Z80APIO	2.40
Z80ASIO-0/1/2	7.00
VL4500A	13.00
8272	9.00
8272A	11.00
6551A	4.50
6800	2.50
6809P	8.00
68809P	12.00
68000P8	20.00
1793	12.00
1691	12.00
9216	12.00
1770	15.00
1772	15.00
8271	33.00
2793	20.00
2797	20.00
ULN2003	0.70
ULN2004	0.70
MC1488	0.58
MC1489	0.58
SN75108	0.90
SN75189	0.70
SN75450	0.70
SN75480	0.99
SN76013	2.70
SN76023	2.80
SN76110	0.90
SN76228	0.90
SN76530	0.70
SN76660	0.70
SN76666	1.00
SN76666N	1.00
ULN2001	0.70
ULN2002	0.70
ULN2002AN	1.10
6522A 3.50 6502A	4.25

MEMORIES

2016AP12	2.95
2114-2	2.25
2716-350N/S	2.50
2732-450N/S	2.50
2732A-200	2.75
2764-200	2.50
2764-25	2.00
27C64-25	6.00
27128-200	3.00
27128-250	2.25
27256-25	4.50
4116-3	0.50
27512-25	15.00
4164P-15	1.50
41256-15	3.00
4864P-2 150N/S	1.50
50258-12	3.50
6116LP3 150N/S	1.50
6116P4 200N/S	1.50
HM6264LP12	3.40
HM6264LP15	3.00
TC5501P	4.00
TC5514AP3	2.95
TC5516APL2	2.90
TC5517BP	2.95
TC5565PL15	3.55
UPD41464C-15	8.00

DIODES

AA119	0.08
AA129	0.20
1N4001	0.04
1N4002	0.04
1N4003	0.05
1N4004	0.05
1N4005	0.06
1N4006	0.06
1N4007	0.06
1N4148	0.03
1N5401	0.09
1N5402	0.09
1N5404	0.12
1N5406	0.12
1N5408	0.14
1S44	0.08
1S920	0.07
1S921	0.08
6A800	0.40

74HC & 74HCT

HC00	0.28
HC02	0.28
HC03	0.28
HC04	0.28
HC08	0.28
HC107	0.35
HC109	0.40
HC10	0.28
HC112	0.40
HC113	0.40
HC11	0.28
HC125	0.40
HC126	0.40
HC132	0.70
HC133	0.28
HC137	0.70
HC138	0.70
HC139	0.70
HC14	0.70
HC15	0.70
HC153	0.50
HC158	0.50
HC160	0.80
HC161	0.80
HC162	0.80
HC165	0.85
HC173	0.80
HC174	0.80
HC175	0.80
HC194	0.80
HC195	0.80
HC240	1.00
HC241	1.00
HC242	1.00
HC244	1.00
HC245	1.00
HC257	0.80
HC266	0.70
HC273	1.00
HC32	0.35
HC390	1.00
HC393	1.00
HC42	0.50
HC51	0.28
HC534	1.00
HC540	2.00
HC541	2.00
HC74	0.50
HC75	0.50
HC85	1.00
HCT240	1.75
HCT241	1.75
HCT244	1.50
HCT245	2.20
HCT640	2.40

CRYSTALS

32.768 KHz	0.95
100.0 KHz	4.00
1 MHz	2.65
1.8432 MHz	1.75
2.0 MHz	1.20
2.4576 MHz	1.75
2.5 MHz	1.80
3.0 MHz	1.80
3.2768 MHz	3.00
3.579545 MHz	1.25
3.6864 MHz	1.70
4.00 MHz	1.20
4.194304 MHz	1.50
4.433619 MHz	0.75
4.9152 MHz	1.20
6.00 MHz	1.20
6.144 MHz	1.30
6.4 MHz	1.30
6.5538 MHz	1.50
7.159 MHz	1.30
7.3728 MHz	1.50
8.0 MHz	1.30
10.0 MHz	1.30
12.00 MHz	1.30
15.00 MHz	1.80
16.0 MHz	1.30
18.432 MHz	1.30
20.0 MHz	1.30
32.00 MHz	1.30
36.00 MHz	1.30
48.00 MHz	1.30

VOLTAGE REGS

7805	0.35
7808	0.35
7808CK	0.56
7812	0.35
7815	0.35
7815CK	0.56
7818	0.35
7824	0.35
78L05	0.20
78L08	0.20
78L12	0.20
78L15	0.30
78L24	0.30
7905	0.40
7908	0.40
7912	0.40
7915	0.40
7918	0.40
7924	0.40
79L05	0.33
79L08	0.40
79L12	0.33
79L15	0.40
79L24	0.80

CMOS

4000	0.18
4001	0.18
4002	0.18
4006	0.50
4007	0.18
4008	0.50
4009	0.25
40103	3.00
40104	0.75
40106	1.50
40107	0.40
40108	2.35
40109	0.87
4010	0.25
40110	1.85
40114	2.10
4011	0.18
4012	0.18
4013	0.25
40147	0.85
4014	0.40
4015	0.40
40160	1.25
40161	1.25
40162B	0.50
40163B	0.50
4016B	0.25
40174B	0.50
40175B	0.50
4017B	0.40
40181B	1.80
4018B	0.40
40192B	0.50
40193B	0.80
40194B	0.80
4019B	0.35
40106B	0.35
40208B	2.10
4020B	0.50
4021B	0.50
4022B	0.50
4023B	0.18
4024B	0.30
40257B	1.50
4025B	0.18
4026B	0.80
4027B	0.25
4028B	0.32
4029B	0.50
4030B	0.18
4031B	1.00
4033B	1.00
4034B	1.10
4035B	0.50
4038B	0.60
4040B	0.45
4043B	0.40
4044B	0.45
4045B	1.00
4046B	0.50
4047B	0.50
4048B	0.30
4049B	0.25
4050B	0.25
4051B	0.50
4052B	0.45
4053B	0.45
4054B	0.60
4055B	0.60
4056B	0.60
4060B	0.50
4063B	0.70
4066B	0.25
4067B	2.00
4068B	0.18
4069B	0.18
4071B	0.18
4072B	0.18
4073B	0.18
4075B	0.18
4076B	0.50
4077B	0.18
4078B	0.18
4081B	0.18
4082B	0.18
4086B	0.45
4089B	0.95
4093B	0.25
4094B	0.60
4095B	0.75
4096B	0.75
4097B	2.25
4099B	0.75
4502B	0.50
4503B	0.33
4508B	0.90
4510B	0.40
4511B	0.40
4512B	1.00
4514B	1.00
4515B	1.00
4516B	0.40
4517B	2.25
4518B	0.40
4520B	1.10
4522B	0.45
4526B	0.50
4527B	0.50
4532B	0.50
4536B	2.00
4538B	0.60
4543B	0.55
4555B	0.30
4556B	0.45
4584B	0.40
4585B	0.40
4724B	1.00

DIL SOCKETS

TP Turned Pin LP Low Profile

	LP	TP
8 PIN I.C. SOCKET	0.05	0.20
14 PIN I.C. SOCKET	0.07	0.35
16 PIN I.C. SOCKET	0.08	0.38
18 PIN I.C. SOCKET	0.09	0.43
20 PIN I.C. SOCKET	0.10	0.48
24 PIN I.C. SOCKET	0.13	0.52
28 PIN I.C. SOCKET	0.14	0.55
40 PIN I.C. SOCKET	0.18	0.85
24 PIN ZIF	4.16	
28 PIN ZIF	4.87	
40 PIN ZIF	7.02	

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Gunshot MSX	£6.50	NEW Kraft IBM Compatible	£21.95

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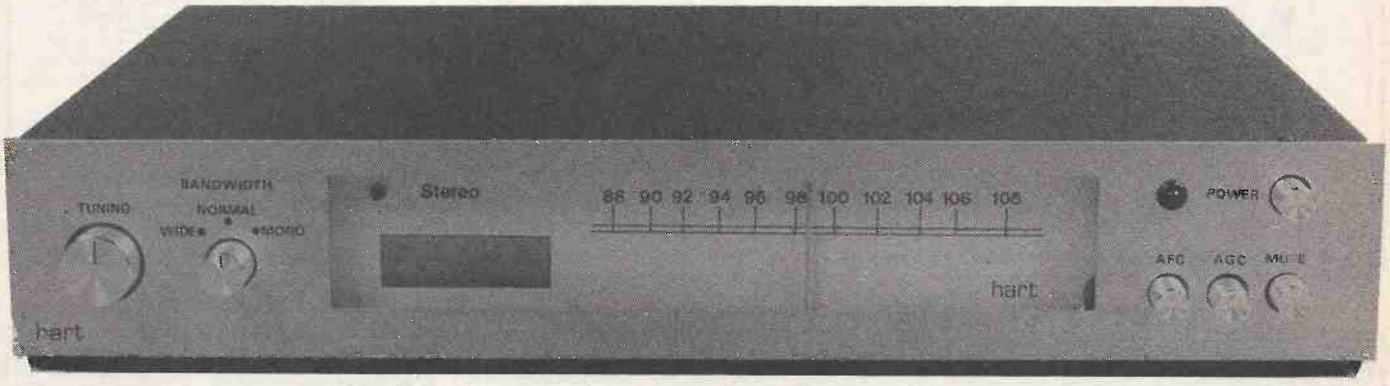
PLL FM TUNER

John Linsley Hood describes the construction of the main boards and the setting-up procedure for the complete tuner.



The complete stereo tuner is assembled on five PCBs. The construction of the stereo decoder board has already been described (ETI February 1987) and the overlays for the remaining four boards are given in Figs. 1-4. Each of these boards carries one section of the circuitry described last month with the exception of the largest board which carries both the VCO and the CA3189.

Construction of the boards should present no problems provided the overlay diagrams are followed carefully. If you plan to use sockets for IC3 and IC4 it is a good idea to solder these into place first. The remaining components can then be installed in the usual sequence, beginning with the resistors and capacitors and moving on to the diodes, transistors and ICs. A ready-wound coil can be used for L1 (see parts list) but more adventurous constructors may prefer to wind their own. The coil used on the prototype consisted of 21 turns of 36 SWG silk-covered enamelled wire on a 4mm slug-tuned ferrite former.

OOPS!

A few errors have crept into the component numbering on this project. Two C28s are shown, one in the stereo decoder circuit (Fig. 6, page 48, ETI February 1987) and one in the IF amplifier circuit (Fig. 8, page 37, ETI March 1987). To avoid confusion, the C28 in the IF amplifier circuit has been re-numbered as C61. The original (and correct) C28 is also missing from the parts list on page 49 of the February issue. It should be 100n ceramic type.

A similar problem has affected the potentiometers. There are two RV2s, one in the stereo decoder circuit and one in the CA3189 circuit (Fig. 9, page 37, ETI March 1987), and two RV3s, one in the stero decoder circuit and one in the VCO circuit (Fig. 5, page 36, ETI March 1987). RV2 in the CA3189 circuit has now been re-numbered as RV7 while RV3 in the VCO circuit is now RV8. The original RV2 and RV3 are not listed in the parts list in the February issue. They are both 10k presets like RV1, as shown correctly on the accompanying circuit diagram.

These three component number changes have been incorporated in the parts lists and overlay diagrams published this month.

In Fig. 5 on page 36 of the March issue, ZD3 is shown as a 3V5 zener diode. It should, of course, be a 3V6 type, as stated correctly in this month's parts list. C49 in the same figure should be a 220p polystyrene type, as given in this month's parts list.

Three capacitors were omitted entirely from the circuit diagrams last month. C65 is a decoupling capacitor in the muting circuit (Fig. 11) and connects between +15V and 0V. C66 is a decoupling capacitor in the 3189/PLL circuit (Figs. 5 and 9) and connects between +12V and 0V. C67 connects directly across the mains transformer primary. All three are included in the parts lists given this month.

The method of assembling the tuner will probably vary according to whether you are using the Hart Electronics kit or not. The complete kit includes a large motherboard onto which the five PCBs are soldered along with the tuner head and some smaller sections of the circuitry. This removes the need for complicated interwiring of boards and greatly simplifies construction. The mother board will be available separately from Hart along with the necessary instructions so even if you aren't buying the complete kit you can still use this method of assembly.

A Hart-Less Approach

The alternative is to mount the five boards into a case using mounting pillars. The boards, the tuner head and the various front panel controls can then be wired up using the information given in the overlay diagrams and the off-board components (indicated by asterisks in the parts lists) can be wired-up on Veroboard or tagstrip. The wiring of these components can be deduced from the circuit diagrams given last month. The connections to the tuner head are shown in Fig. 7 and a suggested layout based on the prototype is shown in Fig. 5.

Particular care should be taken with the installation of the VCO. This has an output of around 500mV peak-to-peak at 10.7MHz while the IF amplifier operates at the same frequency and has an

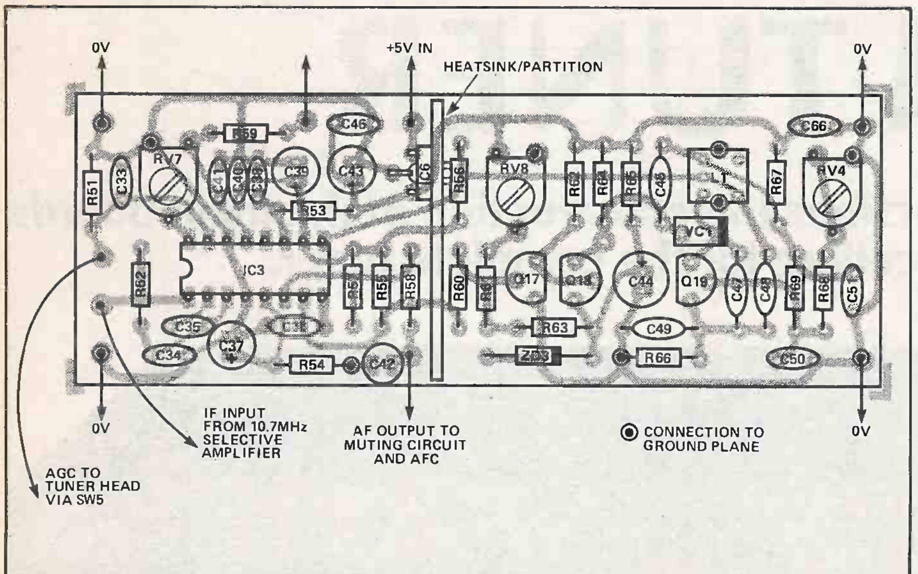


Fig. 1 Component overlay for the 3189 PLL board.

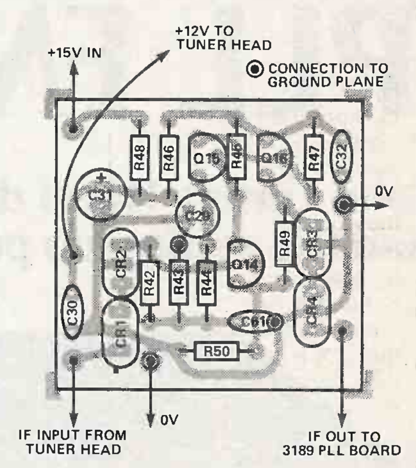


Fig. 2 Component overlay for the 10.7MHz IF amplifier board.

PARTS LIST —3189 PLL BOARD

RESISTORS	
R51	10k
R52	330R
R53	47R
R54	47k
R55, 57	3k9
R56, 58, 67	1k0
R59	470R
R60	18k
R61	39k
R62	22k
R63	390R
R64, 65	2k2
R66	33k
R68	15k
R69	150k
RV4, 7	47k horizontal preset
RV8	22k horizontal preset
CAPACITORS	
C33, 34, 35	10n ceramic disc
C36, 38, 40, 41	100n multi-layer ceramic
C37	2μ2 16V radial electrolytic
C39, 43	47μ 16V radial electrolytic
C42	1n0 ceramic disc
C44	100μ 16V radial electrolytic
C45	150p polystyrene
C46, 50, 51, 66	470n multi-layer ceramic
C47	68p polystyrene
C48	100p polystyrene
C49	220p polystyrene
SEMICONDUCTORS	
IC3	CA3189
IC6	7812
Q17	BC212
Q18, 19	BC182
ZD3	3V6 400mW zener diode
VC1	BB105B varicap diode
MISCELLANEOUS	
L1	2.7μH slug-tuned ferrite inductor (see text)
PCB; 16-pin DIL socket for IC3; metal cover or box for screening; piece of metal for IC6 heatsink; nut and bolt to mount IC6.	

PARTS LIST — SELECTIVE IF AMPLIFIER

RESISTORS	
R42, 47	1k2
R43	330R
R44	560R
R45	3k3
R46, 48	100R
R49	1k0
R50	3R3 non-inductive (eg., composition type, not film)
CAPACITORS	
C29	1n0 ceramic disc
C30, 32	100n multi-layer ceramic
C31	47μ 16V radial electrolytic
C61	470n multi-layer ceramic
SEMICONDUCTORS	
Q14, 15, 16	BC414
MISCELLANEOUS	
CR1-4	10.7MHz ceramic filters, Murata SFE10.7ML or equivalent
PCB.	

input sensitivity of just 1uV. If appropriate precautions are not taken, the strong signal from the oscillator will almost certainly find its way into the amplifier input and upset the operation of the tuner. The solution is to screen the VCO entirely and to make sure its output wiring is kept well away from the IF amplifier input wiring. Sticking closely to the suggested layout will help. The Hart motherboard is arranged so that a metal box can be placed over the VCO for screening. Those not using the motherboard could place the entire VCO/3189 board inside a screened box which should then be connected directly to the 0V line.

The construction of the stereo decoder board was described in the February issue and the overlay diagram includes all the off-board connection details. Note that the stereo/mono switch (SW1) and the stereo width switch (SW2) have been combined in the Hart kit to form a single rotary control labelled Bandwidth. Constructors who are not using the kit may like to adopt this approach.

There are also some small changes to the circuit which could usefully be made before the board is assembled into the tuner. As pointed out in the text, the decoder was intended for use with other stereo tuners as well as in the circuit described here. Since the completion of the prototype, it has become clear that some small changes to the filter characteristics would enable it to better match the performance of this tuner. The changes are shown in Fig. 6 and involve the addition of one capacitor in each channel, a change in one resistor value and the removal of one stage of output filtering. Constructors who have

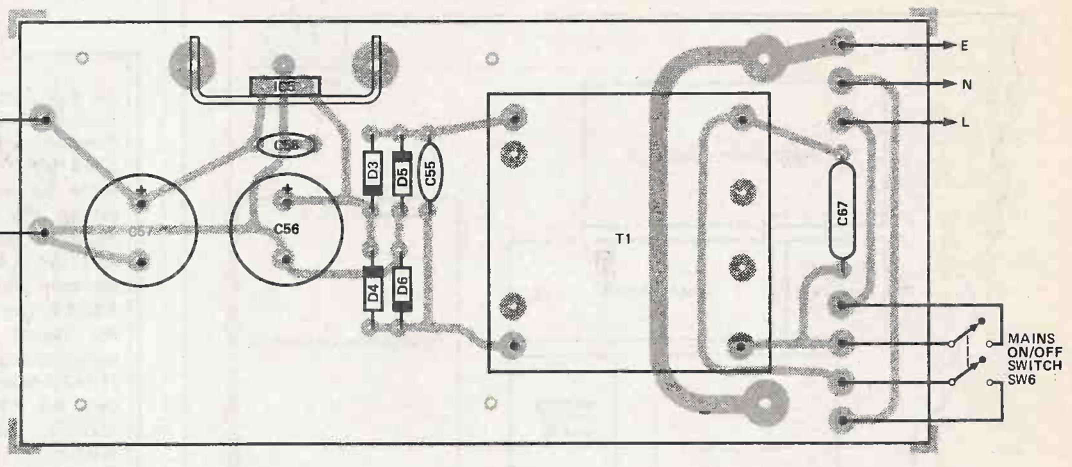


Fig. 3 Component overlay for the power supply board. Note that the AFC and AGC voltage networks are not mounted on the PCB and that IC6 is on the 3189/PLL board.

PARTS LIST —POWER SUPPLY & CASE

RESISTORS	
R81*	470R
R82*, 83*	33k
R84*, 85*	10k
RV6*	22k horizontal skeleton preset
CAPACITORS	
C55	220n polyester
C56	1000µ 25V radial electrolytic
C57, 59*	470µ 25V radial electrolytic
C58, 60*	100n ceramic disc
C62*	2µ2 16V radial electrolytic
C67	100n 250V AC
SEMICONDUCTORS	
IC5	7815
D3-6	1N4002 or IN4003
ZD4*	12V 400mW zener diode
MISCELLANEOUS	
SW4*, 5*	DPST switch: toggle, push-button, etc, as appropriate
SW6*	SPST (or SPDT) mains switch: toggle, push-button, etc, as approriate
T1	15V or 16V 12VA mains transformer, PCB mounting

PCB; case; tuning scale and dial-drive assembly: FF317U tuner head; mains fuse and holder; socket for aerial input; sockets for audio output (or cable and strain-relief bush if preferred); socket for mains input (or cable and strain-releif bush if preferred); knob for tuning dial; PCB pillars, nuts, bolts, etc.

* = Components not mounted on PCB.

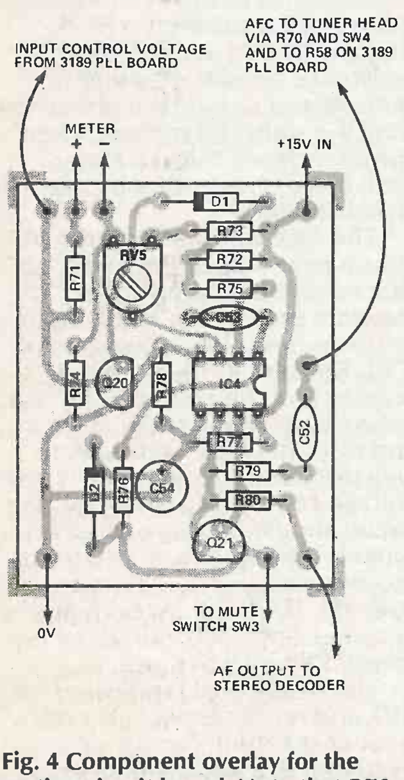


Fig. 4 Component overlay for the muting circuit board. Note that R70 (see last month's circuit diagram) is not mounted on the PCB.

PARTS LIST — MUTING CIRCUIT

RESISTORS	
R70*, 76, 79, 80	100k
R71	27k
R72, 75, 77, 78	15k
R73	33k
R74	2k7
RV5	10k horizontal preset
CAPACITORS	
C52	220n polyester
C53	33n polyester
C54	47µ 25V radial electrolytic
C65*	100n multi-layer ceramic
SEMICONDUCTORS	
IC4	TL072/LF353
Q20	BC212
Q21	2N5457
D1, 2	1N4148
MISCELLANEOUS	
M1*	100µA panel meter
SW3*	SPST switch: toggle, push-button, etc, as appropriate

PCB; 8-pin DIL socket for IC4 if required.

* = Components not mounted on PCB.

made their own PCBs using the pattern given should have no difficulty fitting in the extra capacitors, while those who have yet to etch their boards will find it easy enough to add another set of pads in the space available. Stereo decoder PCBs supplied by Hart will include the extra set of pads and holes.

Setting Up

Good test instrumentation will make this task easier but it is possible to do a good job with quite basic equipment. The only essential item is a DC voltmeter and even this could be made up by soldering a 100k resistor in series with the 100uA tuning meter!

Set all the preset potentiometers and the slug in coil L1 to the middle of their travels. Put the mute, AGC and AFC switches in the off position and, with no aerial connected, switch on the tuner.

Before proceeding further with the setting-up, the AFC voltage needs to be set to a temporary middle value. Measuring the voltage on the wiper of RV6 and

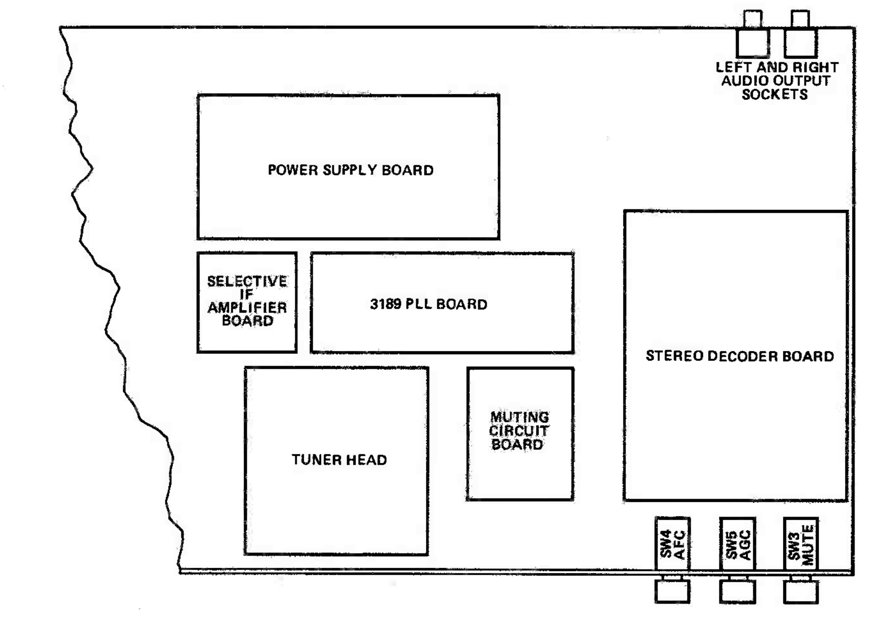


Fig. 5 Suggested layout for the tuner boards.

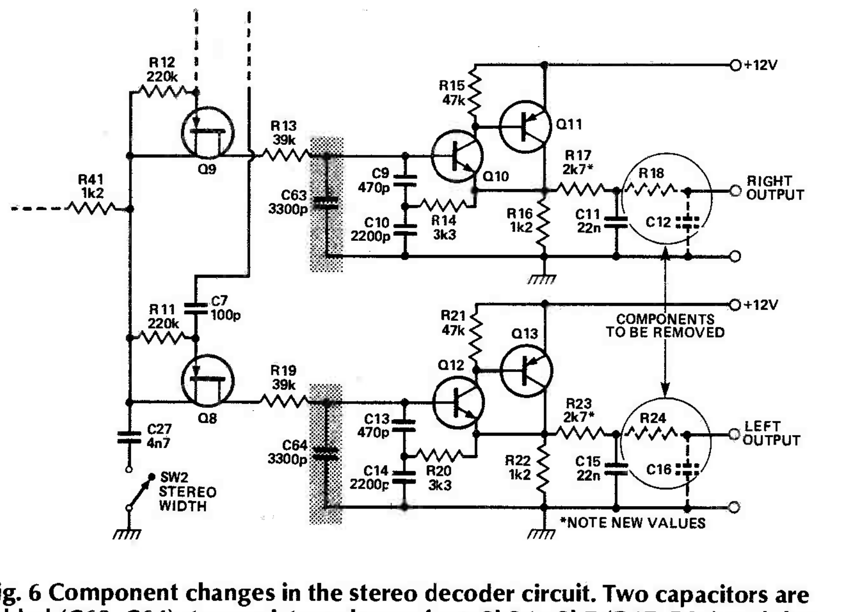


Fig. 6 Component changes in the stereo decoder circuit. Two capacitors are added (C63, C64), two resistors change from 2k2 to 2k7 (R17, R23) and the second stage filtering components (R18/C12, R24/C16) are removed entirely.

BUYLINES

All the parts for this project will be available from Hart Electronic Kits Ltd, Penylan Mill, Oswestry, Shropshire SY10 9AF, Tel (0691) 652 894. The complete kit includes case, tuner head, tuning dial and everything else you need to build the tuner and costs £111.69. A kit containing just the components and the PCB is available for £82.82, the components and PCB for the stereo decoder section can be supplied separately for £15.21, and the FF317V tuner can be purchased on its own for £10.81. The PCBs for each section can also be purchased separately. All prices include postage and packing and VAT. Those who prefer to find the parts individually should not encounter too much problems. The resistors, capacitors and semiconductors are all widely available and the only 'difficult' items are L1, CR1-4 and CV1, all of which can be obtained from Cirkit, Park Lane, Broxbourne, Hertfordshire, EN10 7NQ. Tel: (0992) 444 111. Please note the PCBs will not be available through the PCB Service.

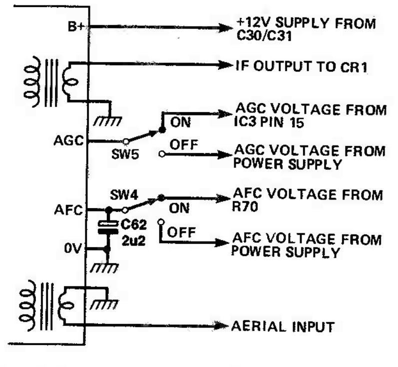


Fig. 7 Connections to the FF317U tuner head.

adjust it to +6V. A more precise adjustment will be made later. Measure the voltage at test point A on the VCO (the junction of Q18 collector, VC1 anode, C45 and R62) and adjust RV8 to give a reading of +9.5V relative to ground. Connect the aerial to the input and turn the tuning dial until a strong signal is indicated on the tuning meter. Using an amplifier to monitor the (mono) signal at the output of the muting circuit (pin 7, IC4), adjust the slug in L1 until a signal is heard. Continue turning the slug so as to determine the limits beyond which the loop drops out of lock then leave it set to a position midway between these two extremes.

The next stage in the setting up is to adjust the HF output level from the VCO using RV4. Although the setting is not critical, the linearity and transient performance of the PLL will suffer if the 3189 is driven too hard. Begin with RV4 at maximum resistance (equals maximum output) and reduce the resistance until the signal disappears. Then slowly increase the value again until there is no further increase in signal strength.

The AGC and AFC circuits are set-up next. Adjust the tuning so that no signal is received and measure the voltage at the input to the muting circuit (junction of C52, R58 and R70). Note the reading and then transfer the test meter leads to the slider of RV6 and reset this potentiometer to give the same voltage. Ideally, the voltage at the input to the muting circuit should be same when the tuner is off-station and when it is receiving a signal at maximum strength. If it is not, tweak the slug in coil L1 until it is or until the best compromise is obtained.

The AGC signal is adjusted by RV7 and is not particularly critical. A suitable setting can be obtained by tuning to a signal which reads full scale on the tuning meter and then adjusting RV7 to give a reading of about 80% of FSD when

AGC is switched in.

The final adjustment is to set the mute threshold using RV5, and the position chosen will be largely a matter of individual taste. A high setting will ensure complete silence when tuning between strong signals but will cause some weaker signals to be missed entirely. A low setting will allow weak signals to be picked up but may also allow some noise to get through on the skirts of the capture range. A good compromise is to set the threshold so that the signal disappears at a level just above the onset of noise as the loop loses lock.

Instructions for setting-up the stereo decoder board were given at the end of the article in the February issue so there is no need to go through them here. The setting-up procedure is unaffected by the circuit changes mentioned earlier.

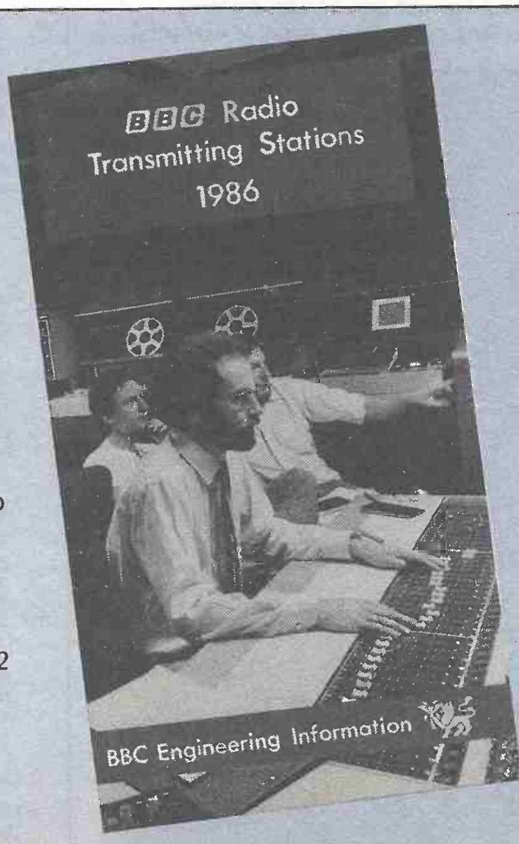
● *Details of BBC radio transmitter locations and frequencies are contained in a booklet called* BBC Radio Transmitting Stations 1986. *The booklet is free and can be obtained by post from:*

Noel Hooper, BBC, Broadcasting House, 21 Whiteladies Road, Clifton, Bristol BS8 2LR.

Mike Hounsell, BBC, South Western House, Canute Road, Southampton SO9 1PF

Garth Jeffrey, BBC Studio Centre, St. Catherine's close, All Saints Green, Norwich NR1 3ND

John Nestor, BBC, Broadcasting Centre, Woodhouse Lane, Leeds LS2 9PX



In Use

This circuit was developed from an earlier design which has been used by the author for some years. The original was generally considered by those who heard it to be superior in tonal quality and stereo image to any commercial unit which had been tried. In particular, the quality was such that differences between the signals offered by various BBC transmitters could easily be detected. For example, there were obvious differences in quality between the same programme signals coming from Rowbridge on the Isle of Wight, which has a direct radio link from the Post Office tower, and from North Hessary Tor which re-broadcasts the off-air signal from the Wenvoe transmitter.

The updated design retains all the tonal quality of its predecessor and the differences in signal quality between various transmitters are even more apparent. This, plus the improved signal-to-noise ratio made possible by the 3189, makes it a design which should satisfy the most demanding listener.

ETI

THE ETIFAKER

Mike Bedford follows his explanation of computer interface standards last month with a useful RS232 patch box to build.

The RS232 interface is a very 'un-standard standard' because it is widely employed outside its intended area of application. The consequences of this in the interfacing of two apparently standard pieces of equipment can be decidedly tricky to the uninitiated.

This article describes the construction of a piece of equipment to simplify the whole process of RS232 interfacing. Although the hardware is very simple, the unit should save many hours of soldering and trying out the numerous lead configurations.

It will be recalled that RS232 specifies a serial interface for the connection of data terminal equipment (DTE) to data communications equipment (DCE). Figure 1(a) shows such a link employing just the transmitted and received data lines and return, the control lines being omitted for clarity.

If we attempt to connect together two DTEs (or two DCEs), on the other hand (a situation which is contrary to the RS232 specification but frequently required) the situation in Fig. 1(b) or Fig. 1(c) applies.

Obviously these configurations just won't work. In such a situation the solution is to provide a cable with a crossover such as that shown in Fig. 1(d) so that each transmitter feeds into a receiver.

It is not the intention of this article to go into great detail about RS232 control lines but exactly the same sort of situation can arise when the interface includes control lines. Once again we can get pairs of transmitters and pairs of receivers connected together in a DTE/DTE or DCE/DCE configuration. Further crossovers in the cabling are required between certain pairs of control signals such as DTR/DSR and CTS-RTS/DCD.

Another situation which can arise is when two pieces of equipment (which could be any combination of DTEs and DCEs) are to be connected and where one supports a full range of control signals but the other uses perhaps just a three line configuration. The system with the full complement of control lines will be expecting the other piece of equipment to indicate its status by means of these lines, something which clearly is not possible.

The overall result is the first

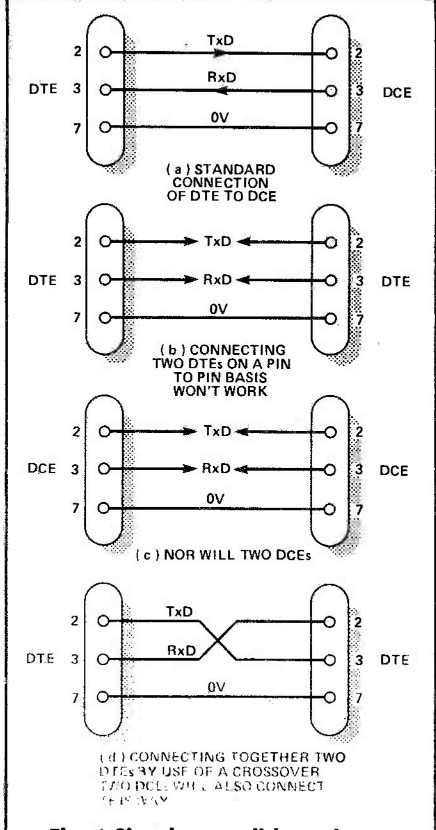
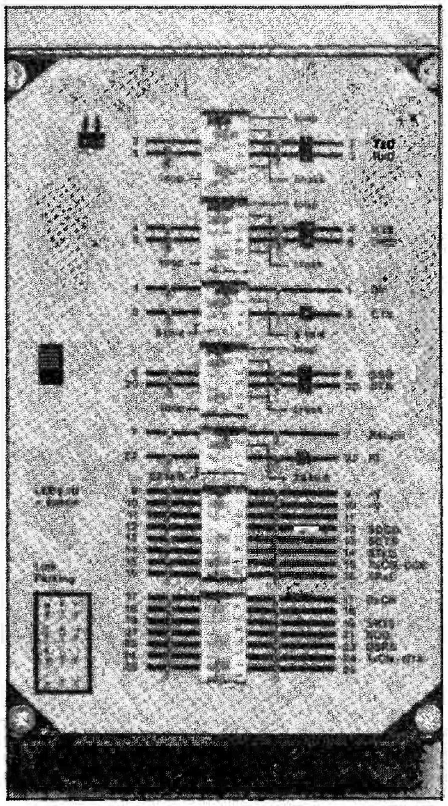


Fig. 1 Simple, possible and impossible RS232 connections.

The completed ETIFaker RS232 patch box. Accurate and comprehensive labelling of the front panel is essential.



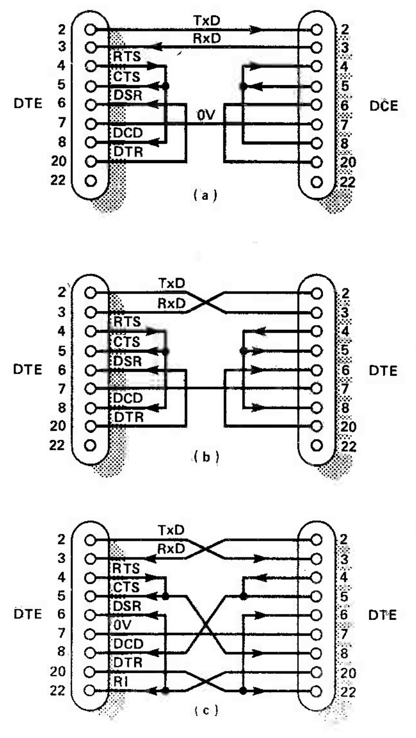


Fig. 2 Commonly encountered cabling arrangements for RS232 connections.

piece of equipment will never accept the other peripheral is present and ready. The answer to this problem is to tie together control lines locally on the one piece of equipment to fool it into thinking that the other equipment is producing control signals.

In such a configuration, of course, no hardware handshaking is possible and flow control methods such as XON/XOFF would be required.

In practice it will be found that certain pairs of signals may or may not require crossing and certain pairs of signals may or may not require linking together. Figure 2 shows a number of the more likely configurations which may be encountered.

Design Considerations

The requirements of simplifying RS232 interfacing are fulfilled in a unit with a D-type connector on each end and a means of allowing any pin on one connector to be connected to any pin on the other connector and inter-linking between pins of the same connector. An additional useful facility is the provision of LEDs to indicate the status of certain signals. Such units are available commercially (usually at very high prices) and are called such names as 'patch boxes' or 'interfakers'. They often use DIL switches to make or break the straight through circuits from one connector to the other and wire links to make crossover or link connections once the appropriate DIL switches are open.

The main disadvantage of these units is although they are flexible,

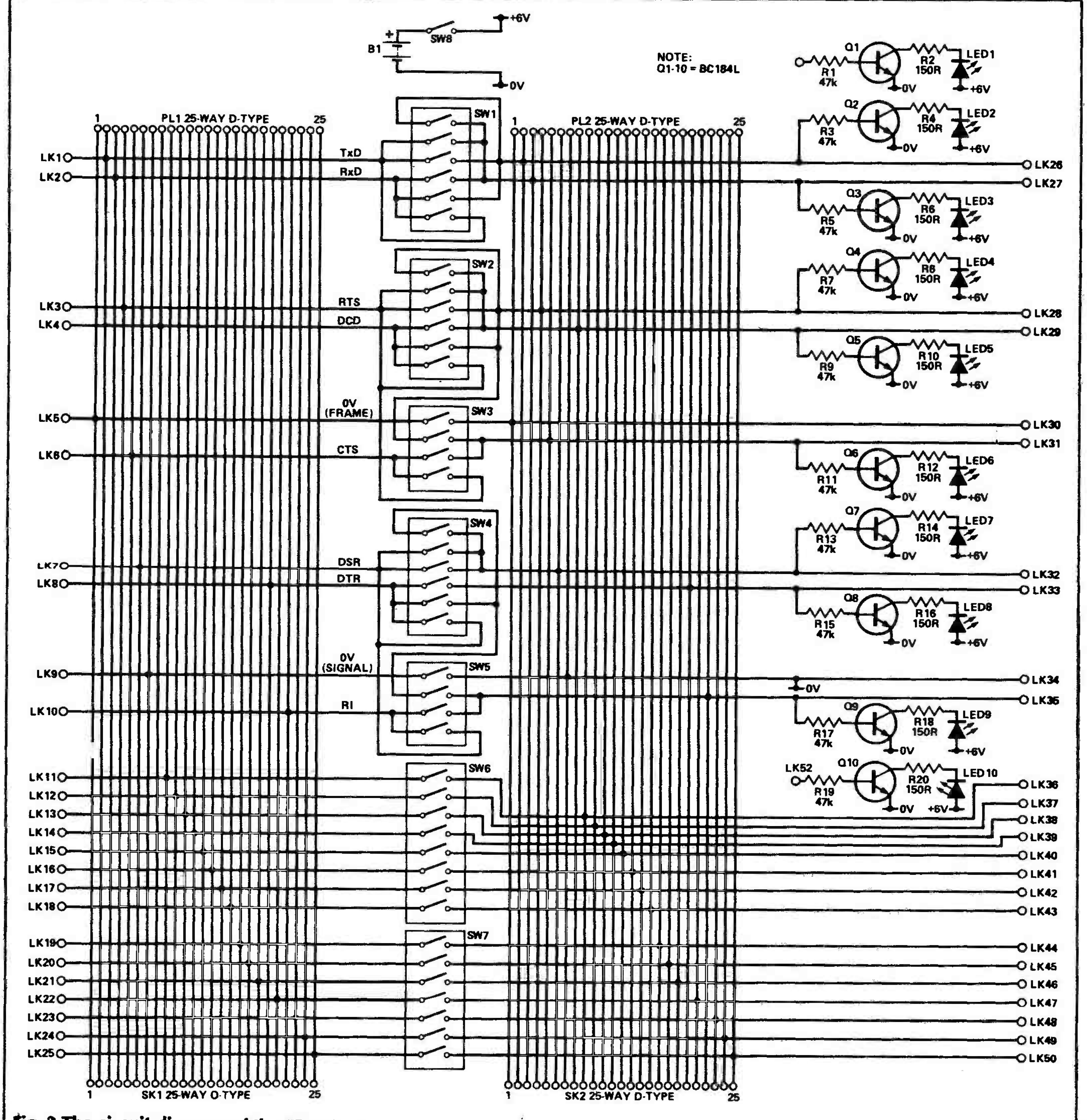


Fig. 3 The circuit diagram of the ETIFaker.

wire links very easily get lost.

A further drawback is that they only have two connectors, usually a male and a female. Actually whatever combination of two connectors is picked, there will be a requirement for two additional convertor cables to cope with all possibilities. Alternatively one of the commercially available connector sex changers or 'gender benders' as they are sometimes called would be required.

The ETIFaker overcomes both these problems. Firstly DIL switches allow all the common configurations to be selected without resorting to wire links and secondly there is both a male and a female connector for both the input and the output. A very large number of switches would be required to allow any of 50 points to be connected to any of the others, so pins to which wire links may be connected have also been provided to allow more obscure configurations to be achieved. LEDs are available on the more common signal lines as well as a couple of general purpose indicators which may be connected to any signal by use of more wire links.

The circuit diagram is shown in Fig. 3. From an electronic point of view it is so simple there is little point saying anything further about it other than the fact that the resistors between certain lines and the bases of the LED driving transistors are of a sufficiently high value to avoid any significant loading on the drivers of these lines.

Construction

Construction of the circuit board is simple. The only opportunity for error is in the polarization of the LEDs. Ensure that the flat on one side of the body (which indicates the cathode) matches the 'k' near the LED on the component overlay diagram (Fig. 4).

The Molex pin strips will probably not be available in the required lengths but these can easily be cut down or butted up end to end to achieve the correct lengths.

The D-type connectors are intended to be fitted onto flying leads rather than directly onto the PCB. In order to keep the PCB to a single sided design without a large number of links,the pads for these connectors are not in the same configuration as on D-type connectors. Accordingly ribbon cable and IDC D-types should not be used. Instead it is recommended that 25-way screened 7/.01 multicore cable be used, using a further length to loop between SK1 and PL1 or SK2 and PL2. Cable ties should be used to provide strain relief for these cables.

The slider on/off switch may not be available in a PCB mounting type, in which case this will have to be bolted to the board having cut a hole to accommodate the depths of its body.

One final point concerns the length of component leads. The transistors should be fitted with very short leads so that their bodies are as close as possible to the PCB. Alternatively they can be bent down flat to the board. otherwise the transistors cause the tops of the DIL switches to sit well below the surface of the lid of the box. The lead length on the LEDs should be sufficient to allow the tip to just protrude through the lid.

Having built up the PCB, the ABS box should be prepared. This involves drilling holes for the LEDs and the link strips, cutting rectangular holes for the DIL switches in the lid and cutting semi-circular notches for cable entry in the top edges of the two longest sides of the box.

It is also strongly recommended that a circuit diagram or a legend such as that shown in Fig. 6 is placed on the lid. As a minimum, this could be a photocopy of Fig. 6 glued onto the lid but better would be a label made from this artwork using a sign making material such as 'Permasign'. Clearly either type of label requires holes cutting in it to match the holes in the lid of the box.

The wire links are simply made from crimp type socket pins for D-type connectors and short lengths of insulated wire.

Two three-socket daisy chained links and three standard links should be sufficient. Sufficient 'parking space' is available to accommodate these.

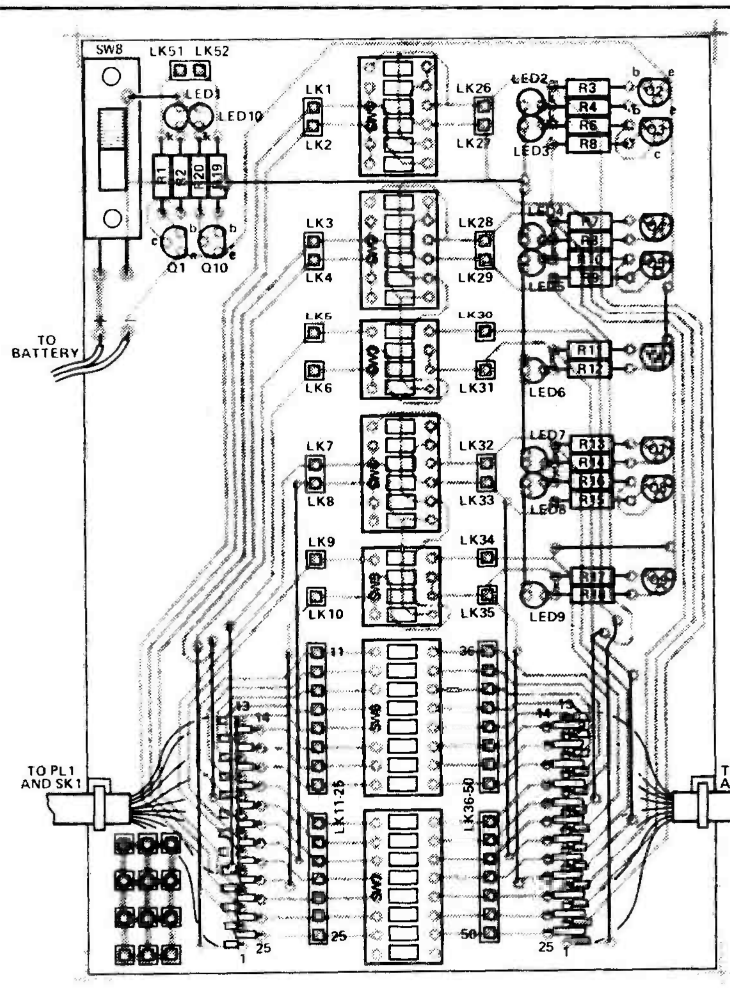


Fig. 4 The component overlay of the ETIFaker.

Using The ETIFaker

The ETIFaker will probably be utilised in two sorts of application.

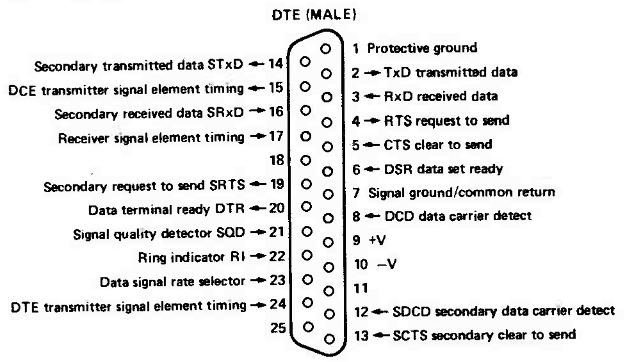
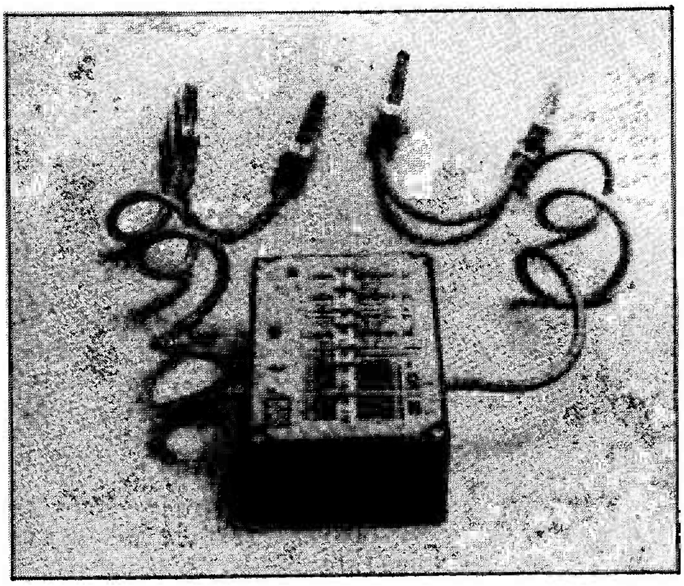


Fig. 5 The full RS232 interface pinout.



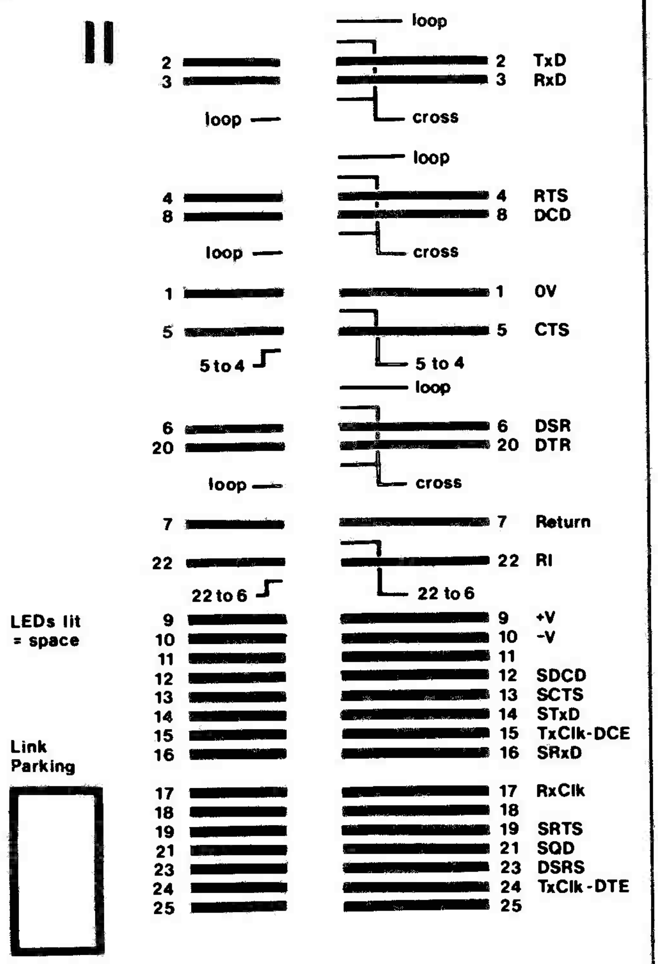


Fig. 6 The ETIFaker front panel legend.

PARTS LIST

RESISTORS (all ¼ watt, 5%)

R1, 3, 4, 7, 9, 11, 13, 15, 17, 19	47k

SEMICONDUCTORS

Q1–10	BC184L
LED1–10	3mm red LED

MISCELLANEOUS

SW1, 2, 4	6xSPST DIL switch
SW3, 5	4xSPST DIL switch
SW6, 7	8xSPST DIL switch
SW8	Miniature on/off
SK1, 2	25 way D-type socket
PL1, 2	25 way D-type line plug
LK1–50	Lengths of Molex PCB headers

PCB; ABS box; 25 way cable; 2x cable ties; Battery clip; Battery holder for 4xAA; 4x AA batteries; Wire for links; D-type socket crimp pins for links.

BUYLINES

All parts for the ETIFaker are easily available from normal suppliers. The crimp pins are available from Electromail (Tel: (0536) 204555) as stock number 469–493.

The first is when there is a requirement to interface a pair of devices for a particular purpose but with little likelihood of wanting to repeat the exercise. The second is to use it to determine the connections required for interfacing two pieces of equipment so that a cable can then be made up for future use.

It is probably obvious just how to make use of the ETIFaker, particularly if a legend has been applied to the unit as suggested but it is worthwhile clarifying a few points.

Firstly a LED is illuminated when the line to which it is connected is in the 'space' state (equivalent to 'on' for control lines). For data lines this will mean they are only illuminated as data is being transferred.

The second point is with regard to the blocks of switches which are grouped in sixes. Although this can be seen from the circuit diagram or legend on the unit, it is useful to remember the following rules.

Each of the three blocks of six switches operate on a pair of signals. The top switch links together these two signals on the right hand connector and the bottom switch connects them together on the left hand connector. The middle two switches switch the two signals straight through and the remaining pair of switches implement a crossover when both are closed.

Although a switch has been provided to take pin 7 to open circuit, to make the unit totally flexible, this corresponds to the common return and will nearly always be closed.

Since the LED indicators are referenced to this signal, unless this switch is in the closed position the status of the LEDs cannot be relied upon when monitoring signals from SK1/PL1.

It should also be mentioned that the pins marked 'link parking' have no electrical connections whatsoever. They are provided solely to park the link wires when not in use hence reducing the likelihood of their getting lost.

Since the ETIFaker has more than just the two D-type connectors, it is also possible to connect a third device in order to monitor data passing between the main two pieces of equipment. **ETI**

BBC MICRO MIDI INTERFACE

John Yau describes a two channel MIDI interface to get the BBC micr singing.

The project presented here is a MIDI interface for the BBC microcomputer. It enables the computer to communicate with MIDI equipped synthesisers, drum machines, effects units and other peripherals. Since the subject of MIDI has already been covered (see ETI January and February 1987), we shall deal directly with the interface itself and present some trial software to experiment with.

A suite of more serious software is available to accompany this project. This is available from the author and ranges from general MIDI utility programs to more sophisticated packages like voice and track dump programs for the Yamaha TX/DX7 synthesiser and Roland TR707 drum machine, and a voice editor for the Yamaha TX/DX7

The BBC micro MIDI interface also serves as a useful diagnostic tool for those who wish to construct the ETI MIDI MASTER KEYBOARD coming next month.

Operation

The interface has four DIN sockets, two for MIDI IN and two for MIDI OUT. The primary reason for the dual channel capablility is to enable one MIDI channel to control a MIDI synthesiser whilst the other is connected to a MIDI drum machine such as the Roland TR707, as shown in Fig.1.

This configuration can be used when the BBC micro operates as a MIDI sequencer, using the drum machine as an external synchronisation source.

Another useful configuration is shown in Fig. 2. Here, a MIDI mother keyboard is connected to an external synthesiser module via the MIDI interface. Using suitable software both the mother keyboard and BBC micro can communicate with the synthesiser module. This is particularly useful for combining performance with voice dump and edit operations.

Construction

The interface is constructed on a compact sized double sided PCB. Figure 4 shows the component overlay. Mount all the resistors and terminals first, soldering the leads to both sides of the PCB where applicable. Next add the capacitors and diodes, leaving just the integrated circuits to be mounted. The important word here is that the IC devices must be mounted directly onto the PCB without IC sockets, since many of the pins require soldering on both sides of the PCB. Sockets can, however, be used to mount the opto isolators ICL7 and IC8. Indeed, this is suggested due to the relatively high cost of the devices.

There are two power supply alternatives. The first is to mount a 5V regulator on the PCB (IC10)

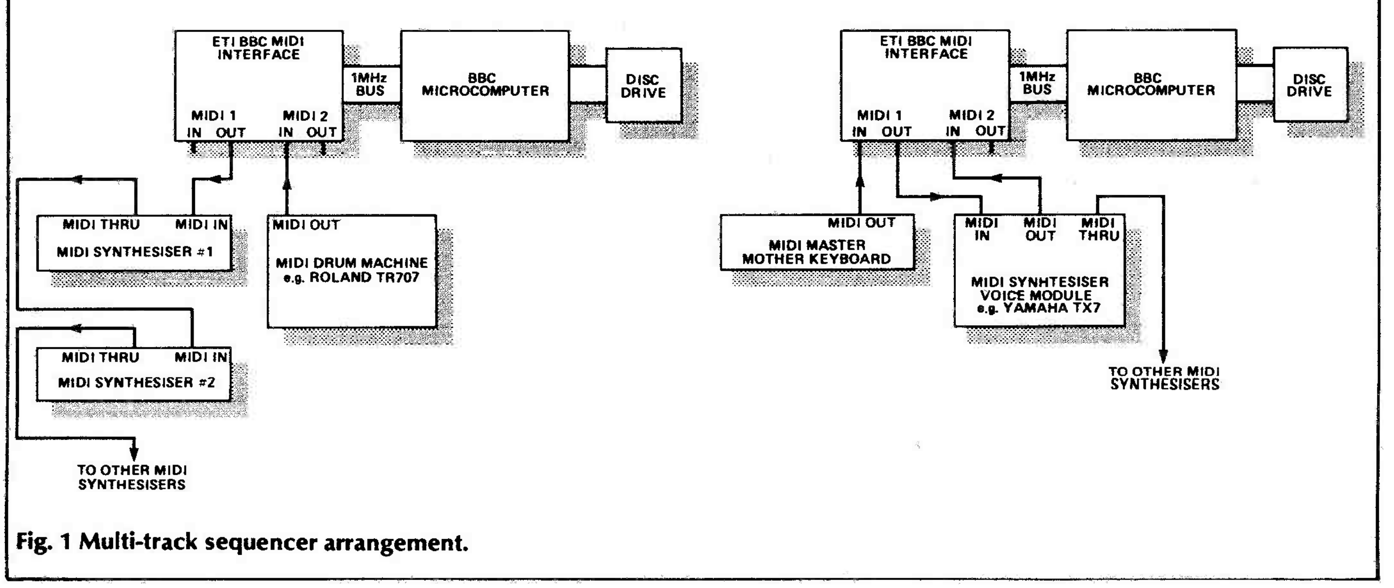
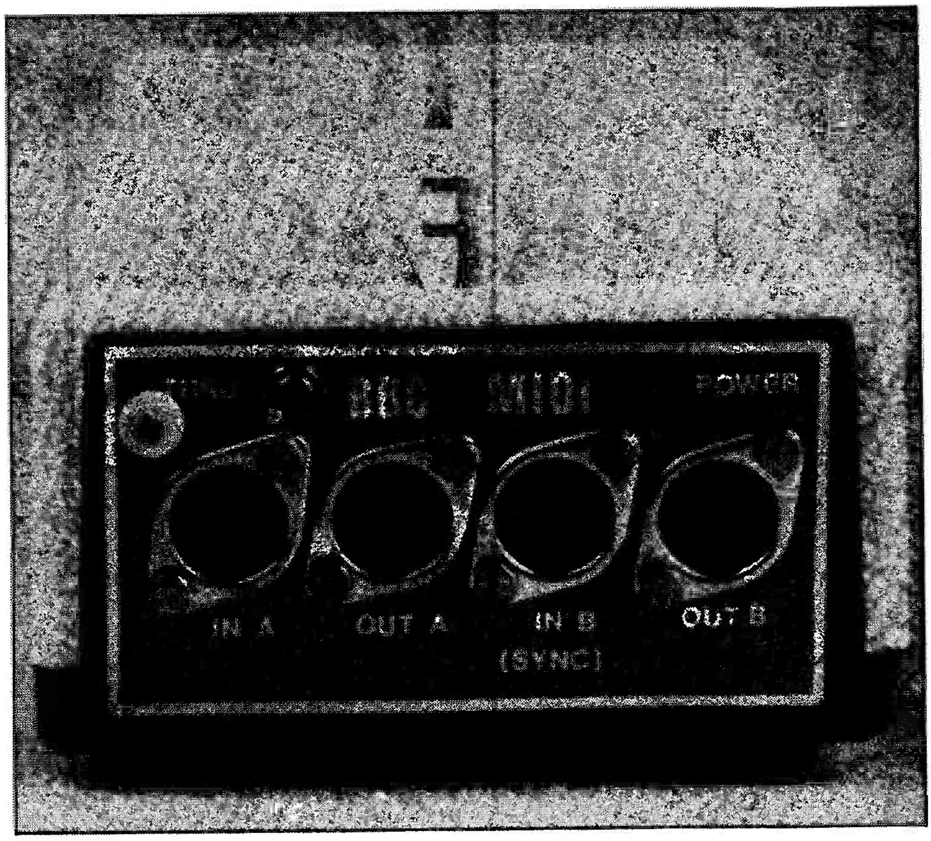
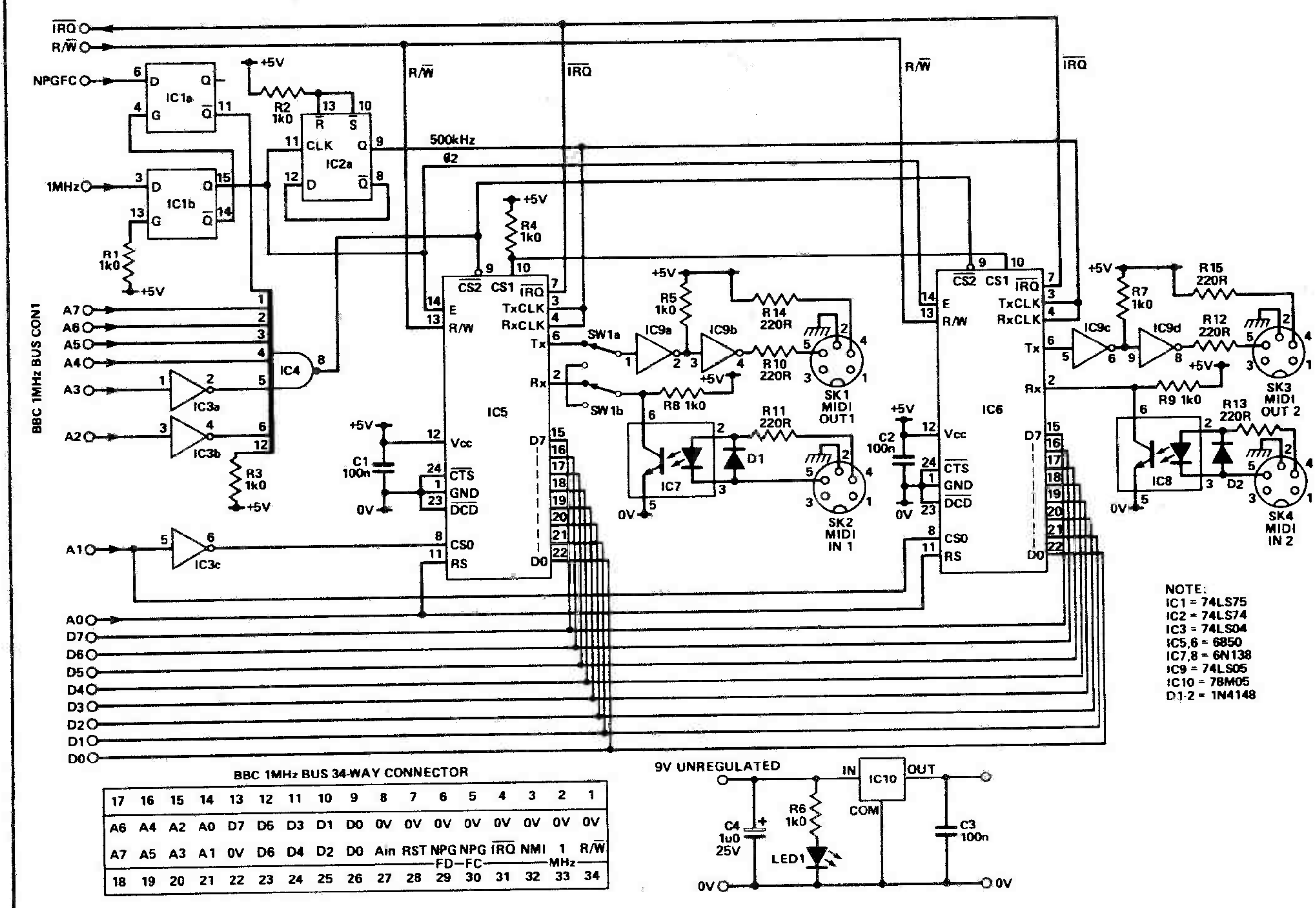


Fig. 1 Multi-track sequencer arrangement.

HOW IT WORKS

Figure 3 shows the complete MIDI interface circuit. The circuitry is centred around IC5 and IC6, which are 6850 ACIAs (Asynchronous Communication Interface Adaptors). The two devices are interfaced to the BBC micro's 1MHz expansion bus using IC1, IC3 and IC4. IC1 is used to 'clean up' the NPGFC bus signal as recommended by Acorn in the applications notes for using the 1MHz bus. IC3 and IC4 provide the address decoding necessary to map the two ACIAs into memory locations &FCF0-1 and &FCF2-3, respectively, in the BBC micro's address space. One of the bistables in IC2 is used to divide the BBC micro's 1MHz system clock down to the 500KHz required for the ACIAs. The remaining circuitry built around IC7, IC8 and IC9 make up the MIDI IN and MIDI OUT terminals. The open collector inverters act as current sinks, forming the MIDI OUT terminals. The MIDI IN terminals reach the ACIAs via opto-isolators in order to minimise the risk of earth loops occuring resulting from interconnection of MIDI equipment.





17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
A6	A4	A2	A0	D7	D5	D3	D1	D0	0V	0V	0V	0V	0V	0V	0V	0V
A7	A5	A3	A1	0V	D6	D4	D2	D0	Ain	RST	NPG FD	NPG FC	IRQ	NMI	1 MHz	R/W
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34

Fig. 3 The circuit diagram of the MIDI interface.

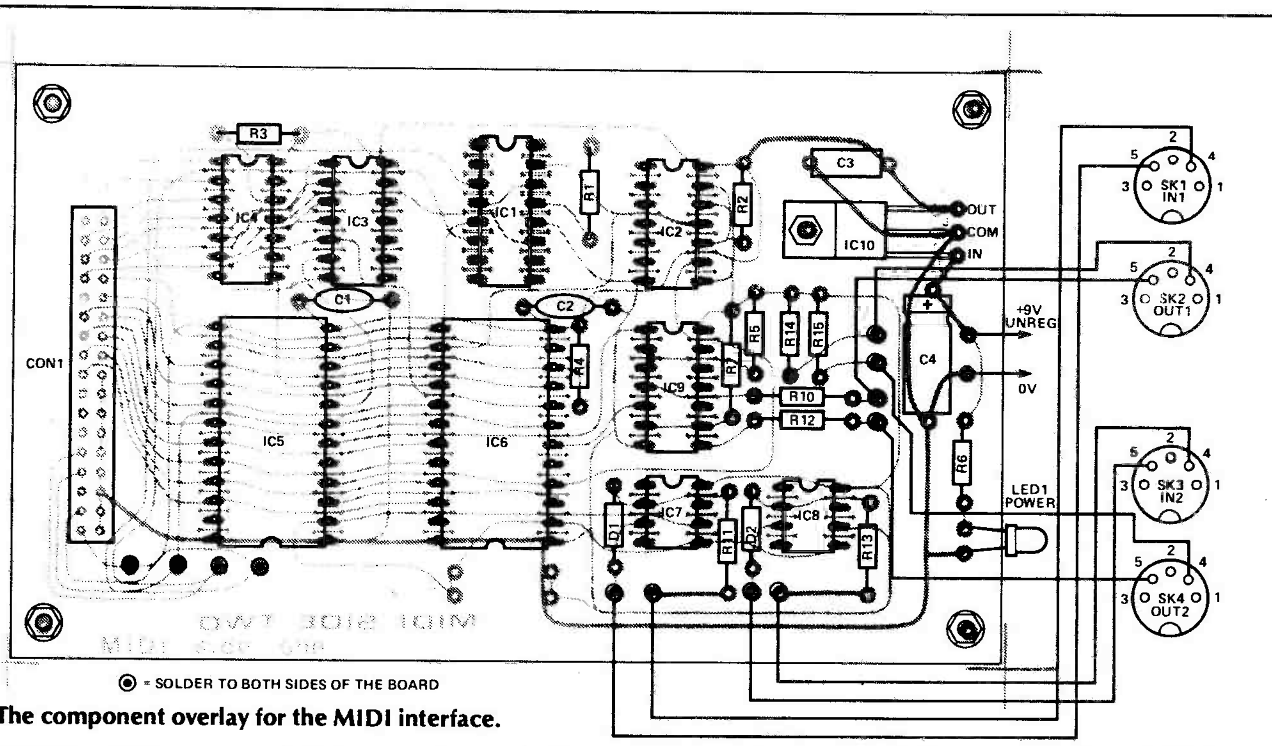


Fig. 4 The component overlay for the MIDI interface.

along with associated components and powering the whole unit from an unregulated DC power source. An ordinary mains battery eliminator giving out 9 volts at 300mA will be sufficient for the purpose. If you already have a regulated 5 volt source then the regulator circuitry components (IC10, C3, 4, RG and LED1) can be simply omitted and bypassed.

Once the PCB has been assembled, check for shorts and unsoldered pads on both sides of the PCB. If everything is satisfactory then proceed with wiring up the 5 pin DIN MIDI sockets as shown in Fig. 3.

The case used to contain the board is not crucial. Any suitable plastic case will serve.

Using The Midi Interface

The program presented in Listing 1 is a simple monitoring program. Connect a MIDI keyboard to the first MIDI IN socket of the interface and run the program. Any data transmitted by the MIDI keyboard will then appear on the screen. Notice that multi byte MIDI events are displayed on the screen if any keys are played, if a program change is made, or if a pitch bend or modulation wheel is moved.

The operation of the program is as follows. The ACIA in the MIDI interface is programmed to interrupt the BBC micro every time it receives a byte of MIDI data through the first MIDI IN terminal. The BBC micro responds to the interrupt by placing the data in a buffer in memory. Whilst all this is happening the Basic program is running checks to see if this buffer is empty. If not, it prints out the contents one by one until it is empty again. Such a FIFO (first in first out) buffer is implemented because a simple Basic program to print out MIDI data as it arrives would not respond fast enough to the relatively high data rate of the MIDI messages.

Listing 2 is a program which allows the BBC's micro QWERTY keyboard to play any MIDI synthesiser that is set to receive on channel 1. The Basic INKEY keyword is used to detect whether a particular key is held down or not. If pressed, the procedure PROCnoteon is called. This transmits the three data bytes of a MIDI note-on event. The program then waits until the key is released, when it transmits a note-off event. This very simple program only permits monophonic playing, ie only one note at a time. However, it serves to demonstrate note-on and note-off events,

BUYLINES

None of the components used for the MIDI interface are difficult to obtain.

A Verobox type 103 was used for the prototype. This is available from Maplin, as are the 6850 ACIAs.

The 6N138 opto isolators are available from Electromail (Tel: (0536) 204555) as catalogue number 302–126.

PARTS LIST

RESISTORS			**regulator**
R1-9	**1k0**	**D1, 2**	**1N4148**
R10–15	**220R**	**LED1**	**Red LED**
CAPACITORS		**MISCELLANEOUS**	
C1, C2, C3	**0.1μF polyester**	**SW1**	**2 pole, 2 way toggle switch (see text)**
C4	**1μ0 25V electrolytic**		
		SK1–4	**5 pin DIN sockets**
SEMICONDUCTORS		**CON1**	**34-way IDC PCB mounting bus connector (male)**
IC1	**74LS75**		
IC2	**74LS74**		
IC3	**74LS04**	**PL1**	**34-way IDC plug**
IC4	**74LS30**	**PCB, heatsink for IC10 (if used), suitable power input socket, plastic case, 34-way IDC plug, 34-way IDC ribbon cable, nuts and bolts.**	
IC5, 6	**6850 ACIA**		
IC9	**74LS05**		
IC10	**78MO5 voltage**		

```
  10 REM BBC micro MIDI interface
  20 REM Receiver Program by J.F.S.Yau
 100 MODE7
 110 PROCassem
 120 FOR I%=0 TO 1:VDU132:VDU157:VDU141:VDU
131:PRINTSPC(6)"MIDI Reciever Program":NEXT
 130 VDU28,1,24,39,3
 140 CALL start%
 150 REPEAT
 160 IF ?outptr%=?inptr% GOTO 210
 170 data%=buff%?(?outptr%)
 180 IF (data% AND 128)<>0 THEN PRINT
 190 PRINT data%;
 200 ?outptr%=?outptr%+1
 210 UNTIL FALSE
 220 END
1000 DEFPROCassem
1010 DIM start% 100,buff% 256
1020 @%=4:sysvec%=&70:irq2v%=&0204
1030 inptr%=&72:outptr%=&73
1040 ACIA_C%=&FCF0:ACIA_D%=&FCF1
1050 FOR pass%=0 TO 2 STEP 2
1060 P%=start%:[OPT pass%:SEI
1070 LDA irq2v%:STA sysvec%
1080 LDA irq2v%+1:STA sysvec%+1
1090 LDA #acia% MOD 256:STA irq2v%
1100 LDA #acia% DIV 256:STA irq2v%+1
1110 LDA #&03:STA ACIA_C%:STA &FCF2
1120 LDA #&95:STA ACIA_C%:STA &FCF3
1130 LDA #0:STA inptr%:STA outptr%
1140 CLI:RTS
1150 .acia%
1160 PHA:TYA:PHA:PHP
1170 LDA ACIA_C%:AND #128:BEQ exit%
1180 LDY inptr%:LDA ACIA_D%:STA buff%,Y
1190 INC inptr%
1200 .exit%
1210 PLP:PLA:TAY:PLA:JMP (sysvec%):]
1220 NEXT pass%
1230 ENDPROC
```

Listing 1: The BBC Basic MIDI receiver program.

```
  10 REM BBC micro MIDI interface
  20 REM key test program by J.F.S.Yau
 100 DIM N% 23
 110 *FX11
 120 PROCinit:OCT%=4:L%=0
 130 ACIA_C%=&FCF0:ACIA_D%=&FCF1
 140 ?ACIA_C%=&03:?ACIA_C%=&15
 150 D$=CHR$9+"Q2W3ER5T6Y7UI9O0P@^[\_"
 160 REPEAT
 170 PROCnoteoff(L%)
 180 REPEAT:J$=INKEY$(0):UNTIL J$<>""
 190 K%=INSTR(D$,J$)
 200 IF K%=0 GOTO 180
 210 L%=K%+OCT%*12:PROCnoteon(L%)
 220 PRINT'"Note ";L%;"played"
 230 IF INKEY(-N%?K%) THEN 230
 240 UNTIL FALSE
1000 DEFPROCinit
1010 FORI%=1TO23:READ A%:N%?I%=A%:NEXT
1020 ENDPROC
1030 DEFPROCwaitTx
1040 REPEAT:UNTIL ?ACIA_C% AND &02:ENDPROC
1050 DEFPROCnoteoff(NT%)
1060 PROCwaitTx:?ACIA_D%=144:PROCwaitTx:?AC
IA_D%=NT%
1070 PROCwaitTx:?ACIA_D%=0:ENDPROC
1080 DEFPROCnoteon(NT%)
1090 PROCwaitTx:?ACIA_D%=144:PROCwaitTx:?AC
IA_D%=NT%
1100 PROCwaitTx:?ACIA_D%=100:ENDPROC
1110 DATA 97,17,50,34,18,35,52,20,36,53,69,
37
1120 DATA 54,38,39,55,40,56,72,25,57,121,41
```

Listing 2 The program for playing MIDI instruments from the BBC Micro.

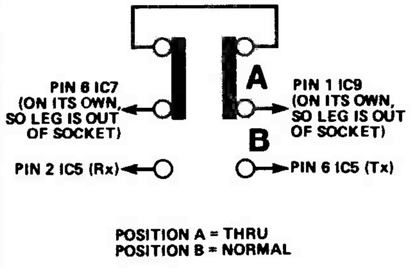
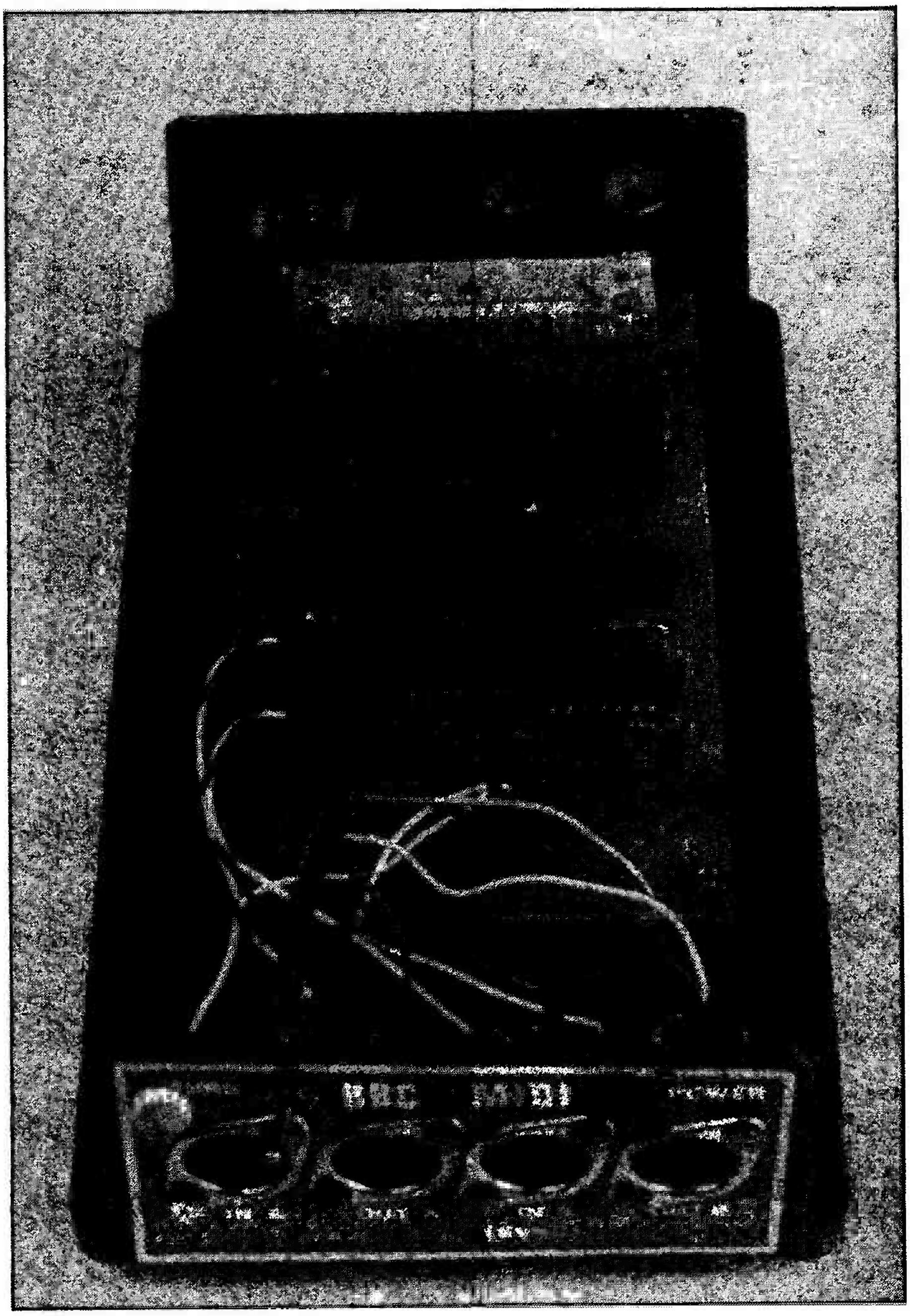


Fig. 5 Wiring the optional 'Thru' switch.



which are the most frequently used MIDI messages as far as synthesisers are concerned.

Applications

Applications for the MIDI interface depends on what MIDI equipment it is to be used in conjunction with. The most immediate application is to use the BBC micro's disc filing system to store synthesiser voice programs or drum machine track programs. More complex software to use the MIDI communication protocols found in the data manuals for the equipment concerned can also be written to make full use of the interface.

For synthesisers such as the Yamaha DX7 it is possible to write a voice editor to program new voices from the BBC micro. When programming a new sound for the DX7 only one parameter can be accessed at any one time. With a voice editor program all the parameters can be seen on the screen at once and freely accessed. Voice editing from the BBC micro, along with the advantages of its disk filing system, forms a powerful sound management system for the DX7.

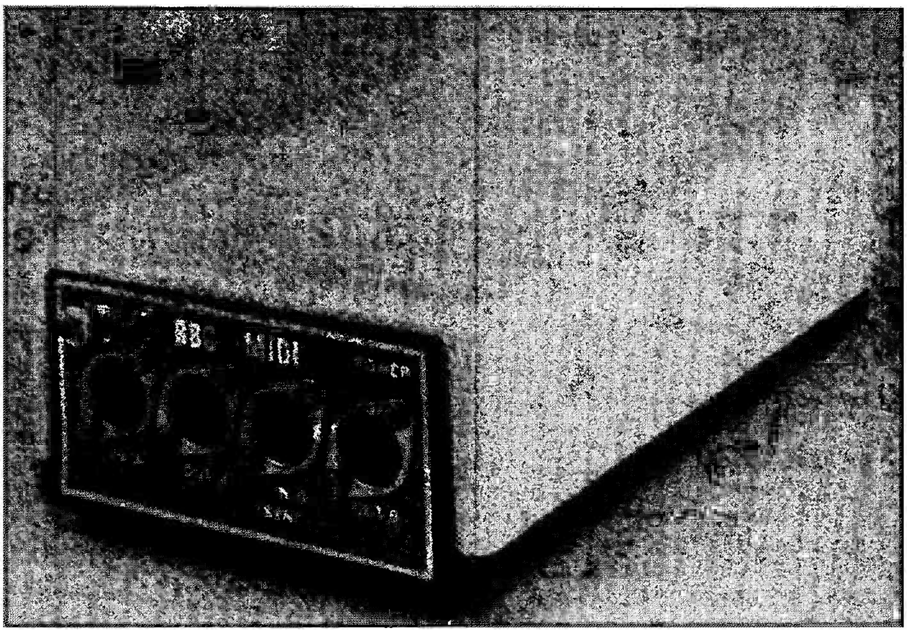
Thru Switch

The THRU toggle switch shown on the front panel of the prototype unit serves to link the MIDI IN1 to the MIDI OUT1 for use when the BBC micro is not running software

The author has a range of software on 5¼in disk to make full use of the MIDI interface. Orders and requests for further details should be addressed to John Yau, 7 Maurice Place, Edinburgh, EH9 3EP.

- *Track dump software for the Roland TR707 drum machine. This enables the currently held patterns and track programs to be stored and read from floppy disk.*
- *Voice Dump/Editor software for the Yamaha DX/TX7. This software allows single voices or complete banks of voices to be stored and read from floppy disk. This software also enables DX voices to be edited from the BBC micro. All the parameters are displayed on the screen and can be modified using a simple slider control which plugs into the BBC micro's analogue user port. Wiring details for the slider control are supplied.*
- *Four track step time MIDI Sequencer for synthesisers arranged as in Fig. 1 with external synchronisation.*

The programs cost £12, £18, and £16 respectively.



which actively merges the MIDI IN1 input stream with the MIDI OUT1 output stream. The switch simply links pin 6 of IC7 to pin 1 of IC9 while isolating them from their original connections to Tx and Rx of IC5. This arrangement allows data to pass unaltered from MIDI IN1 to MIDI OUT1, even when the BBC micro is switched off. The THRU option was added as an afterthought and the PCB does not include this feature but it can be easily included with the minimum of alterations if this feature is required.

ETI

ROBOTICS CIRCUITS

Motor drivers and sensor Tech Tips for the mechanically minded.

Motor Speed Regulator

This circuit uses the LM2907 tachometer as part of the control loop to maintain a constant motor speed. To measure the motor speed a shaft encoder is necessary. Some expensive motors for industrial applications already have encoders fitted but your average model motor does not. The answer is to use a disc with holes drilled in it with a slotted opto switch or a metal toothed wheel and a variable reluctance magnetic pickup, as illustrated in Fig. 2. As the average slotted opto detector is not very sensitive, a transistor may be needed to amplify the output signal. A suggested circuit is shown in Fig. 3.

The functioning of the control loop itself is straightforward. The output voltage from pin 4 of IC1 is proportional to the pulse rate fed into it, and because this signal is fed to the inverting input of IC2 this tends to reduce the speed. RV2 sets the voltage on the positive input of IC2, tending to increase the motor speed.

A stable speed results when the balance of the two provides the motor with the voltage it needs to maintain its speed.

Any reduction in motor speed will increase the voltage fed to it while any increase in speed will reduce the voltage. The gain of this control system is set by adjusting RV1 to the lowest value that does not cause speed oscillation due to overcorrection during the response time of the motor. In most cases the permissible gain will be suffcient to ensure that wide load variations on the motor alter the speed very little.

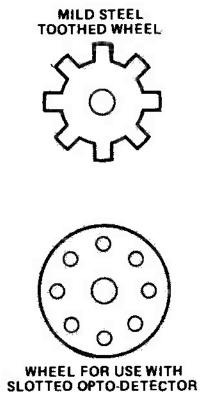


Fig. 2 Shaft encoders.

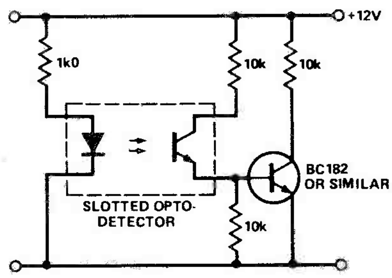


Fig. 3 Optical shaft encoder amplifier.

The LM2907 tachometer works as follows. On each input cycle, C2 is charged to a set voltage, and the charge is transferred to C3. The voltage on C3 does not rise indefinitely but stabilises at the point where the discharge current through R2 is equal to the average current due to the transfer of charge. The output stage of the chip is simply wired as a buffer to feed the signal to the display.

The output voltage of the LM2907 is given by the formula:

Vout =

V supply x Frequency x C2x R8

The component values here are suitable for a fairly high pulse rate from the encoder wheel and a high motor speed. For lower pulse rates C2 should be increased. To keep the ripple within reasonable bounds C3 may also have to be increased but if it is increased too far the time constant may become comparable with the mechanical time constant of the motor and the control system will oscillate.

If a higher pulse rate is required and it is not practical to drill twice as many holes or cut twice as many teeth then a second detector half a hole out of phase may be used. If the accuracy of the encoder is good enough, combining the two outputs in an exclusive OR gate will give a double frequency output. The waveforms are illustrated in Fig. 4.

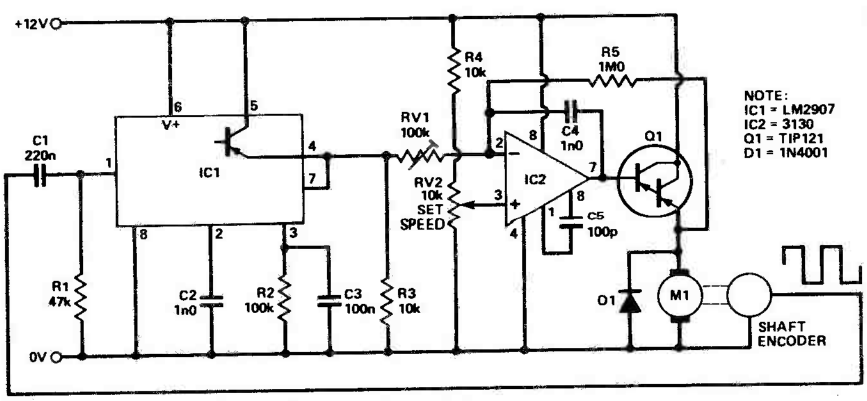


Fig. 1 The circuit of the motor speed regulator.

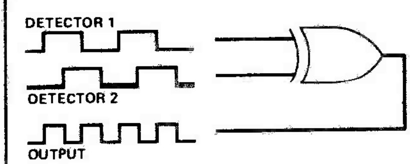


Fig. 4 Using an OR gate and out of phase signals to double the shaft encoder output.

Shaft Position Indicator

This gadget indicates the angular position of a shaft to a resolution of three bits. The same principle with much more complexity can be used to provide more resolution but for simple robotics control this design should do just fine.

It works by using two linear Hall effect devices at points 90° apart on the rotation of the shaft to measure the position of a bar magnet. The field distribution of the magnet on its own is not likely to be ideal so pole pieces should be used. Figure 1 shows a suitable arrangement.

The idea is to get an approximately sinusoidal distribution of field strength for the hall device to detect.

To increase the magnetic field available to the Hall devices, a disc or ring of iron or mild steel should be positioned on the opposite side from the magnet and pole pieces.

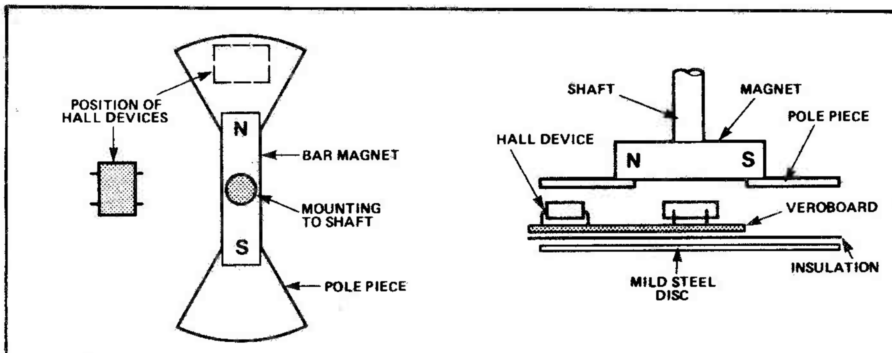


Fig. 2 The positioning of the magnet and Hall probes.

The circuit contains two identical channels for the two Hall devices, with one extra comparator on the output. I shall describe just Channel A.

IC3a works as a subtractor to provide an output dependent only on the difference between the differential outputs of the Hall device. RV1 is fitted to compensate for any offset on the output of the Hall device and allows the subtractor to be adjusted to 0V in the absence of any magnetic field. IC4a is a comparator which switches during the zero crossings of IC3a's output.

To generate a magnitude signal to compare with the other channel, IC3c is used as a simple precision rectifier. It works as a resistive divider during positive half cycles, the output being VinxR12/(R10+R11+R12). During negative half cycles the circuit works as a half-wave inverting rec-

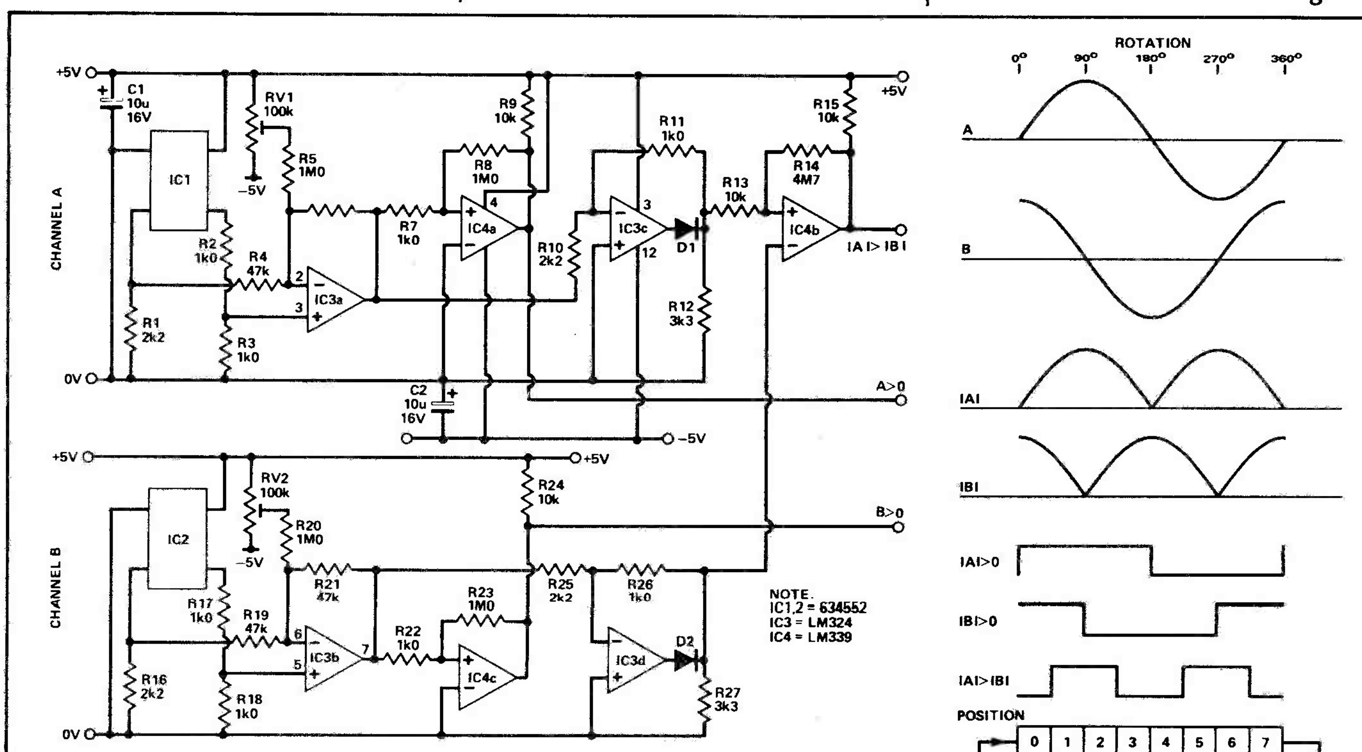


Fig. 1 The circuit of the indicator and ideal waveforms.

tifier, with an output of VinxR11/R10. The component values are chosen to make the gain on each half cycle as near as possible the same, given an E12 choice of resistor values. The outputs from the precision rectifiers in each channel are fed to a final comparator which generates the final logic signal.

Some experimentation with the shape of the pole pieces will be necessary to achieve good results. The figure shows ideal waveforms. A and B are both the magnetic field received by the Hall transducers and the outputs from the differential amplifiers, IC3a and IC3b. The outputs from the Hall transducers are differential, which is all to the good as these devices can drift.

The next two waveforms show the magnitude of the A and B signals regardless of polarity. The final three waveforms show the result of comparing A with 0V, B with 0V, and the magnitude of A with that of B, respectively.

As the waveforms show, only one of the three output signals changes at each transition between position areas. There is no incorrect transitional state as would be possible with the normal binary counting sequence. It is not unknown for encoders using a normal binary sequence to give a false state of, for example, 101 between 011 and 100.

Despite the fact that the sequence is different, each combination possible with three bits is used, so the position may be displayed with the aid of a 3 line to 8 line deoder. The outputs simply have to be arranged in a different order. Figure 4 shows a simple indicator.

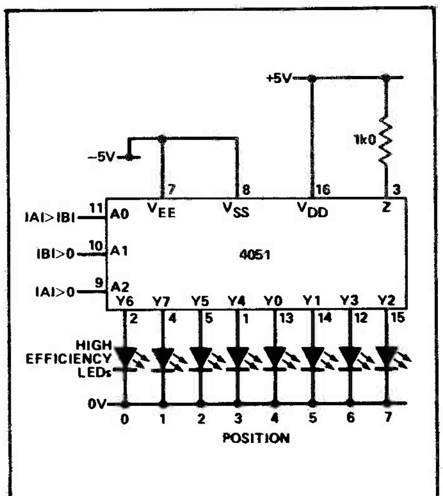


Fig. 3 A simple position indicator.

Coherent Optical Proximity Detector

This optical proximity detector can either detect the proximity of reflective objects over fairly short ranges or it can be arranged to detect objects interrupting the beam. Unlike the author it is coherent. It will respond to its own optical signal and ignore quite high levels of extraneous light.

IC1a is connected as a square wave oscillator. This oscillator switches the LED, and also controls the synchronous detector. The synchronous detector itself switches between inverting and non-inverting amplification, with the same gain in either direction.

When non-inverting the LED is ON and the signal received is the wanted signal added to the extraneous signal. When the detector is inverted only the extraneous signal is received, and this is subtracted.

The functioning of the synchronous detector is simpler than it appears from the circuit diagram. IC2a acts as a logic inverter to drive IC2b out of phase with the other analogue switch parts. In the invert mode, the gain is R4/R11 (=4.7) and in the non-invert mode the gain is R14+R11+R12)/(R11+R12) (=4.7). The addition of R12 compensates for the extra gain which would be present in the non-inverting mode of the circuit.

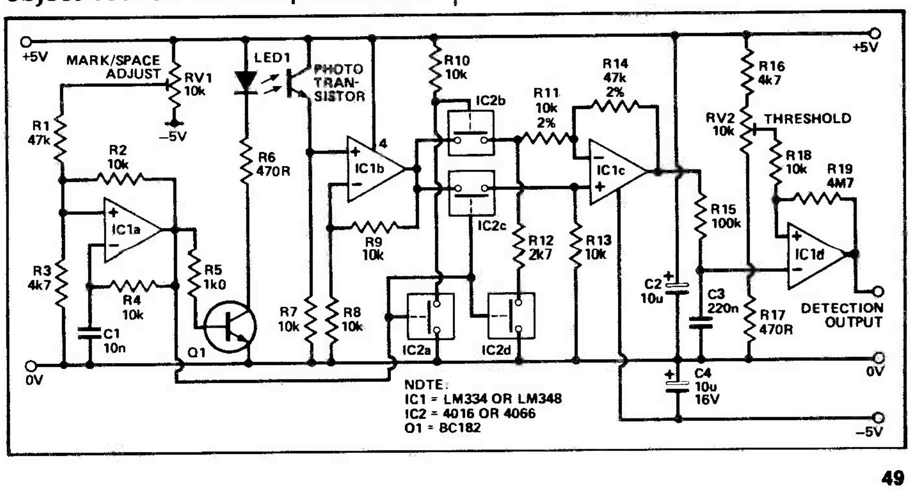
If the mark/space ratio of the oscillator is adjusted correctly the output of IC1c averaged by R15 and C3 will be exactly zero. This is in fact the method of setting the mark/space ratio. Disconnect the LED and adjust for 0V on C3 using a sensitive voltmeter.

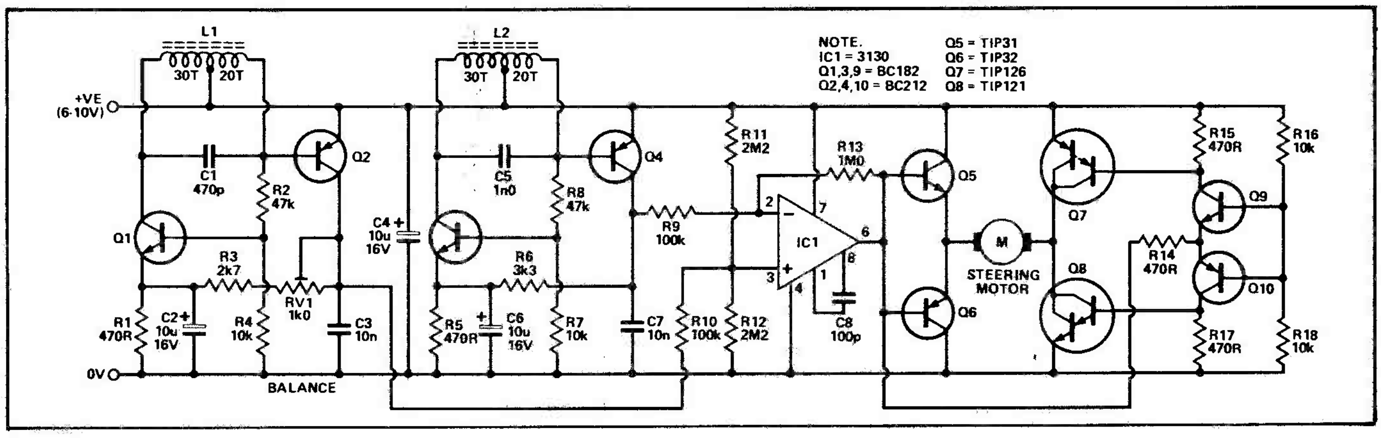
If the LED is reconnected, any signal from the LED received by the phototransistor will give a net positive output on C3. IC1d is wired as a comparator which switches low when signal from the LED exceeds a preset threshold.

The circuit has many applications. It could form the basis of an object counter or a simple but reliable intruder alarm, in which case a matched infra red emitter and receptor should be used and R6 reduced to increase the LED power and range.

Most usefully the circuit can be used as a proximity detector. In this an angled infra red emitter and receptor assembly (available from Electromail) should be used. This is focused at about 5mm, and can be used to form a reliable limit switch.

To get more range, to use it more as an optical radar, a discrete LED and detector can be used with an opaque screen between them to prevent the direct passage of light. It is in this application that the ability of the unit to reject the extraneous light is most useful.





Inductive Track Follower

This project is used to steer mobile robots along a trail of aluminium foil by sensing the absorption of high frequency energy from an LC oscillator.

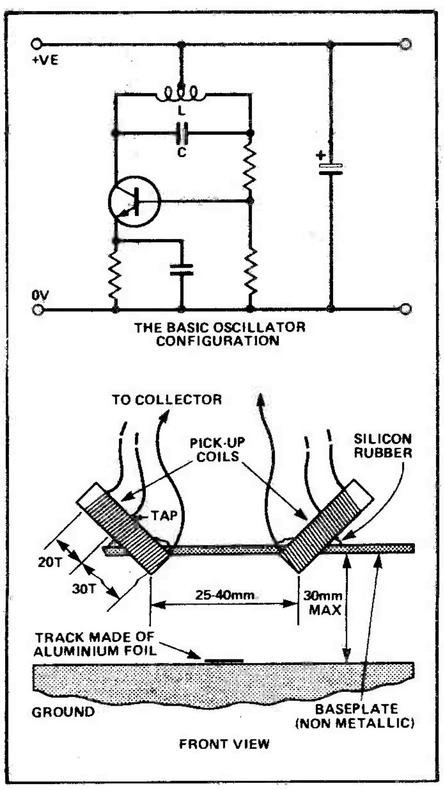
Two similar oscillators are used but they operate on different frequencies to avoid interaction. Figure 1 shows the basic oscillator configuration. This circuit will oscillate powerfully — into clipping in fact. The frequency will be close to the resonant frequency determined by L and C, although not exactly so because the clipping will lower the effective Q of the circuit.

Any slight amount of power absorption from the circuit by nearby metallic objects will reduce the clipping slightly. As a result the frequency will change a little.

Looking at the first oscillator in the circuit diagram, an extra transistor is added to stabilise the output level. When the signal on the 20 turn end of the inductor exceeds about 0.6V, Q2 starts to conduct to reduce the current through Q1. The presence of R3 in the circuit means that voltage gain is introduced. However much Q2 has to raise the emitter voltage of Q1 to stabilise the output, the collector voltage of Q2 is raised that much more in the ratio of R3 to R1.

Both oscillators should settle to give the same control voltage (apart from the effect of component tolerances which RV1 compensates for). This pot should be adjusted to give no voltage difference between the collectors of Q2 and Q4 with no aluminium around.

The outputs of the two detectors are fed to a subtractor circuit which is biased to give an output of half the supply voltage when the two inputs are equal. The presence of a piece of aluminium closer to one detector than the other will unbalance the control voltages because the power absorbed by the aluminium will reduce the voltage needed to stabilise the oscillator power.



THE BASIC OSCILLATOR CONFIGURATION

FRONT VIEW

The motor drive circuit is arranged as a bridge configuration with a dead band so that small unbalances will not cause the motor to move. Q5 and Q6 follow the op-amp output (with crossover distortion) and provide the current drive needed for the steering motor. Q9 and Q10 serve as level shifters to drive Q7 and Q8 which are connected to switch to the polarity inverse of that of the op-amp output.

Assuming the motor turns the steering in the correct direction, the robot will turn to follow any aluminium track so long as it is initially positioned with the detectors either side of the track.

The assembly of this unit is slightly critical. 0V connections should be kept as short as is practical, and the decoupling capacitor C4 should ideally be connected to a point between the two oscillators. A tantalum type is used here because it has good high frequency performance and will decouple the power supply better at the frequencies in use.

The coils are wound on short lengths of ferrite rod — about an inch to an inch and a half. A suitable wire diameter is 0.25mm, but this is not critical as the current is very low.

The detection system has only been tested with the pickup coils parallel, but it seems likely that angling them as shown will give better performance. At any rate, it is worth a try.

ETI

BIRD'S EYE VIEW

The ETI office receives a large amount of mail, much of which consists of technical queries from readers. Putting aside, for the minute, the fact that ETI does not aim to answer technical questions on projects that originate outside these pages, I came across a missive the other day that amply demonstrates one of the more worrying aspects of 'hobby' electronics. It ran (in a less abbreviated form) like this:

I recently bought a book which included a circuit for transmitting signals over the mains wiring system. I built a simple oscillator and I connected the output to the Earth and Neutral of a 13A plug.

I also connected a loudspeaker to the earth and neutral of another plug and put both plugs into separate sockets in our house's mains.

I then turned on the oscillator hoping the sound would come out of the speaker. However, in our house we have an Earth Leakage Detector. If any electrical apparatus in the house should develop a fault it turns off all the electricity. This obviously makes the house much safer but it also turned off the electricity when I turned on the circuit I built.

Could you tell me a way of still transmitting signals over the mains wiring but not triggering the Earth Leakage Detector.

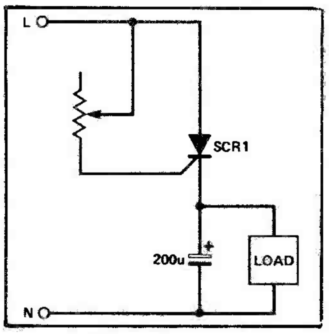
I won't reveal the correspondent's name for his own sake. However, he is not alone in falling foul of circuits in books.

As I see it, there are two problems with his intercom. First of all, sooner or later it will kill somebody. Secondly, if the house burnt down as the result of an electrical fault, his insurance company would make a silly fuss about paying out. They may even say it was his own fault.

The obvious solution is to remove or short out your ELCB. After all, it's only there for safety! Anyone who would suggest connecting neutral and earth together via a few ohms of speaker can't have regard for such wimpish things.

I hope you'll excuse my heavy handed irony but somehow or other I have to make the point as emphatically as possible: DON'T TRUST BOOKS OF HOBBY CIRCUITS.

More often than not, they are a case of the blind leading the blind. Much of the time the circuits are poorly designed, won't work or are downright dangerous. The diagram shows a little gem I came across recently.



No kidding, this is described as a variable voltage DC Power supply. There are so many things wrong with it that it's hard to know where to begin.

It's very dangerous. The capacitor is not isolated from the mains and off-load, the voltage across it will *always* rise to the peak mains voltage regardless of the setting of the pot.

What's more, the capacitor will retain its charge of up to 340V or so when the circuit is disconnected and a capacitor charged to that kind of voltage is something to be treated with great respect!

The regulation is so poor that the circuit is useless for any practical purpose anyway and the wrong setting of the pot will quickly blast the SCR to eternity. Need I say more?

Anybody who tried to flog this thing to the unsuspecting public would face a huge fine and almost certainly a long prison sentence. Yet there it is in a book of 'hobby projects'.

In my opinion the irresponsible publication of this kind of circuit is deplorable. Many of the people who buy these books are unable to tell the difference between a good circuit and a bad one and, more importantly, a safe one or a dangerous one. Many have a touching faith that because it has been published, it must be OK.

A fitting punishment for those who perpetrate this kind of crime would be to have their house fitted out with all their own circuits! I'd give them a life expectancy of a week at most.

John Bird

OPEN CHANNEL

Things are changing in the City of London. By the end of this year, for example, British Telecom hopes to complete over 60,000km of optical fibre cabling in a move to install a new telecommunications network costing about £50 million in the City itself. This is in direct response to Mercury Communication's fibre optic network which already has a thousand or so users.

It's interesting to stand back and watch this David and Goliath battle for customers. On the one hand there is the established giant who traditionally has had all (well, not quite all — see later) customers purely by chance of its monopoly. On the other hand is the new boy who must fight for every customer it can get.

At the moment the BT giant would have us think Mercury's David is no more than a thorn in the side. But the City of London, remember, is only the first battleground and British Telecom may well soon be having to fight tooth and nail to retain its customers.

If the pay dispute, currently being fought between BT and the National Communication Union as I write, continues and escalates as it seems to be doing then Goliath may already be toppling.

North of Watford

To those City-dwellers who believe that life stops at Luton and that the few unemployed souls who *do* venture further up the map wander around eating Mrs. Currie's fish and chips wrapped in yesterday's Sun (wouldn't you just guess I'm a northerner?), here's a gentle reminder that communications up in t'north is something a bit better than smoke signalling.

Telephone users in the Hull vicinity are connected not to BT's national phone network but to Hull's own telephone network — the only private network to exist in Britain prior to the telecommunications liberalisation of recent years.

Now that Mercury is in the pot, Hull system users have a choice when making a call outside the vicinity — whether to use BT or whether to user Mercury. Furthermore, choice is directly up to users, merely by keying a two-digit pre-dialling sequence.

Each customer is informed of the tariffs charged by the two networks (which vary according to where the call is placed) so bills can be easily minimised.

Beat that, city-folk!

Skynet Satellites

NATO has recently awarded a £100 million plus contract to British Aerospace and Marconi to deliver two Skynet IV military communications satellites to replace existing satellites which are approaching the end of their useful life. This is not only good news for the two companies involved, but is also good news for Britain as a whole. The satellites to be replaced are of US origin.

If flights of the European rocket, Ariane, commence on schedule in 1988 (having been temporarily grounded with serious problems) it's likely the satellites will be going up in late 1990 — just in time before the existing satellites conk-out.

Thou Shalt Not . . .

Back on the ground, users of cellular telephones and any other mobile communciations systems will now have to be wary about making and taking calls on the move. The latest edition of the Highway Code tells drivers not to use hand-held microphones or handsets while on the move except in an emergency.

Furthermore, hands-free communictions should only be used if the driver's attention is not distracted from the road. Theoretically, drivers 'nicked' under these clauses could be prosecuted for careless driving or improper use of a vehicle.

I find this interesting. Firstly, because I have long felt that it *should* be illegal for drivers to use mobile communications while on the move. Drivers are (or, should be) responsible for the control of a lethal weapon and any obstruction to the driver's control *must* be avoided.

Handsfree types of communications may not, arguably, distract the driver, but trying to use a handset certainly does.

Secondly (and more involved perhaps) why was this situation not thought of when cellular systems were first being evolved? Only a few percent of new and existing celluar users have handsfree equipment which means that all suppliers are effectively committing most of their customers to some time or another break the law.

Keith Brindley

BOOK LOOK

It is the dream of many an electronics hobbyist to surround themself with all manner of gadgetry and gimmickry to (supposedly, at least) make their life one of luxury.

These three recent publications aim to help the struggling pioneer of home automation.

Electronic Circuits for the Computer Control of Robots
R.A. Penfold (Bernard Babani) £2.95

First up is a familiar looking work from the bottomless publishing well of Babani and the irrepressable Robert Penfold.

Like most of Penfold's works this is more a collection of related circuits than a course in practical robot building. To be accurate none of these circuits could easily be used for much more than the intelligent 'buggy' type of robot. Dreams of humanoid tin men are not going to be realised here.

There are about 27 circuits in this book, divided into two categories — motor control circuits and various sensors.

The motor driver circuits range from the inevitable simple power darlington model motor drive to stepper motors driven with SAA1027 chips. The sensor circuits cover similar ground from microswitch bumpers to ultrasonic range finders.

Any regular reader of ETI will have seen many of these before in one guise or another as Tech Tips (and there's plenty more in this issue, in the Robotics Tech Tips Special). However, as an introduction to the field and as a springboard to experimentation this follows in the excellent footsteps of previous Babini produce.

Build a Remote Controlled Robot for Under $300
David Shircliff (John Wiley & Sons) £9.00

This book is an entirely different kettle of fish. It's American and aims to show you how to construct a fully-fledged electronics manservant (thingservant?).

Questor (as the author's prototype is called) comes complete with optional extras such as a drinks dispenser and a vacuum cleaner.

The title says all this is possible for under $300. That presumably seems little to transatlantic builders but to me it seems rather a lot. For that money I would expect a little more than a trundling aluminium box, which is really all that Questor is.

However, that aside, this book certainly shows you just how to build a professional aluminium box! In fact most of the pages are given over to constructional details — plans and domensions of various parts of Questor's superstructure and numerous tag strip layouts.

The electronics content is fairly minimal (as anyone who actually tries to create such a beast soon finds — it's the mechanics that cause the most headaches).

Questor is based on a platform with castors driven by model motors. Control is via a remote control box that works on a very simple direct wiring principle. His arm is just a fixed pipe down which suitable refreshment can flow under the control of a small pump (it's what your right arm's for!).

Even the refinements of fancy paintwork and a light-up bow tie fail to cover up that Questor is basically a Neanderthal beast.

If you're really serious about constructing a home help then judicious design borrowed from the likes of Mr. Penfold would add up to a more useful beast and probably for less than $300 too.

62 Home Remote Control and Automation Projects
Delton Horn (John Wiley & Sons) £11.60

In its way this is a much better book than the last American import. The 62 circuits cover a wide range. The book starts off with simple low voltage relay controlled mains circuits and works up to comparatively complex touch tone remote control.

The whole thing is done in a tutorial fashion. With each circuit there is a circuit diagram, parts list and a description of how it all works. However, there are no PCBs.

The book's main let down is its foreign origin. Not only do some of the circuits use components that are not easily available in the UK but a few also talk about 120V 60Hz mains. This is going to help neither the construction nor the understanding of these projects.

This book is also criminally short of computer control circuits but otherwise provides a good grounding. Most importantly it increases the confidence of anyone going into automation for the first time, and actually encourages some experimentation.

Malcolm Brown

ALF'S PUZZLE

The latest gadget to emerge from Alf's workshop is a distortionless amplifier. As usual, Alf's reasoning is not at all clear but with the aid of his notes that we found on the back of a coffee stained envelope we eventually pieced together the way it works.

Alf started by thinking about an ordinary amplifier (Fig. 1a). If you put in a signal v, what should come out is Av — the input multiplied by the gain A.

However, what comes out of any real amplifier is Av+d, where d is a term which includes all the distortion, noise and general crud introduced by the amplifier.

Muddling

Ever since Alf started his evening classes at the local Tech, he has been obsessed by something he calls 'muddling'. It sounds like something that would suit Alf down to the ground but he probably means 'modelling'.

According to Alf, an amplifier can be represented by a distortionless amplifier with an extra pretend input with an imaginary distortion signal (Fig. 1b). Seems reasonable so far.

Alf's next idea was to derive a signal −d/A which would be fed into the input of the amplifier together with the signal v. The way he went about deriving this signal is shown in Fig. 1c. Alf worked out that the output of the amplifier would now be A(v− d/A) from the amplified input, plus d from the amplified pretend distortion input, giving Av. The world's first distortionless amplifier!

Alf is willing to concede that the two unity gain amplifiers may introduce a little distortion of their own. However, he maintains that this can be made so small that even the most sensitive and well calibrated hi-fi buff could not detect it.

Furthermore, Alf says the initial amplifier needn't be very good. In fact, it could be absolutely awful. His circuit changes the most grotty low-fi amplifier into purest hi-fi.

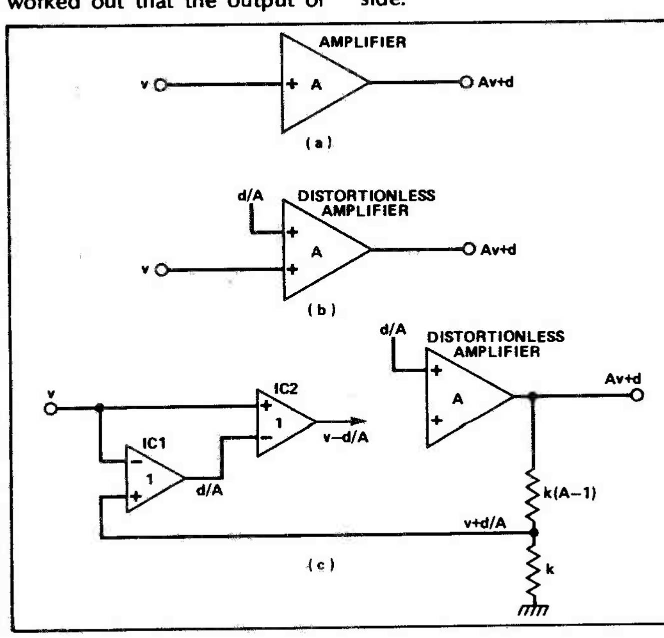
So, what's wrong with Alf's reasoning?

Last Month's Puzzle

The answer to Last Month's puzzle:

It is possible (though not certain) that Alf's triacs were being triggered into conduction by the sudden voltage rise across them. The critical dv/dt (see Snubber Networks, ETI March 1987 for explanation) varies widely between one device and another.

A glance through the TAG data book shows figures of anything between 10V/µs for triacs with otherwise similar ratings. Alf's may have been on the low side.



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E8402-4	Modular Pre-amp Relay, PSU	F
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E8405-2	ZX81 EPROM Programmer	N
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E8405-6	Drum Synth	F
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E8406-2	Spectrum Joystick	E
E8406-3	Audio Design RIAA Stage	G
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E8411-7	Mains Failure Alarm	D
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E8411-9	Stage Lighting Interface	F
E8411-10	Perpetual Pendulum	E
E8412-1	Spectrum Centronics Interface	F
E8412-4	Active - 8 Protection Unit	F
E8412-5	Active - 8 Crossover	F
E8412-6	Active - 8 LF EQ	F
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E8511-3	Specdrum	L
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E8604-1	JLLH PA PSU	H
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E8604-3	Matchbox Amp Bridging Version	C
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E8605-2	Baud Rate Converter	M
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E8605-4	Portable PA	H
E8606-1	Midi-CV Converter Board	H
E8606-2	Midi-CV Converter PSU	D
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E8611-3	Upgradeable Amp PSU	J
E8611-4	Call meter, main bd	O
E8611-5	Call meter, interface bd	N
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E8612-2	Biofeedback monitor (Free PCB)	E
E8701-1	RGB Converter	F
E8701-2	Mains Controller	D
E8701-3	Flanger	H
E8701-4	Audio Selector main board	M
E8701-5	Audio Selector PSU	H
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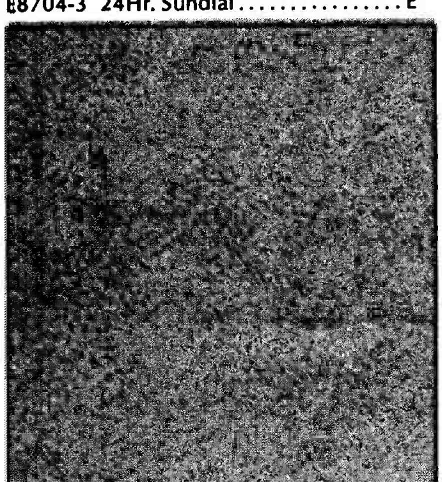
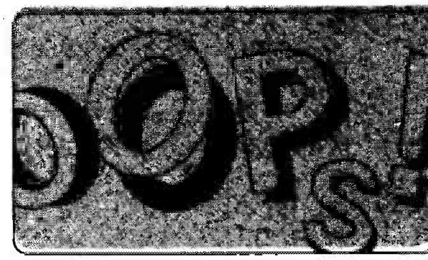




Baud Rate Converter (May, 1986)
In Fig. 4 some confusion has crept in to the ins and outs of the circuit diagram. IC6a and IC5c need to be turned round and pins 20 and 25 of IC2 swapped round. In Fig. 5, D4 and D3 are shown the wrong way round on the overlay. This could of course lead to the destruction of C10 as well as the presence of second +12V rail instead of the required −12V. In Fig. 6, SK4.3 and SK3.3 must be swapped over. In the Parts List, C10 should be 1000µF, not 100µF.

RF Oscillators (June, 1986)
Fig. 12 does not, infact, show a working oscillator. For a series fed arrangement, take the link from CV1a,b junction to R3 and Q1 emitter junction and not 0V, remove C1 and move C2 to shunt R2. For a shunt-fed arrangement, break the link between L1 and Vcc and take Q1 collector to Vcc via a 4k7 resistor.

Speaking Alarm Clock (August, 1986)
In the circuit diagram, Fig. 2, diode D3 and resistor R14 shoudl be in parallel not series as shown. The link from IC10, pin 1, to battery positive should be removed.

Biofeedback Monitor (December, 1986)
The capacitor C4 is shown the wrong way around in the component overlay diagram (Fig. 4).

The Intelligent Call Meter (December, 1986)
The hex dump listing of the ROM for this project (Table 3) was badly printed with the byte at location BF missing. This should read 7F.

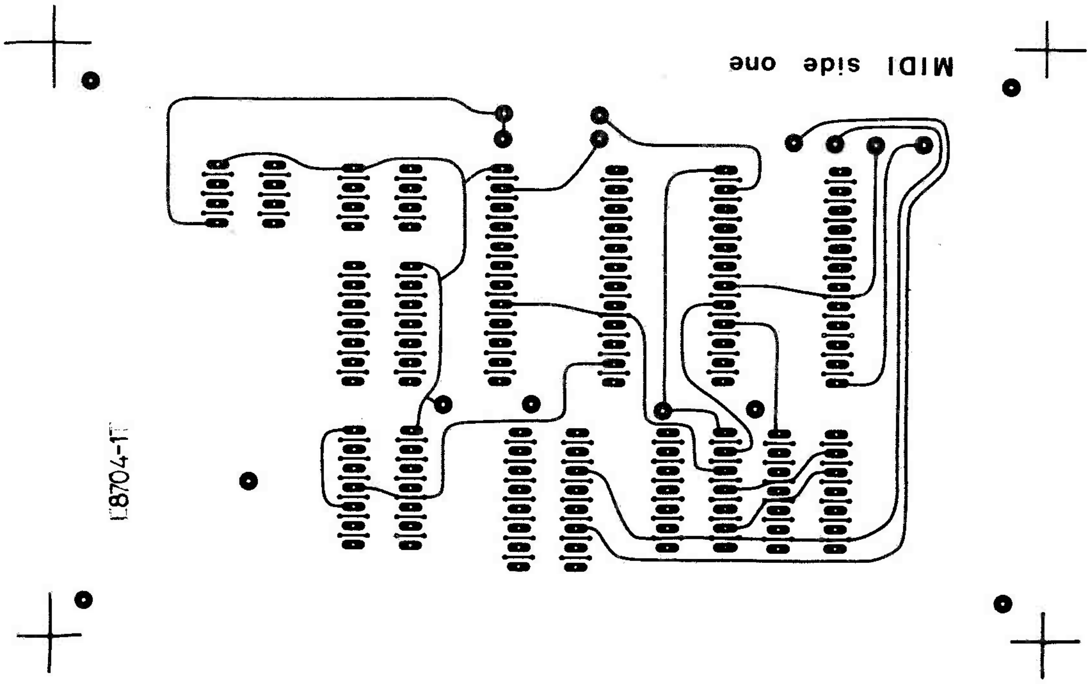
The Better Flanger (January, 1987)
In the circuit diagram (Fig. 2) D1 is not labelled. This is connected to Q1. In the component overlay (Fig. 5) several components are missing. A link should connect the two pads to the left of C1. Q1 is situated next to D1 and connection point P4 is situated between R16 and R33. In addition, the positions of R16 and C11 should be swapped.

Aerial Without Holes (In-Car Tech Tips, January, 1987)
Using enamelled wire of only 0.5mm diameter for the bifilar coils could cause overheating problems and even a fire risk with some cars. A much thicker wire (1.5mm should be sufficient) should be used.

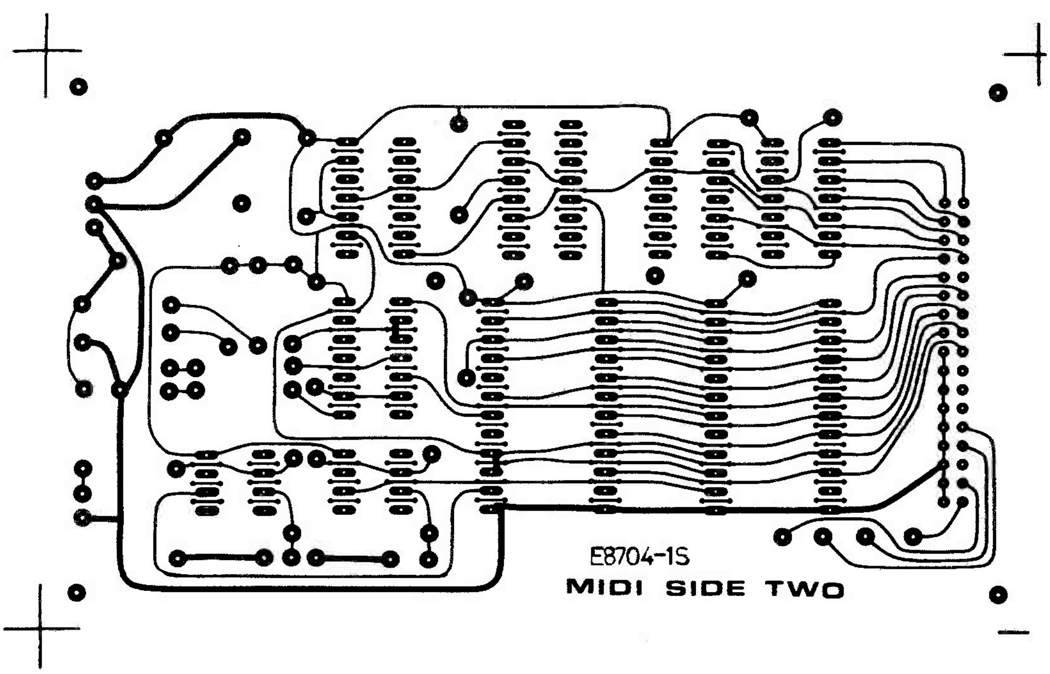
Credit Card Casino (March, 1987)
The circuit diagram (Fig. 1) incorrectly showed a connection between C2 (negative lead) and the positive rail. The PCB foil is correct.

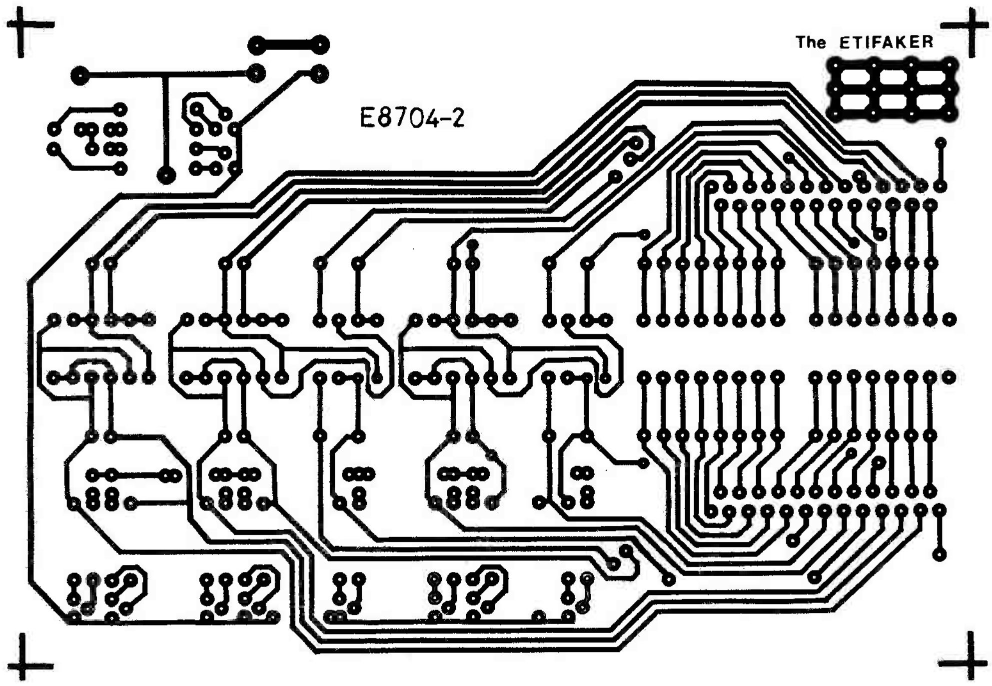
Capacitometer (March, 1987)
The circuit diagram (Fig. 1) should show pin 1 of IC1 connected to 0V. The zener diode (ZD1) should be connected between the junction of R10/R11 and 0V. The PCB foil is correct.

PCB FOIL PATTERNS

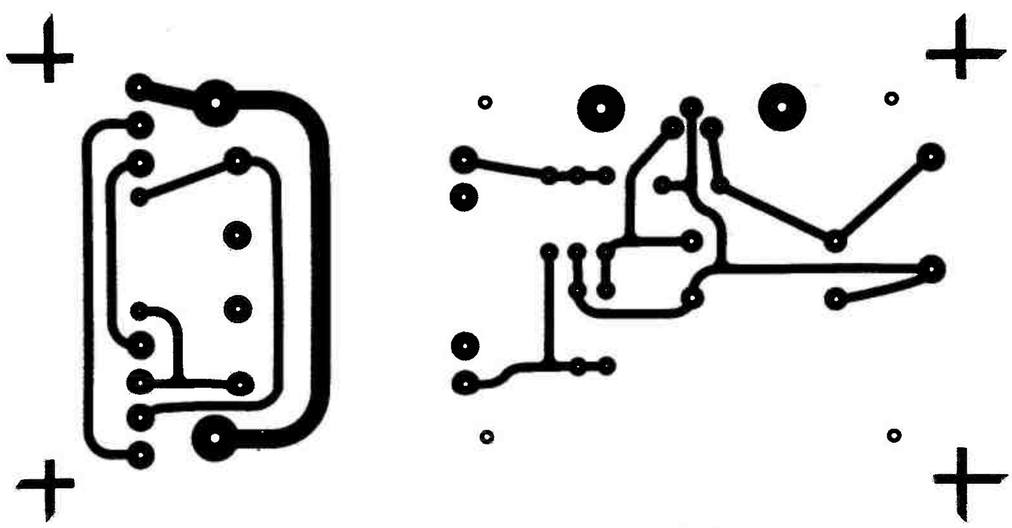


The MIDI Interface board.

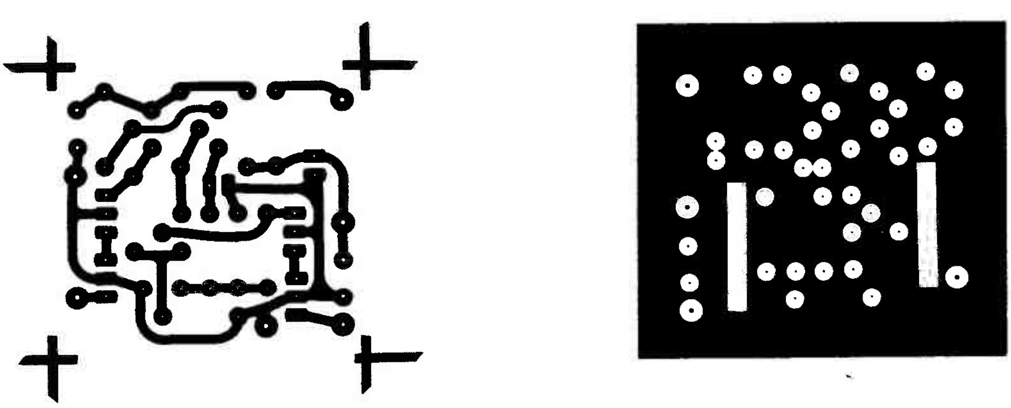




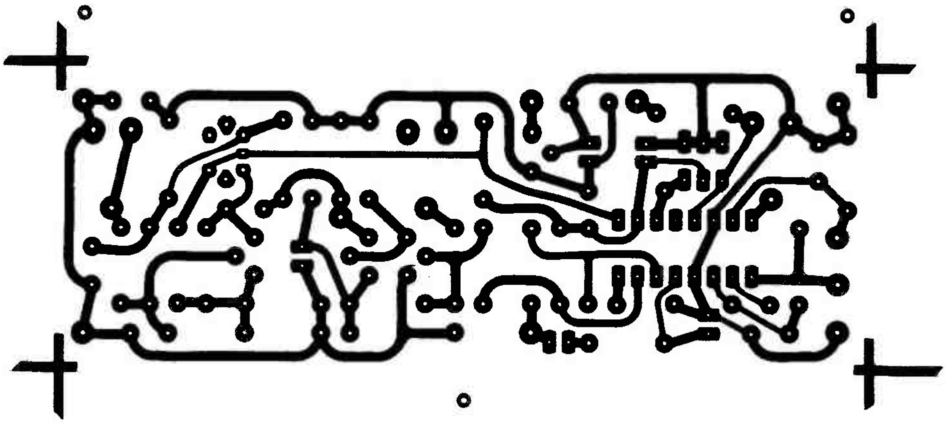
The foil pattern for the ETIfaker board.



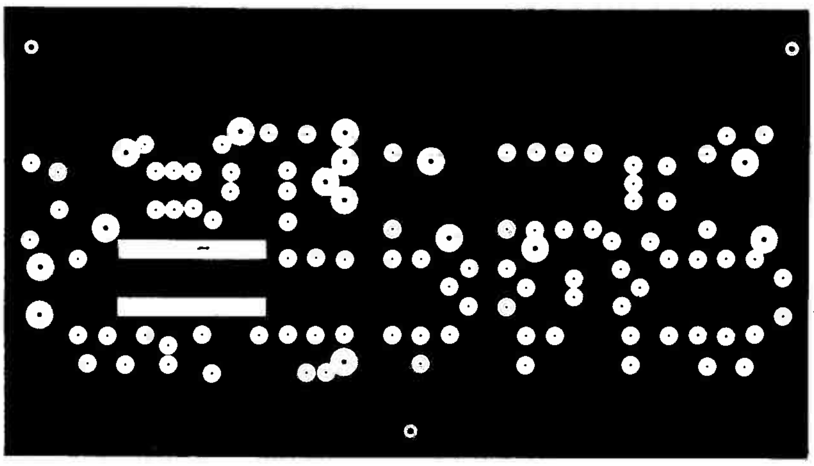
The FM Tuner power supply board foil pattern.

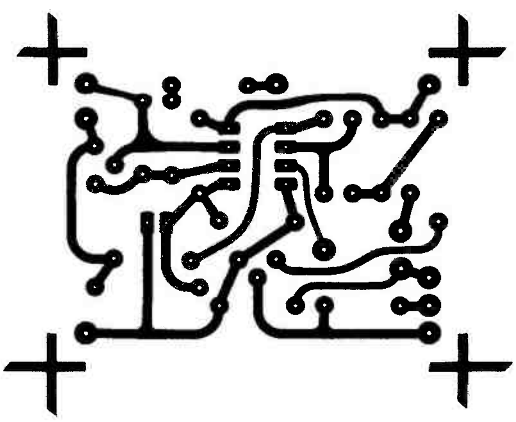


The underside and ground plane foils for the FM Tuner Selective Amplifier board.

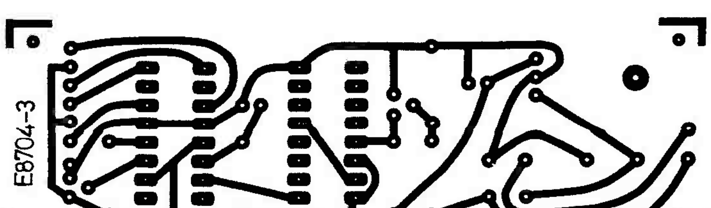


The underside and ground plane foils for the FM Tuner 3189/PLL board.





The FM Tuner Muting Circuit foil pattern.



The 24hr Sundial board.

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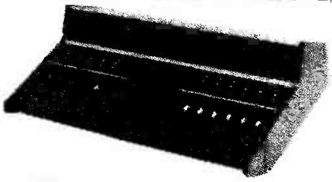

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