AN ARGUS SPECIALIST PUBLICATION

electronics today

INTERNATIONAL JUNE 1987 £1.20

INSIDE THE TELEPHONE SYSTEM

PLUS:

RIAA EQUALISATION

FLAT ALARM

FOURIER ANALYSIS

ACCURATE HI-FI POWER METER

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

OMP POWER AMPLIFIER MODULES

★ PRICES INCLUDE V.A.T. ★ PROMPT DELIVERIES ★ FRIENDLY SERVICE ★ LARGE S.A.E. 28p STAMP FOR CURRENT LIST

OMP POWER AMPLIFIER MODULES

Now enjoy a world-wide reputation for quality, reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices, NOTE all models include Toroidal power supply, Integral heat sink, Glass fibre P.C.B. and Drive circuits to power compatible Vu meter. Open and short circuit proof. **Supplied ready built and tested.**

OMP100 Mk II Bi-Polar Output power 110 watts R.M.S. into 4 ohms, Frequency Response 15Hz - 30KHz −3dB, T.H.D. 0.01%, S.N.R. −118dB, Sens. for Max. output 500mV at 10K, Size 355 × 115 × 65mm.
PRICE £33.99 + £3.00 P&P.

OMP/MF100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz −3dB, Damping Factor 80, Slew Rate 45V/uS, T.H.D. Typical 0.002%, Input Sensitivity 500mV, S.N.R. −125dB, Size 300 × 123 × 60mm. PRICE
PRICE £39.99 + £3.00 P&P.

OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz −3dB, Damping Factor 250, Slew Rate 50V/uS, T.H.D. Typical 0.001%, Input Sensitivity 500mV, S.N.R. −130dB, Size 300 × 150 × 100mm. PRICE
PRICE £62.99 + £3.50 P&P.

OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms, Frequency Response 1Hz - 100KHz −3dB, Damping Factor 350, Slew Rate 60V/uS, T.H.D. Typical 0.0008%, Input Sensitivity 500mV, S.N.R. −130dB, Size 330 × 147 × 102mm. PRICE
PRICE £79.99 + £4.50 P&P.

NOTE: Mos-Fets are supplied as standard (100KHz bandwidth & Input Sensitivity 500mV). If required P.A. version (50KHz bandwidth & Input Sensitivity 775mV). Order − Standard or P.A.

Vu METER Compatible with our four amplifiers detailed above. A very accurate visual display employing 11 L.E.D. diodes (7 green, 4 red) plus an additional on/off indicator. Sophisticated logic control circuits for very fast rise and decay times. Tough moulded plastic case, with tinted acrylic front. Size 84 × 27 × 45mm.
PRICE £8.50 + 50p P&P.

BURGLAR ALARM

Better to be **'Alarmed'** then terrified.
Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable. **FULLY GUARANTEED.**
Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.
Indoor alarm — Electronic swept freq. siren. 104dB output.
Outdoor Alarm — Electronic swept freq. siren. 98dB output. Housed in a tamper-proof heavy duty metal case.
Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

IDEAL for Workshops, Factories, Offices, Home, etc. Supplied ready built.

SAVE £138.00 Usual Price £228.85
BKE's PRICE £89.99 + £4.00 P&P
? Why buy a collection of self assembly boards!

OMP LINNET LOUDSPEAKERS

The very best in quality and value. Made specially to suit todays need for compactness with high sound output levels. Finished in hard wearing black vynide with protective corners, grille and carry handle. All models 8 ohms. Full range 45Hz - 20KHz. Size 20" × 15" × 12". Watts R.M.S. per cabinet. Sensitivity 1W, 1mtr. dB.

OMP 12-100 Watts 100dB. Price £149.99 per pair.
OMP 12-200 Watts 102dB. Price £199.99 per pair.
Delivery: Securicor £8.00 per pair

OMP 19" STEREO RACK AMPS

Professional 19" cased Mos-Fet stereo amps. Used the **World** over in clubs, pubs, discos etc. With twin Vu meters, twin toroidal power supplies, XLR connections. MF600 Fan cooled. **Three models** (Ratings R.M.S. into 4ohms). Input Sensitivity 775mV

MF200 (100 + 100)W. £169.00 **Securicor**
MF400 (200 + 200)W. £228.85 **Delivery**
MF600 (300 + 300)W. £299.99 **£10.00**

1 K-WATT SLIDE DIMMER

- Control loads up to 1Kw
- Compact Size 4½" × 1" × 2½"
- Easy snap in fixing through panel/cabinet cut out
- Insulated plastic case
- Full wave control using 8 amp triac
- Conforms to BS800
- Suitable for both resistance and inductive loads. Innumerable applications in industry, the home, and disco's, theatres etc.

PRICE £13.99 + 75p P&P

LOUDSPEAKERS 5" to 15" up to 400 WATTS R.M.S.

Cabinet Fixing in stock. Huge selection of **McKenzie Loudspeakers** available including Cabinet Plans. **Large S.A.E. (28p) for free details.**

POWER RANGE
8" 50 WATT R.M.S. Hi-Fi/Disco.
20 oz. magnet. 1½" ally voice coil. Ground ally fixing escutcheon. Res. Freq. 40Hz. Freq. Resp. to 6KHz. Sens. 92dB. PRICE £10.99 Available with black grille £11.99. P&P £1.50 ea.
12" 100 WATT R.M.S. Hi-Fi/Disco
50 oz. magnet. 2" ally voice coil. Ground ally fixing escutcheon. Die cast chassis. White cone. Res. Freq. 25Hz. Freq. Resp. to 4KHz. Sens. 95dB. PRICE £28.60 + £3.00 P&P ea.

McKENZIE
12" 85 WATT R.M.S. C1285GP Lead guitar/keyboard/Disco
2" ally voice coil. Ally centre dome. Res Freq 45Hz. Freq. Resp. to 6.5KHz. Sens. 98dB. PRICE £29.99 + £3.00 P&P ea.
12" 85 WATT R.M.S. C1285TC P.A/Disco 2" ally voice coil. Twin cone.
Res. Freq. 45Hz. Freq. Resp. to 14KHz. PRICE £31.49 + £3.00 P&P ea.
15" 150 WATT R.M.S. C15 Bass Guitar/Disco.
3" ally voice coil. Die-cast chassis. Res. Freq. 40Hz. Freq. Resp. to 4KHz. PRICE £57.87 + £4.00 P&P ea.
10" 60 WATT R.M.S. 1060GP Gen. Purpose/Lead Guitar/Keyboard/Mid. P.A.
2" voice coil. Res. Freq. 75Hz. Freq. Resp. to 7.5KHz. Sens. 99dB. PRICE £19.99 + £2.00 P&P
10" 200 WATT R.M.S. C10200GP Guitar, Keyboard, Disco.
2" voice coil. Res. Freq. 45Hz. Freq. Resp. to 7KHz. Sens. 101dB. PRICE £44.76 + £3.00 P&P
15" 200 WATT R.M.S. C15200 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 5KHz. Sens. 101dB. PRICE £62.41 + £4.00 P&P
15" 400 WATT R.M.S. C15400 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 4KHz. Sens. 102dB. PRICE £89.52 + £4.00 P&P.

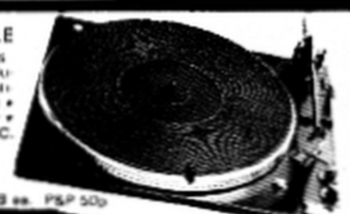
WEM
5" 70 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 52Hz. Freq. Resp. to 5KHz. Sens. 89dB. PRICE £22.00 + £1.50 P&P ea.
8" 150 WATT R.M.S. Multiple Array Disco etc.
1" voice coil. Res. Freq. 48Hz. Freq. Resp. to 5KHz. Sens. 92dB. PRICE £32.00 + £1.50 P&P ea.
10" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 92dB. PRICE £36.00 + £2.00 P&P ea.
12" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1½" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 94dB. PRICE £47.00 + £3.00 P&P ea.

SOUNDLAB (Full Range Twin Cone)
5" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil. Res. Freq. 63Hz. Freq. Resp. to 20KHz. Sens. 86dB. PRICE £9.99 + £1.00 P&P ea.
6½" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1" voice coil. Res. Freq. 56Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £10.99 + £1.50 P&P ea.
8" 60 WATT R.M.S. Hi-Fi/Multiple Array Disco etc.
1¼" voice coil. Res. Freq. 38Hz. Freq. Resp. to 20KHz. Sens. 89dB. PRICE £12.99 + £1.50 P&P ea.
10" 60 WATT R.M.S. Hi-Fi/Disco etc.
1¼" voice coil. Res. Freq. 35Hz. Freq. Resp. to 15KHz. Sens. 89dB. PRICE £16.49 + £2.00 P&P

BSR P295 ELECTRONIC TURNTABLE

- Electronic speed control 45 & 33⅓ r.p.m.
- Plus Minus variable pitch control
- Belt driven
- Aluminium platter with strobed rim
- Cue lever
- Anti-skate (bias device)
- Adjustable counter balance
- Manual arm
- Standard ½" cartridge fixings
- Supplied complete with cut out template
- D.C. Operation 9-14v D.C. 65mA

Price £36.99 £3.00 P&P



ADC Q4 mag. cartridge for above. Price £4.99 ea. P&P 50p

PIEZO ELECTRIC TWEETERS - MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is **not** required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**

TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.90 each + 40p P&P.**
TYPE 'B' (KSN1005A) 3½" super horn. For general purpose speakers, disco and P.A. systems etc. **Price £5.99 each + 40p P&P.**
TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £6.99 each + 40p P&P.**
TYPE 'D' (KSN1025A) 2" × 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. **Price £9.99 each + 40p P&P.**
TYPE 'E' (KSN1038A) 3½" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £5.99 each + 40p P&P.**
LEVEL CONTROL Combines on a recessed mounting plate, level control and cabinet input jack socket. 85 × 85 mm. **Price £3.99 + 40p P&P.**

PANTEC HOBBY KITS

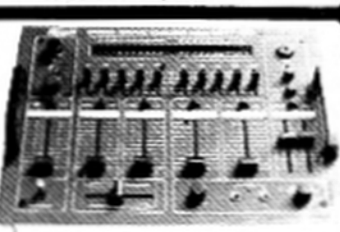
Proven designs including glass fibre printed circuit board and high quality components complete with instructions.

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 × 46 × 14mm (9 volt). **Price: £8.62 + 75p P&P.**
3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled professional performance. Range up to 3 miles 35 × 84 × 12mm (12 volt) **Price: £14.49 + 75p P&P.**
SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/RECEIVER 27MHz. Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 × 70 × 22mm (9/12 volt). **Price: £17.82 Transmitter 80 × 50 × 15mm (9/12 volt). Price: £11.29 P&P + 75p each.** S.A.E. for complete list.

3 watt FM Transmitter

STEREO DISCO MIXER

STEREO DISCO MIXER with 2 × 5 band L. & R. graphic equalisers and twin 10 segment L.E.D. Vu Meters. **Many outstanding features.** 5 Inputs with individual faders providing a useful combination of the following:— 3 Turntables (Mag), 3 Mics, 4 Line plus Mic with talk over switch. Headphone Monitor. Pan Pot. L. & R. Master Output controls. Output 775mV. Size 360 × 280 × 90mm.
Price £134.99 — £3.00 P&P



VISA

POSTAL CHARGES PER ORDER £1.00 minimum. OFFICIAL ORDERS WELCOME, SCHOOLS, COLLEGES, GOVERNMENT BODIES, ETC. PRICES INCLUSIVE OF V.A.T. SALES COUNTER. VISA/ACCESS/C.O.D. ACCEPTED

B. K. ELECTRONICS DEPT ETI

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX. SS2 6TR TEL: 0702-527572

electronics today

INTERNATIONAL

JUNE 1987 VOL 16 NO 6

Gary Herman: Editor
Ian Pitt: Deputy Editor
Paul Chappell: Project Editor
Jerry Fowler: Technical Illustrator
Paul Stanyer: Ad. Manager
Duncan Neilson: Classified Sales Executive
Andrew Selwood: Copy Control
Dave Bradshaw: Group Editor - Electronics

PUBLISHED BY:
Argus Specialist Publications Ltd.,
1 Golden Square, London W1R 3AB,
DISTRIBUTED BY:
Argus Press Sales & Distribution Ltd.,
12-18 Paul Street, London EC2A 4JS
(British Isles)
TYPESET AND ORIGINATION BY:
Design International
PRINTED BY
The Garden City Press Ltd.,
COVER DESIGN BY:
Argus Design
COVERS PRINTED BY:
Loxley Brothers Ltd.,

ABC Member of the Audit Bureau of Circulation

Electronics Today is normally published on the first Friday in the month preceding cover date. The contents of this publication including all articles, designs, plans, drawings and programs and all copyright and other intellectual property rights therein belong to Argus Specialist Publications Limited. All rights conferred by the Law of Copyright and other intellectual property rights and by virtue of international copyright conventions are specifically reserved to Argus Specialist Publications Limited and any reproduction requires the prior written consent of the Company. © 1986 Argus Specialist Publications Ltd U All reasonable care is taken in the preparation of the magazine contents but the publishers cannot be held legally responsible for errors. Where mistakes do occur, a correction will normally be published as soon as possible afterwards. All prices and data contained in advertisements are accepted by us in good faith as correct at time of going to press. Neither the advertisers nor the publishers can be held responsible, however, for any variations affecting price or availability which may occur after the publication has closed for press.

Subscription Rates. UK: £18.10. Overseas: £22.50.
USA: $29.50. Airmail: £49.50.

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

FEATURES

PROJECTS

REGULARS

01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Micro Computer System

BBC Master Series
AMB15 BBC MASTER Foundation computer 128K .... £395 (a)
AMB12 BBC MASTER Econet computer 128K (only ANFS) .... £319 (a)
AMC06 Turbo (65C102) Expansion Module .... £102 (b)
ADF13 Rom Cartridge .... £13 (d)
ADF10 Econet Module .... £43 (c)
ADJ22 Ref. Manual Part I ..... £14.95 (c)
ADJ23 Ref. Manual Part II ..... £14.95 (c)
ADJ24 Advanced Ref. Manual . £19.50 (c)

ACORN ADD-ON PRODUCTS
Z80 2nd Processor .... £329 (a)
6502 2nd Processor .... £160 (b)
Multiform Z80 2nd Processor .... £299 (b)
Acorn Teletext Adaptor .... £125 (b)
Acorn IEEE Interface .... £269 (a)

TORCH Z80 2nd Processor
ZEP100: (64K) .... £229 (a)
TZDP240: ZEP100 with Technomatic PD800P dual drive with built-in monitor stand .... £449 (a)

UPGRADE KITS
1770 DFS Upgrade for Model B £43.50 (d)
Dual Disc Controller Board for Model B incl. 1770 controller .... £35 (a)
1.2 OS ROM .... £15 (d)
DNFS ROM .... £17.50 (d)
ADFS Rom (for B with 1770 DFS & B Plus) .... £26 (d)
64K Upgrade Kit for B Plus .... £35 (d)

ECONET ACCESSORIES
Econet Starter kit .... £85 (d)
Econet Socket Set .... £29 (c)
Econet Bridge .... £174 (b)
File Server Level II .... £179 (d)
Printer Server Rom .... £41 (d)
10 Stallion 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.

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

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 .... £259 (a)
PD800 (2 × 400K/2 × 640K 40/80T DS) .... £239 (a)
TD800 (as PD800 but without psu) .... £209 (a)
TS400 1 × 400K/1 × 640K 40/80T DS .... £109 (b)
PS400 with psu 1 × 400K/1 × 640K 40/80T DS .... £129 (b)

3.5" DRIVES
1 × 400K/1 × 640K 80T DS TS35 1 .... £109 (b)
PS35 1 with psu .... £121 (b)
2 × 400K/1 × 640K 80T DS TD35 2 .... £189 (b)
PD35 2 with psu .... £209 (b)

3M FLOPPY DISKS

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

5¼" DISCS
40T SS DD £11.00 (d) 40T DS DD £15.00 (d)
80T SS DD £16.50 (d) 80T DS DD £18.50 (d)

3½" DISCS
80T SS DD £20.00 (d)
80T DS DD £27.00 (d)

PRINTERS

EPSON
LX-80NLQ .... £195 (a)
Optional Tractor Feed .... £20 (c)
FX85 (80col) NLQ 8K RAM ... £321 (a)
FX80 .... £260 (a)
FX105 (136col) .... £449 (a)
LQ800 (80col) .... £479 (a)
LQ1000 (136col) .... £729 (a)
JX80 4 colour .... £420 (a)

TAXAN KP810 (80col) NLQ ... £225 (a)
TAXAN KP910 (156col) .... £369 (a)
JUKI 5510 (80col) NLQ .... £239 (a)
JUKI 6100 Daisy Wheel ...... £249 (a)
BROTHER HR15 Daisy Wheel £325 (a)
BROTHER M1109 (80col) ..... £179 (b)
BROTHER M1409 (80col) ..... £299 (a)
BROTHER M1509 (136col) ... £399 (a)
CANNON PJ1080A .... £409 (a)
EPSON HI80 A4 Plotter ...... £325 (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)
FX80 Tractor attachment .... £37.00 (c)
Interfaces: 8143 RS232 .... £28.00 (c)
8148 RS232 + 2K .... £57.00 (c)
8132 Apple II .... £60.00 (c)
8165 IEEE + cable .... £65.00 (c)
Serial & Parallel Interfaces with larger buffers available.
Ribbons: RX/FX/MX80 .... £5.00 (d)
RX/FX/MX100 .... £10.00 (d)
LX80 .... £8.00 (d)
Spare pens for H180 .... £7.50/set (d)
FX80 Tractor Attachment £37 (c)

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

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

BROTHER HR15:
Sheet Feeder .... £189 (a)
Tractor Feeder .... £99 (a)
Ribbons Carbon or Nylon .... £4.50 (d)
Red Correction Ribbon .... £2.00 (d)

BBC Printer Lead:
Parallel (42") .... £7.00 (d)
Serial .... £7.00 (d)
Printer Leads can be supplied to any length

DISC ACCESSORIES

FLOPPICLENE Disc Head Cleaning Kit with 20 disposable cleaning discs ensures continued optimum performance of the drives .... 3½" £16 (d), 5¼" £14.50 (d)

Single Disc Cable .... £6 (d)
10 Disc Library Case .... £1.80 (c)
40 Disc Lockable Box .... £14 (c)
Dual Disc Cable .... £8.50 (d)
30 Disc Case .... £6 (c)
100 Disc Lockable Box .... £19 (c)

MICROVITEC

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

14" RGB
1431 Std Res .... £179 (a)
1451 Med Res .... £225 (a)
1441 Hi Res .... £365 (a)

14" RGB with PAL & Audio
1431 AP Std Res .... £195 (a)
1451 AP Med Res .... £275 (a)

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

20" RGB with PAL & Audio
2030CS Std Res .... £380 (a)
2040CS Hi Res .... £885 (a)

TAXAN SUPERVISION III with amber/green option, BBC & IBM ... £325 (a)
MITSUBISHI XC1404 14" RGB Med Res IBM & BBC Compatible .. £229 (a)

MONOCHROME MONITORS:

TAXAN KX1201G Hi Res 12" Etched Green Screen .... £90 (a)
TAXAN KX1202G Hi Res 12" Long Persistence (P39) .... £98 (a)
TAXAN KX1203A Hi Res 12" Etched Amber Screen .... £98 (a)
PHILIPS BM7502 12" Hi Res Green Screen .... £75 (a)
PHILIPS BM7522 12" Hi Res Amber Screen .... £79 (a)
Swivel Base for Kaga Monochrome fitted with Digital Clock .... £21 (c)

MODEMS

— All modems listed below are BT approved

SPECIAL OFFER

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

MIRACLE 2000
A world standard modem covering V21, V23 (Bell 103/113/108 outside UK) and including 75, 300, 600, 1200 baud ratings. Optional Auto dial, auto answer cards, complete control from computer keyboard. WS2000 £95 c

GEC DATACHAT 1223:
BABT approved modem complying with CCITT V23 standard. Supplied with software .... £69 (b)

Data Cables for above modems available for most computers.

SPECIAL OFFER

2764-25 .... .. £2.00
27128-25 ...... £2.50
6264LP-15 .... £3.40

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 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)

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
28 pin £9.00
24-pin £7.50
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 (ZX61)	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	IDC
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 36 way 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
24" Single end Female
24" Female Female
24" Male Male
24" Male Female

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

RIBBON

(grey/metre)

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

DIL HEADERS

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

TECH NOLI NE 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	30p
7417	40p
7420	30p
7421	60p
7422	36p
7423	36p
7425	40p
7426	40p
7427	40p
7428	43p
7430	30p
7432	36p
7433	30p
7437	30p
7438	40p
7439	40p
7440	40p
7441	80p
7442A	70p
7443A	100p
7444	110p
7445	100p
7446A	100p
7447A	100p
7448	120p
7450	36p
7451	35p
7453	38p
7454	38p
7460	55p
7470	50p
7472	55p
7473	55p
7474	50p
7475	60p
7476	45p
7480	65p
7481	180p
7483A	105p
7484A	125p
7485	110p
7486	42p
7489	210p
7490A	55p
7491	70p
7492A	70p
7493A	55p
7494	110p
7495A	80p
7496	80p
7497	210p
74100	180p
74107	60p
74109	75p
74110	75p
74111	55p
74116	170p
74118	110p
74119	170p
74120	100p
74121	55p
74122	70p
74123	60p
74125	65p
74126	55p
74128	65p
74132	75p
74136	70p
74141	60p
74142	250p
74143	270p
74144	270p
74145	110p
74147	170p
74148	140p
74150	175p
74151A	70p
74153	60p
74154	140p
74155	80p
74156	80p
74157	80p
74159	175p
74160	110p
74161	80p
74162	110p
74163	110p
74164	120p
74165	110p
74166	140p
74167	400p
74170	200p
74172	420p
74173	140p
74174	110p
74175	105p
74176	100p
74178	150p
74179	150p
74180	100p
74181	340p
74182	140p
74184	180p
74185A	180p
74190	130p
74191	130p
74192	110p
74193	115p
74194	110p
74195	80p
74196	130p
74197	110p
74198	220p
74199	220p
74221	110p
74251	100p
74259	150p
74265	380p
74273	200p
74276	140p
74278	170p
74279	80p
74283	105p
74285	320p
74290	80p
74293	80p
74298	180p
74351	200p
74365A	80p
74366A	80p
74367A	80p
74387A	80p
74368A	70p
74376	180p
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	24p
74LS43	150p
74LS47	80p
74LS48	80p
74LS49	100p
74LS51	24p
74LS54	24p
74LS55	24p
74LS73A	35p
74LS74A	35p
74LS75	45p
74LS76A	36p
74LS83A	70p
74LS85	75p
74LS86	35p
74LS90	45p
74LS91	80p
74LS92	55p
74LS93	54p
74LS95B	75p
74LS96	80p
74LS107	40p
74LS109	40p
74LS112	45p
74LS113	45p
74LS114	45p
74LS122	70p
74LS123	80p
74LS124/629	140p
74LS125	80p
74LS126	80p
74LS132	65p
74LS133	40p
74LS136	45p
74LS138	55p
74LS139	55p
74LS145	95p
74LS147	175p
74LS148	140p
74LS151	65p
74LS152	200p
74LS153	65p
74LS154	150p
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	180p
74LS190	75p
74LS191	75p
74LS192	80p
74LS193	80p
74LS194A	75p
74LS195A	75p
74LS196	80p
74LS197	80p
74LS221	80p
74LS240	80p
74LS241	80p
74LS242	80p
74LS243	80p
74LS244	80p
74LS245	110p
74LS247	110p
74LS248	110p
74LS249	110p
74LS251	75p
74LS253	75p
74LS256	80p
74LS257A	70p
74LS258A	70p
74LS259	120p
74LS260	75p
74LS261	120p
74LS266	80p
74LS273	125p
74LS279	70p
74LS280	180p
74LS283	80p
74LS290	80p
74LS292	800p
74LS293	80p
74LS295	140p
74LS297	£9
74LS298	100p
74LS299	220p
74LS321	370p
74LS323	300p
74LS324	320p
74LS348	200p
74LS352	120p
74LS353	120p
74LS356	210p
74LS363	180p
74LS364	180p
74LS365	60p
74LS366	50p
74LS367	60p
74LS368A	50p
74LS373	80p
74LS374	80p
74LS375	75p
74LS377	130p
74LS378	85p
74LS379	130p
74LS381	450p
74LS385	325p
74LS390	80p
74LS393	100p
74LS395A	100p
74LS399	140p
74LS445	180p
74LS465	120p
74LS487	120p
74LS490	150p
74LS540	100p
74LS541	100p
74LS608	700p
74LS610	1000p
74LS612	1000p
74LS624	350p
74LS626	225p
74LS628	225p
74LS629	125p
74LS640	200p
74LS640-1	300p
74LS641	150p
74LS642-1	300p
74LS643	280p
74LS643-1	300p
74LS644	350p
74LS645	200p
74LS645-1	400p
74LS668	80p
74LS669	80p
74LS670	170p
74LS682	250p
74LS684	350p
74LS687	350p
74LS688	350p
74LS783	£21

74S SERIES

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

4000 SERIES

4000	20p
4001	24p
4002	25p
4006	70p
4007	25p
4008	60p
4009	45p
4010	50p
4011	24p
4012	25p
4013	36p
4014	60p
4015	70p
4016	30p
4017	55p
4018	80p
4019	80p
4020	80p
4021	60p
4022	70p
4023	30p
4024	48p
4025	24p
4026	80p
4027	40p
4028	60p
4029	75p
4030	35p
4031	125p
4032	100p
4033	125p
4034	250p
4035	70p
4036	70p
4037	110p
4038	100p
4039	250p
4040	60p
4041	55p
4042	60p
4043	60p
4044	60p
4045	100p
4046	60p
4047	60p
4048	55p
4049	36p
4050	36p
4051	55p
4052	80p
4053	60p
4054	60p
4055	60p
4056	85p
4059	450p
4060	7[illegible]
4063	85p
4066	40p
4067	230p
4068	25p
4069	24p
4070	24p
4071	24p
4072	24p
4073	24p
4075	24p
4076	65p
4077	25p
4078	25p
4081	24p
4082	25p
4085	50p
4086	75p
4089	120p
4093	35p
4094	80p
4095	80p
4096	80p
4097	270p
4098	75p
4099	80p
4501	35p
4502	55p
4503	36p
4504	65p
4505	360p
4506	60p
4507/4030	35p
4508	120p
4510	55p
4511	55p
4512	55p
4513	150p
4514	110p
4515	110p
4516	55p
4517	220p
4518	40p
4519	32p
4520	60p
4521	115p
4522	80p
4526	70p
4527	80p
4528	65p
4529	100p
4531	75p
4532	65p
4534	380p
4536	250p
4538	75p
4539	75p
4541	80p
4543	70p
4551	100p
4553	240p
4555	36p
4556	36p
4557	240p
4560	140p
4566	140p
4568	240p
4569	170p
4572	45p
4583	60p
4584	48p
4585	60p
4724	150p
14411	750p
14412	750p
14418	300p
14419	260p
14490	420p
14495	450p
14500	650p
14599	200p
22100	350p
22101	700p
22102	700p
40014/4584	
40106	48p
40085	120p
40097	36p
40098	48p
40100	150p
40101	125p
40102	130p
40103	200p
40104	120p
40105	150p
40106	48p
40107	55p
40108	320p
40109	200p
40110	225p
40114	225p
40147	280p
40163	100p
40173/4067	120p
40174	100p
40175	100p
40192	100p
40244	150p
40245	150p
40257	180p
40373	180p
40374	180p
80C95	75p
80C97	75p
80C98	75p

LINEAR ICs

AD7581	£15
ADC0808	1150p
AM7910DC	£25
AN103	320p
AY-1-5050	100p
AY-3-1350	450p
AY-3-8910	450p
AY-3-8912	550p
CA3019A	100p
CA3028A	110p
CA3046	70p
CA3059	300p
CA3060	300p
CA3080E	70p
CA3086	50p
CA3089E	210p
CA3090AQ	375p
CA3130E	90p
CA3130T	130p
CA3140E	45p
CA3140T	100p
CA3160E	100p
CA3161E	160p
CA3162E	450p
CA3189E	275p
CA3240E	120p
CA3280G	275p
D7002	£8
DAC1408-8	300p
DAC0800	300p
DAC0808	300p
HA1366	180p
ICL7106	675p
ICL7611	95p
ICL7650	400p
ICL7660	250p
ICL8038	300p
ICM7216B	£22
ICM7217	750p
ICM7555	80p
ICM7556	140p
LC7120	300p
LC7130	350p
LC7137	350p
LF347	130p
LF351	50p
LF353	90p
LF355	90p
LF356N	110p
LF357	100p
LM10C	400p
LM301A	30p
LM307	45p
LM308CN	75p
LM310	300p
LM311	80p
LM318	180p
LM319	180p
LM324	45p
LM334Z	115p
LM335Z	130p
LM336	180p
LM339	45p
LM348	60p
LM358P	90p
LM377	180p
LM380N-8	180p
LM380	100p
LM381AN	170p
LM382	180p
LM383	325
LM384	220
LM386N-1	100p
LM387	270p
LM389	180p
LM391	180p
LM392N	110p
LM393	300p
LM394CH	400p
LM709	80p
LM710	45p
LM711	100p
LM723	30p
LM725CN	400p
LM733	100p
LM741	18p
LM747	70p
LM748	35p
LM1011	400p
LM1014	180p
LM1801	300p
LM1830	300p
LM1871	300p
LM1872	300p
LM1886	300p
LM1889	300p
LM2917	300p
LM3302	80p
LM3900	80p
LM3909	100p
LM3911	100p
LM3914	300p
LM3915	300p
LM3916	300p
LM13600	180p
M51513L	300p
M51516L	300p
MB3712	250p
MC1310P	180p
MC1413	75p
MC1458	45p
MC1495L	300p
MC1496	70p
MC3340P	120p
MC3401	70p
MC3403	80p
MF10CN	400p
MK50240	80p
MK50398	750p
ML920	400p
ML922	400p
MM58221A	300p
NE531	130p
NE544	180p
NE555	80p
NE556	80p
NE564	400p
NE565	180p
NE566	180p
NE567	125p
NE570	400p
NE571	400p
NE592	100p
NE5532P	180p
NE5533P	180p
NE5534P	100p
NE5534AP	140p
OP-07EP	300p
PLL02A	500p
RC4136	60p
RC4151	300p
RC4558	60p
S566B	300p
SAA1900	£16
SFF96364	£8
SL490	300p
SN76033N	300p
SN76489	400p
SN76495	400p
SP0256AL2	750p
TA7120	130p
TA7130	140p
TA7204	180p
TA7205	80p
TA7222	150p
TA7310	180p
TBA231	180p
TBA800	80p
TBA810	80p
TBA820	80p
TBA820M	75p
TBA920	300p
TBA950	300p
TC9109	300p
TCA940	175p
TDA1010	300p
TDA1022	600p
TDA1024	110p
TDA1170S	300p
TDA2002	300p
TDA2003	300p
TDA2004	300p
TDA2006	300p
TDA2020	300p
TDA2030	300p
TDA2593	300p
TDA3810	750p
TDA7000	300p
TEA1002	750p
TL061CP	40p
TL062	80p
TL064	90p
TL071	40p
TL072	70p
TL074	110p
TL081	30p
TL082	60p
TL083	75p
TL084	100p
TL094	180p
TL170	50p
UA759	300p
UA2240	150p
UAA170	170p
UCN4801A	300p
ULN2003A	75p
ULN2004A	75p
ULN2068	300p
ULN2802	180p
ULN2803	180p
ULN2804	180p
UPC575	275p
UPC592H	200p
UPC1156H	300p
UPC1185H	300p
XR210	400p
XR2206	375p
XR2207	375p
XR2211	575p
XR2216	675p
XR2240	120p
ZN409	180p
ZN414	80p
ZN419P	175p
ZN423E	130p
ZN424E	130p
ZN425E8	300p
ZN426E	300p
ZN427E	600p
ZN428E	400p
ZN429E8	300p
ZN447E	£9.50
ZN449E	300p
ZN450E	750p
ZN459CP	300p
ZN1034E	200p
ZN1040E	600p
ZNA134J	£23
ZNA234E	300p

VOLTAGE REGULATORS

FIXED PLASTIC

		+ve		+ve	
1A 5V		7805	45p	7905	60p
6V		7806	50p	7906	80p
18V		7808	50p	7908	60p
12V		7812	45p	7912	80p
15V		7815	50p	7915	60p
18V		7818	50p	7918	80p
24V		7824	50p	7924	50p
5V	100mA	78L05	30p	79L05	45p
8V	100mA	78L08	30p		
12V	100mA	78L12	30p	79L12	50p
15V	100mA	78L15	30p	79L15	50p

OTHER REGULATORS

Fixed Regulators		
LM309K	1A 5V	140p
LM323K	3A 5V	250p
78H05KC	5A 5V	575p
78H12	5A 12V	750p
Variable Regulators		
LM305AH		250p
LM317T	TO-220	150p
LM317K	TO3	240p
LM337T	3A+VAR	225p
LM350T	5A+VAR	400p
LM396K	10A+VAR	£15
LM723N		50p
78HGKC	5A+VAR	650
79HGKC	5A+VAR	675p
78GUIC	1A+VAR	225p
79GUIC	1A+VAR	250p
Switching Regulators		
ICL7660		250p
SG3524		300p
TL494		300p
TL497		300p
78S40		250p

COMPUTER COMPONENTS

CPU

1802CE	650p
2650A	1050p
6502	400p
6502A	450p
65C02A	£15
6800	250p
6802	300p
6809	650p
6809E	£8
68B09	£10
68B09E	£12
68000-LB	£36
8035	350p
8039	420p
80C39	700p
8080A	420p
8085A	300p
80C85A	900p
8086	£22
8088	1750p
8741	£12
8748	£16
TMS9980	£14.50
TMS9995	£12
Z80	250p
Z80A	290p
Z80B	550p
Z80CMOS (CMOS Z80)	750p

8279	£11
8282	300p
8284	600p
8287	300p
8288D	600p
8755A	£18
TMS9901	£14
TMS9901	300p
TMS9902	600p
TMS9911	£18
TMS9914	£14
Z80PIO	300p
Z80APIO	300p
Z80BPIO	600p
Z80CTC	300p
Z80ACTC	375p
Z80BCTC	600p
Z80DART	650p
Z80ADART	750p
TMS4500	£14
TMS9901	600p
TMS9902	600p
Z80DMA	750p
Z80ADMA	750p
Z80ASIO-0/1/2 /9	700p
Z80BP10	600p
Z80BCTC	600p
Z80DART	600p
Electrically programmable and erasable PROMS	
2816-30	£15
9306	600p

SUPPORT DEVICES

2651	£12
3242	600p
3245	600p
6520	300p
6522	600p
6522A	600p
6532	600p
6551	300p
6821	150p
68B21	300p
6829	£12.50
6840	375p
68B40	600p
6850	160p
68B50	300p
6852	600p
6854	600p
68B54	300p
6875	600p
8154	300p
8155	600p
8156	300p
8205	600p
8212	300p
8216	160p
8224	300p
8226	600p
8228	600p
8243	300p
8250	600p
8251A	300p
8253C-5	300p
8255AC-5	320p
8256	£18
8257C-5	400p
8259C-5	400p
8275	£29

EPROMs

2516+5v	300p
2516-35	300p
2532	600p
2532-30	300p
2564	£11
2708	600p
2716+5v	300p
2716-35	300p
2732	600p
2732A-2	600p
2732A-35	£7
2764-25	200p
27C64-25	£10
27128-25	250p
27128-30	600p
27256	£5
TMS2716	600p

CRT CONTROLLER

CRT5027	£18
CRT5037	£12
CRT8545	£9
EF9364	£8
EF9365	£25
EF9366	£25
EF9367	£36
MC6845	300p
MC6845SP	600p
MC6847	600p
SFF96364	£8
TMS9916	£18
TMS9928	£10
TMS9929	£10

INTERFACE ICs

AD558CJ	775p
AD561J	£20

AD7581	£18
ADC0808	1150p
AM25S10	300p
AM25LS2521	300p
AM25LS2538	300p
AM26LS31	120p
AM26LS32	120p
D7002	£9
DAC80-CB1-V	£28
DM8131	300p
DP8304	300p
DS3691	300p
DS8830	140p
DS8831	180p
DS8832	150p
DS8833	600p
DS8835	300p
DS8836	150p
DS8838	600p
MC1488	60p
MC1489	60p
MC3446	300p
MC3459	600p
MC3470	475p
MC3480	600p
MC3418L	300p
MC3486	300p
MC3487	300p
MC4024	600p
MC4044	600p
MC14411	600p
MC14412	750p
ULN2003	75p
ULN2004A	75p
ULN2068	300p
ULN2802	180p
ULN2803	180p
ULN2804	180p
75107	80p
75108	80p
75109	120p
75110	80p
75112	180p
75113	120p
75114	140p
75115	140p
75121	140p
75122	140p
75150P	120p
75154	180p
75159	300p
75160	600p
75161	300p
75162	600p
75172	300p
75182	80p
75188	80p
75189	60p
75365	150p
75450	60p
75451	80p
75452	60p
75453	75p
75454	70p
75480	150p
75491	65p
75492	65p
8T26	120p
8T28	180p
8T95	120p
8T96	120p
8T97	180p
8T98	180p

81LS95	140p
81LS96	140p
81LS97	140p
81LS98	140p
88LS120	300p
9602	300p
9636A	160p
9637AP	160p
9638	190p
ZN425E8	350p
ZN426E8	350p
ZN427E	600p
ZN428E8	450p
ZN429E	210p
ZN447E	900p

MEMORIES

2016-150	400p
2101	400p
2102	250p
2107B	500p
2111A-35	400p
2114-3L	250p
2147	400p
4116-15	200p
4416-15	300p
4532-20	250p
4816AP-3	300p
5101	370p
5514	450p
5516	550p
6116P-3	350p
6116LP-3	400p
6264-15	700p
6264LP-15	340p
6810	260p
74S189	225p
74S201	350p
74S289	225p
93415	600p
93L422	950p
93425	600p

ROMS/PROMs

28L22	400p
24S10	250p
18S030	200p
18SA030	200p
74S188	180p
74S287	225p
74S288	180p
74S387	225p
82S23	150p
82S123	150p

DISC CONTROLLER ICs

756A	£10
6843	£8
8271	£48
8272	£12
D765A	£13
FD1771	£20
FD1791	£20
FD1793	£20
FD1797	£22
WD2793	£27
WD2797	£27
WD1691	£15
WD2143	£12

CHARACTER GENERATORS

R03-32513	
UC	850p
LC	850p

KEYBOARD ENCODERs

AY 5 2376	1150p
74C922	500p
74C923	600p

BAUD RATE GENERATORS

MC14411	750p
COM8116	650p
4702B	750p

UARTs

AY-3-1015P	300p
AY-5-1013P	300p
COM8017	300p
IM6402	450p

UHF MODULATORS

6MHz UHF	375p
MHz UHF	450p
Sound & Vision 12MHz	£12

CRYSTALS

32.768 KHz	100p
100 KHz	400p
1.00MHz	270p
Freq in MHz	
1.8432	225p
2.00	255p
2.45760	200p
2.5	250p
2.662	250p
3.12MHz	175p
10.00MHz	175p
3.276	150p
3.5795	100p
4.00	140p
4.194	150p
4.43	100p
4.608	250p
4.9152	200p
5.000	150p
6.00	140p
17.734	200p
7.00	150p
7.168	175p
8.00	150p
8.867	175p
10.50	250p
10.70	150p
11.00	300p
12.00	150p
14.00	175p
14.318	160p
14.756	250p
15.00	200p
16.00	200p
18.00	170p
18.432	150p
19.969	150p
20.00	175p
24.00	150p
48.000	175p
116	250p
PXO1000	£12

REAL TIME CLOCK

MC6818P	400p
MM58174AN	990p
MSM5832RS	350p

TELETEXT DECODER

SAA5020	600p
SAA5030	700p
SAA5041	£16
SAA5050	900p

Turned Pin Low Profile Sockets

8 pin	25p	22 pin	50p
14 pin	30p	24 pin	65p
16 pin	35p	28 pin	65p
18 pin	40p	40 pin	90p
20 pin	45p		

LOW PROFILE SOCKETS BY TEXAS

8 pin	30p	22 pin	22p
14 pin	10p	24 pin	24p
16 pin	11p	28 pin	26p
18 pin	16p	40 pin	30p
20 pin	18p		

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	22 pin	75p
14 pin	30p	24 pin	75p
18 pin	42p	28 pin	100p
18 pin	50p	40 pin	130p
20 pin	66p		

OPTO-ELECTRONICS

		MAN4640	200p
		MAN6610	200p
		NSB5881	570p
		TIL311	650p
FND357	100p		
MAN74/DL704	100p		
MAN71/DL707	100p	MAN8910	120p
MAN3640	175p		
TIL32	75p	TIL78	75p
TIL31A	120p	TIL81	120p
TIL100	90p	SFH305	100p

DRIVER

9368	350p

COUNTERS

74C925	650p
74C926	650p
74C928	650p
ZN1040	670p

OPTO-ISOLATORS

ILQ74	130p	TIL111	70p
MCT26	100p	TIL112	70p
MCS2400	190p	TIL113	70p
MOC3020	150p	TIL116	70p
ILQ74	220p	16N137	360p
		6N139	175p

LEDS

TIL209 Red	12p
TIL211 Green	15p
TIL212 Yellow	20p
TIL220 Red	15p
TIL212 Green	18p
TIL226 Yellow	22p
Bar Arrays	
Red (10)	225p
Green (10)	225p
RECT. LEDS	
Red, Green, Yellow	30p

'Please note all prices are subject to change without notice.'

We also stock a large range of Transistors, Diodes, Bridge Rectifiers, Triacs, Thyristors and Zeners. Please call for details.

TECHNOMATIC LTD

MAIL ORDERS TO: 17 BURNLEY ROAD, LONDON NW10 1ED
SHOPS AT: 17 BURNLEY ROAD, LONDON NW10
(Tel: 01208 1177) Telex. 922800
305 EDGWARE ROAD, LONDON W2

PLEASE ADD 50p p&p & 15% VAT
(Export: no VAT, p&p at Cost)
Orders from Government Depts. & Colleges etc. welcome.
Detailed Price List on request.
Stock items are normally by return of post

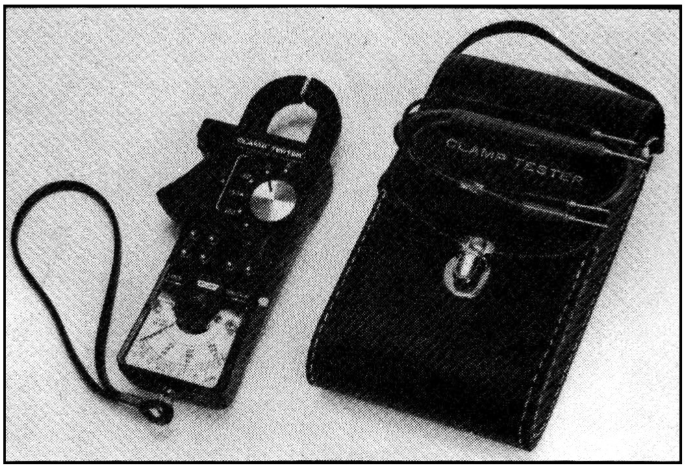
● **West Hyde claims to be the leading supplier of cases and accessories to the UK electronics industry. The company's Spring 1987 catalogue contains 104 A4 pages and lists both metal and plastic enclosures suitable for just about every imaginable application. Case accessories such as handles, knobs, feet and ventilation grilles are included and there are also sections devoted to switches, indicators, tools and component storage systems. West Hyde Developments Ltd, 9-10 Park Street Industrial Estate, Aylesbury, Buckinghamshire HP20 1ET. Tel (0296) 20441.**

● GP Electronic Services has acquired a small number of the Symot cassette mechanisms specified for use in last month's Telfax project. The mechanisms are designed for use with endless tape cassettes as explained in the text and GP is offering them for an all-inclusive price of £15 while stocks last. Contact GP Electronic Services, 87 Willowtree Avenue, Durham DH1 1DZ.

● *From somewhere or other Greenweld Electronics has managed to acquire a stock of the defunct Enterprise 64 computer. There are several hundred of them, all brand new and boxed, and they are being offered at an all-inclusive price of £39.95. For that you get a Z80-based machine with 64K of RAM, 256 colours and on-board word processor. Greenweld Electronics Ltd, 443 Millbrook Road, Southampton SO1 0HX. Tel (0703) 772 501.*

● IC Electronics offers a wide range of products by mail-order including components, tools, electrical appliances, records and games. The company's latest catalogue includes an extensive selection of telephones and accessories plus watches, clocks, calculators, car loudspeakers, tape players and many more items. Copies cost 60p (refunded on first order) from IC Electronics Business Centre, PO Box 130, Aberdeen AB9 8QH.

● **Sage Audio has developed a dual-rail power supply module which is said to offer the smoothest regulated DC output on the market. It is designed for use in pre-amplifiers and offers 200mA at either ±12V, ±15V, ±18V or ±36V. Sage claims the output noise and ripple level is 1000 times less than obtained from 78/79 series IC regulators and that the unit also offers improved line and load regulation. Prices start at £20 inclusive. Sage Audio, Construction House, Whitley Street, Bingley, West Yorkshire BD16 4JH. Tel (0274) 568 647.**



Low-Cost AC Clamp Tester

Clare Instruments has introduced a clamp tester which is claimed to be the cheapest available in the UK.

It measures DC resistance as well as AC voltage and current and costs £32 plus VAT.

Like other clamp testers, the Clare ST 300 uses a current transformer to measure the AC current flowing in a conductor. This removes the need to break into a circuit to make current measurements, simplifying the test procedure and greatly reducing the risks where mains voltages are involved.

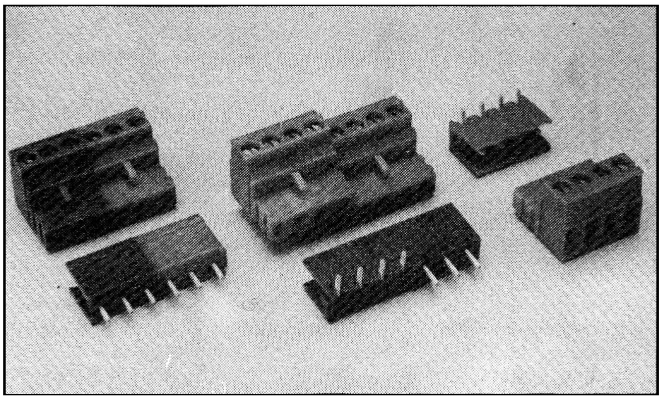
In use, the jaws of the tester are simply clamped around the current-carrying conductor. Cables of up to 28mm overall diameter can be accommodated and the current is displayed in five ranges with FSDs from 6A to 300A.

AC voltage is measured using a set of plug-in test leads and displayed in three ranges, from 150 to 600V FSD. The fuse-protected resistance range also uses the plug-in leads and has an FSD of 1k0 and a centre-scale value of 30R. Accuracy is ±3% of FSD for voltage and current and ±3% of reading for resistance.

A useful feature is the scale lock which clamps the meter needle in position when operated. This allows readings to be taken in poor light or in awkward positions and the reading preserved for subsequent checking.

The Clare ST 300 measures 196 x 86 x 46mm and comes complete with test leads and 1.5V AA battery in a sturdy carrying case.

Clare Instruments Ltd, Woodsway, Goring-by-Sea, Worthing, West Sussex BN12 4QY. Tel (0903) 502 551.



Many Ways To A Good Connection

Printed circuit board connectors can be made up to any number of ways and colour-coded for identification using a new modular terminal system from Components & Electronics Ltd.

The board-mounting plugs and matching cable sockets are available with two, three or four ways and will slot together to form longer connectors. The plugs have straight or right-angled pins for soldering to a PCB while the sockets are equipped with screw terminals.

A positive latching action prevents accidental disengagement of mated connectors and a series of ridges on one side only provides polarisation. All sizes are available in both red and green versions to allow colour-coding of connector assemblies.

Components and Electronics Ltd, PO Box 88, Haslemere, Surrey GU27 2RF. Tel (0428) 54141.

The Shrinking Compact Disc

Philips and Sony have announced joint plans to develop several new consumer electronics products based on compact disc technology.

With the standard compact disc already well established as an alternative to 12 inch analogue LP's, the two companies have decided to develop a smaller CD which will be able to compete effectively with 7 inch 'single' records.

Single music tracks are already available on standard-sized CDs but reducing the playing time in this way doesn't bring the pro-duction costs down. Existing CD singles are therefore compara-tively expensive.

No standard has been agreed for the new CD single but the initial proposal is that it will be a 3" disc capable of carrying up to 20 minutes of music. New com-pact disc players would handle both sizes of CD while a simple adapter would enable the 3 inch disc to be played on existing equipment.

The two companies are also planning to develop a standard sized compact disc which will carry five minutes of combined music and video. This would complement the larger, longer playing video discs already in use and would prove an ideal medium for pop videos.

The music and video disc would be coloured gold to distinguish it from music-only CDs and the audio track would be replayable on standard compact disc players.

In time, it is anticipated that companies will develop combina-tion optical disc players providing both audio and video outputs of high quality. These would handle all the different sizes of disc now in use or under development.

Amstrad Gets BBC Apology

The BBC has apologised unreservedly after receiving a libel writ from Amstrad.

The action followed the publication of an article in Ariel, the BBC's house magazine, which questioned the safety of Amstrad's PC1512 IBM clone.

Amstrad admits there have been several enquiries about the absence of a mains lead on the 1512 but insists that none is needed. The machine has full BEAB class II certification and can be operated safely without an earth.

Amstrad has accepted the apology and says it will not be pursuing the libel action.

Putting On A Colourful Face

Multi-colour front panels with a professional finish can be produced quickly and easily using a new process devised by Mega Electronics.

The Gedakop system uses thin aluminium sheets which are pre-coated with a light-sensitive photo-resist. A positive artwork carrying the required panel markings is laid over the aluminium sheet which is then exposed in a light box.

The board is developed with water to leave a positive image of the artwork which will accept colour dyes. The dyes will not attach to the non-image area and any excess or unwanted dye can be removed with a stripping solution.

When complete, the aluminium can be sealed to protect the coloured image against scratching and chemical damage.

Mega supply the pre-coated aluminium in a range of sizes from 250 x 230mm up to 500 x 1000mm and in thicknesses from 0.125 to 3.0mm. Twenty-nine different dyes are available and they can be mixed to produce an almost infinite range of colours.

An introductory kit consisting of two pre-coated sheets, black dye and stripping solution costs £16 and further dyes can be obtained for £4.50 each. There is also a comprehensive starter kit costing £43 which includes four 160 x 250mm sheets of aluminium in various thicknesses, four different colour dyes, thinner, touch-up solution, stripper and various accessories. These prices do not include VAT, and there is a £2 post and packing charge on all orders.

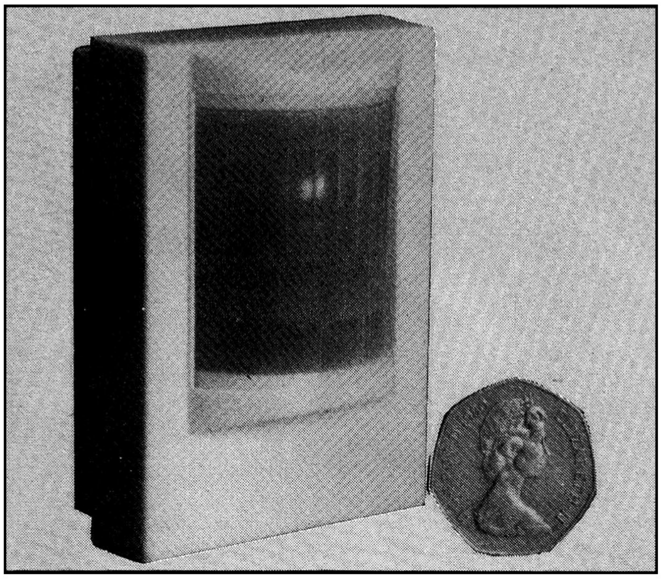
Mega Electronics Ltd, 9 Radwinter Road, Saffron Walden, Essex CB11 3HU. Tel (0799) 21918.

More Jobs In Electronics

41% of employers in the electronics manufactur-ing industry plan to take on more staff during the second quarter of 1987 according to a survey conducted by temporary staff specialist Manpower PLC.

This is slightly higher than the figure for the same period last year (39%) and well up on the 27% recorded during the first quarter of 1987.

The number of employers planning to cut jobs has risen slightly from 11% last quarter to 12% for the next quarter, but this figure is still an improvement on the 15% figure obtained for the same period last year.



Miniature Infra-Red Detector

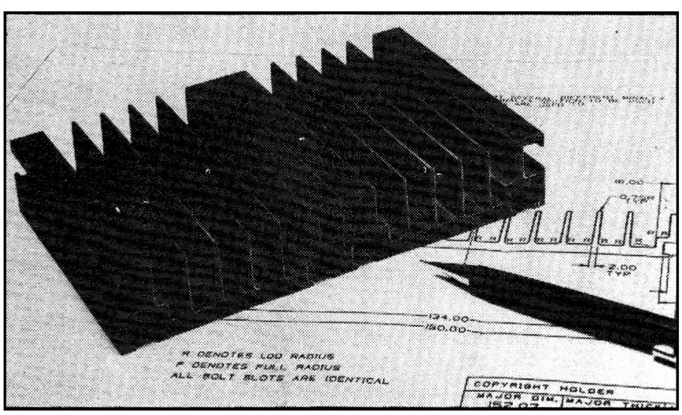
Riscomp has introduced a passive infra-red detector suitable for use in many automation and security applications.

It senses body heat at distances up to 12 metres in an 85° arc and responds by closing a relay. The output could be used to switch on a porch light or an alarm or even to operate an automatic door or other entry control system.

The RP33 detector uses a 24-facet Fresnel lens to give graduated coverage in three vertical planes. This allows the detector to be at its least sensitive near the ground where movements from animals might cause false alarms.

The RP33 is designed for easy installation and its small size (80 x 60 x 40mm) allows it to be hidden in almost any recess. A switchable walk-test facility allows the effective range to be checked during setting-up. Operation is from a 12V supply and full installation instructions are provided.

The RP33 costs £23.95 and is available from Riscomp Ltd, 51 Poppy Road, Princes Risborough, Buckinghamshire HP17 9DB. Tel (08444) 6326.



Boxing Clever With Heatsinks

A new range of heatsinks from Marston-Palmer has an unusual interlocking feature which allows several heatsinks to be connected together to form box structures or large panels.

Known as the Comb-Lok range, the new heatsinks have two lipped grooves on each side, positioned at right angles to each other. When the grove on one extrusion is lined up next to the groove on another, an X-shaped coupling extrusion can be slid into place to lock the heatsinks together. The grooves will also accept caged nuts so that heatsinks can be attached to a panel without being drilled.

Comb-Lok heatsinks are available in ten standard extrusion profiles from 75 x 25mm up to 300 x 40mm and in a range of lengths from 75 to 250mm. Thermal efficiencies range from 3.4°C/W for a 100mm length of 75 x 25mm extrusion down to 0.5°C/W for a 100mm length of 300 x 40mm extrusion.

Marston-Palmer Ltd, Wobaston Road, Fordhouses, Wolverhampton WV10 6QJ. Tel (0902) 783 361.

The latest Rapid Electronics catalogue runs to 128 A4 pages and includes a number of new product lines. Cases and test equipment are among the ranges which have been expanded along with tools, PCB drafting aids and etching kits. Copies are available free-of-charge from Rapid Electronics, Hill Farm Industrial Estate, Boxted, Colchester, Essex CY4 5RD. Tel (0206) 272 730.

● Free from Analog Devices is an 8-page booklet called 'Analogue-to-Digital conversion Using Voltage-to-Frequency Converters'. It describes several methods of using a V-F converter in an ADC system and includes notes and circuit diagrams for a 16-bit converter and several other configurations. Copies are available from Analog Devices, Central Avenue, East Moseley, Surrey KT8 0SN. Tel 01-941 0466.

If owning a dog sounds a bit too much like hard work (all those 'walkies' and trying to read copies of ETI with teeth marks) you may prefer to build TK Electronics' microchip mongrel. Better known as kit XK125, it is designed to deter burglars and simulates the sound of any dog from a terrier to an alsatian. The XK125 kit is not included (as far as we can see) in the otherwise quite comprehensive TK catalogue, but a whole range of other products are, including semiconductors, cases, test equipment and all the usual stuff. Plus, of course, kits. TK Electronics, 13 Boston Road, London W7 3SJ. Tel 01-567 8910.

● **Law enforcement agencies in America are using a high resolution scanning system to speed up the processing and retrieval of fingerprints. Instead of using a conventional ink and paper approach, suspects' finger prints are scanned electronically and then digitized for storage. The resulting data can be found instantly from among a vast number of other prints, can be compared electronically in a computer with other prints to aid identification and can be sent down the telephone line to other police stations and centres. The system is expected to speed up the processing of suspects.**

● *Believe it or not, you can now buy calculators and watches which are said to be water-powered. All they need is to be immersed in water every few months and they will go on working for ages. It all seems too good to be true. If anyone can explain how this works we'd be happy to hear from them. Meanwhile we're trying to obtain a few samples for review.*

NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

KAPELLMEISTERS

Vot do you sink you are doingk listening to zose deredful loudshpeckers. Built a pair of ETI's Kapellmeister transmission line units immediately or suffer ze consequences ov der horrid hi-fi for ze rest of your life.

SURFACE MOUNTING

As commercial electronic equipment gets smaller and smaller ET/ takes a look at the surface mounting process while it's still visible.

TELEPHONE ALARM

In these days of high technology there's no need to disturb the neighbours with a lot of bells and sirens when you're being burgled in your absence. Fit an ETI Telephone Alarm and keep in touch.

AND IN THE BLUE CORNER

Everything you always wanted in an electronics mag but were afraid to even hope for. News, diary, Tech Tips, practical projects, fascinating features, readers' ads, and much, much more. Don't miss it.

Don't miss the July issue of ETI - out 5th June

All the articles listed are in an advanced state of preparation but circumstances beyond our control may prevent publication.

Zenith Electronics

Kits - Modules - Hardware

YOU KNOW US FOR OUR TRANSMITTER KITS - NOW TAKE A LOOK AT OUR GROWING RANGE OF QUALITY KITS AND READY-BUILT PROJECTS. MODULES AND ELECTRONIC HARDWARE

The following are examples of our proven product designs in kit form:

- ★ Miniature FM Transmitter; 60–145MHz. Kit £6.95; R/Built £8.95.
- ★ 3 Watt FM Transmitter, 80–108MHz. Kit £13.99; R/Built £18.99.
- ★ 10 Channel Variable Speed Running Light; Drives LEDs or mains lamps. Kit £14.97.
- ★ 3 Note Electronic Door Chime unit; 9 volt operation, 3 melodious tones; variable frequency. Kit £9.83.
- ★ 300 Watt Light Dimmer unit for 240 volt mains lights. Kit £6.95
- ★ 5 Code Digital Code unit plus Key Pad—select own code; 9 volt. Kit £14.21.
- ★ 5–100 Watt Electronic Loudspeaker Overload Protector, adjustable. Kit £11.11.
- ★ VU Meter 10 LED indicator; –5 to +12dB range. Kit £12.59.
- ★ Automatic light controller; automatically turns on and off lights at pre-set times and triggered by darkness. Kit £25.08.
- ★ Mains Wiring and Metal Detector; complete with case. £11.00
- ★ Digitial Clock module; 12–24 hour timing; LED type—£17.49, or LCD type—£22.80.
- ★ Amplifier Power Meter; 10 LED indicator from 0·25–100 Watt Input—9 volt operation. Kit £9.52.
- ★ Light sensitive relay unit; variable sensitivity trigger control; senses light or dark—selectable. Kit £8.45.

ALL KITS CONTAIN FULL INSTRUCTIONS: P.C.B.s AND COMPONENTS.

ALL PRICES INCLUDE VAT AND POSTAGE & PACKING.

OVERSEAS ORDERS—ADD 10% TO ABOVE PRICES.

PLEASE SEND CHEQUE OR POSTAL ORDERS WITH ORDER.

★ S.A.E. For — FREE — Data Pack ★

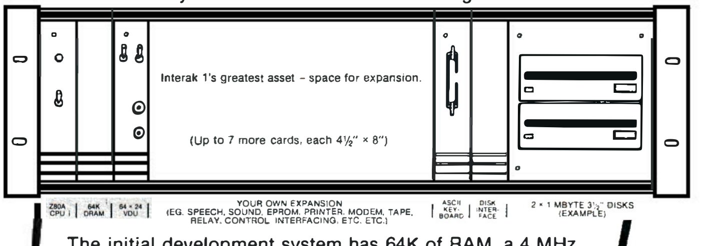
Zenith Electronics, 14 Cortlandt Business Centre, Hailsham, E. Sussex, U.K. BN27 1AE. Tel: 0323 847973 Dept 2.

Interak 1

AN EXPANDABLE DISK-BASED Z80A DEVELOPMENT SYSTEM YOU CAN BUILD YOURSELF!

Universities, Colleges, Industry, Enthusiasts:

Unlike home computers, development systems have entirely "open" architectures, use standard TTL etc. chips (ie no ULA's!), and are built in a proper engineering fashion. Usually these superior products carry a correspondingly superior price tag, but you can build Interak yourself board by board and thus afford a system which would normally be out of your reach and/or understanding.



The initial development system has 64K of RAM, a 4 MHz Z80A CPU, parallel ASCII keyboard interface, VDU Interface (TV set or monitor), and a floppy disk drive interface for up to 4 drives. Any size (including 8" double density) can be used, but our 1 Megabyte 3.5" drives are proving very popular because they can fit into the system rack, (and they only cost £94.00 each + VAT). CP/M Plus is available, giving access to thousands of "public domain" programs.

The system can be described as "future proof" because it uses plug in 4.5" × 8" cards in an industrial quality 19" 3U rack. We have been established since 1970, and this system was first made in 1977 so (unlike almost all other computers) it has stood the test of time.

Send two second class stamps, or telephone for a detailed descriptive leaflet, specification, prices, etc.

Greenbank

Greenbank Electronics (Dept T6E), 460 New Chester Road, Rock Ferry, Birkenhead Merseyside L42 2AE. Tel: 051-645 3391

British Electronics Week — 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.

UK Telecommunications Networks: Present & Future — June 2-3rd
IEE, London. Conference. Contact the IEE at the address below.

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

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.

Condition Monitoring For Safety — June 25th
Regent Crest Hotel, London. Seminar and Exhibition. Contact ERA Technology on (0372) 374 151.

Satellite Communication Systems — July 26-31st
University of Surrey. Vacation school organised by the IEE. Contact them at the address below.

Designing For Electromagnetic Compatibility — September 13-18th
University of Sussex. Vacation school organised by the IEE. See address below.

Design Engineering Show — September 15-18th
NEC, Birmingham. Exhibition and conference covering all areas of engineering including electronics and CAD/CAM. Contact Cahners on 01-891 5051.

IDEX '87 — September 21-23rd
Metropole Exhibition Halls, Brighton. See April '87 ETI or contact Nutwood Exhibitions on (04848) 25891.

Automotive Electronics — October 12-15th
The IEE, London. International conference organised by the IEE in conjunction with many other professional bodies. Contact them at the address below.

Radar '87 — October 19-21st
Kensington & Chelsea Town Hall, London. International conference on civil and military systems organised by the IEE and the American IEEE. Contact the IEE at the address below.

International Video & Communications Exhibitions — October 18-21st
Metropole Exhibition Centre, Brighton. Exhibition with seminar programme covering video equipment, services, programme production, etc. Contact Peter Peregrinus Ltd at the IEE address below.

Electronic Displays — November 17-19th
Kensington Exhibition Centre, London. Contact Network Events at the address below.

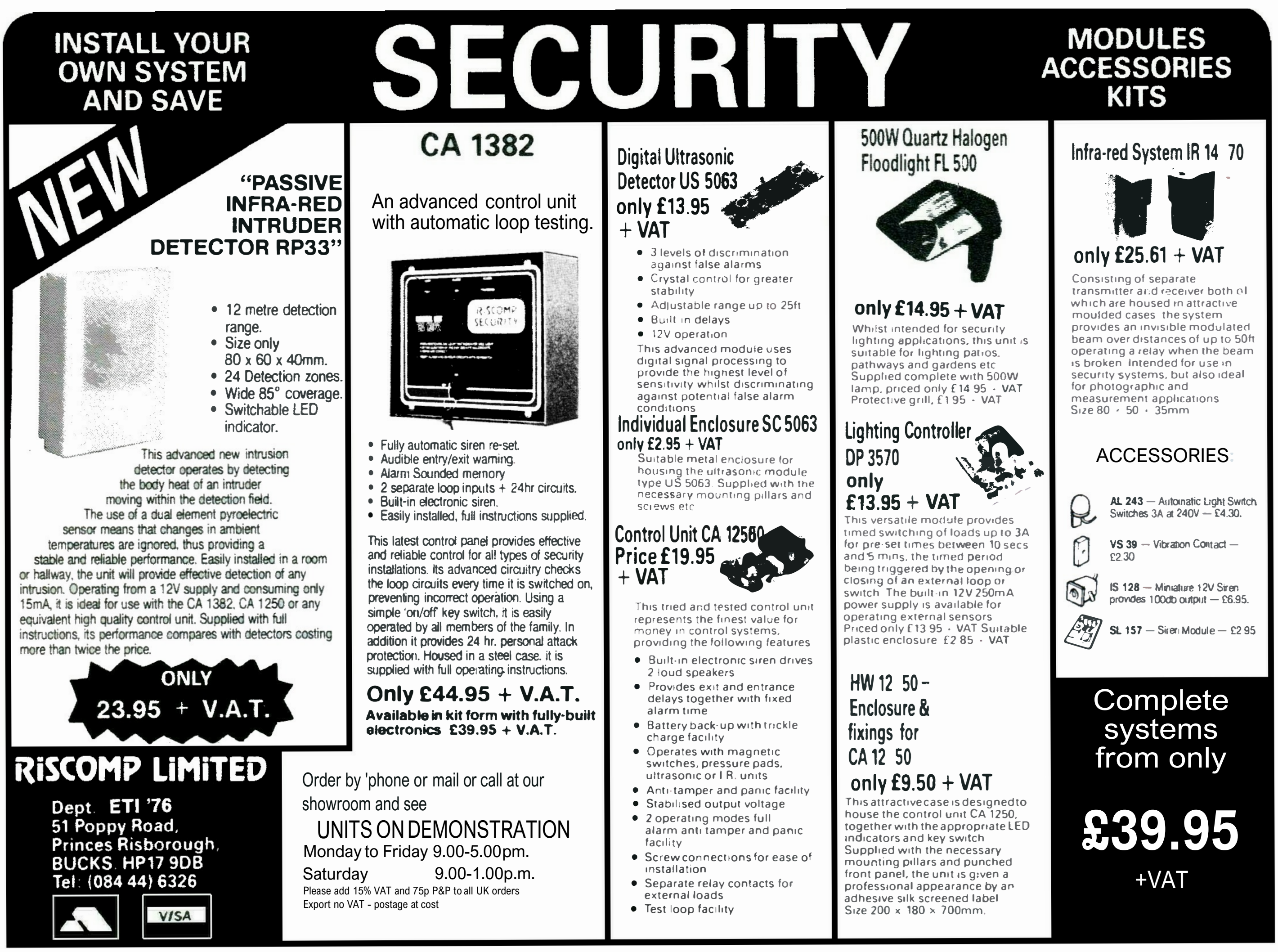
Interact '87 — November 17-19th
Kensington Exhibition Centre, London. Exhibition and conference covering all aspects of interactive technology including touch screen displays, interactive videos, computer training sustems, etc. Contact Network Events at the address below.

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.

Network Events Ltd, Printers Mews, Market Hill, Buckingham MK18 1JX. Tel (0280) 815 226.



HART ELECTRONICS are specialist producers of kits for designs by JOHN LINSLEY-HOOD. All kits are APPROVED by the designer.

LED DISPLAY DIGITAL ELECTRONIC CLOCK MODULE

Electronic clock module with MOS LSI circuit, 4-digit 0.5" LED display, power supply and other components on a single PCB. Only needs a transformer and switches to construct a complete pretested digital clock/timer for many applications. Suitable for 50 or 60 Hz mains supplies. Direct (non-multiplexed) LED drive eliminates RF interference.
Supplied complete with 240v mains transformer and wiring diagram/data. Order as SOL 144 Alarm Clock Module **£6.85**

LIQUID CRYSTAL DISPLAY WATCH MODULE

With LCD display, 2 pieces of Polarising material, backlight diffuser, micro lamp, precision crystal, trimmer, battery contacts and open microcirtuit. Untested .... **5 for £1**

PLESSEY MAINS INTERFERENCE SUPPRESSORS

Filter unit for mains borne interference. Max current 1.5A. Our Price, brand new .... **only £2.27**
Same item, store soiled .... **only £1.61**
Similar Unit but 10A. Brand new **£3.49**

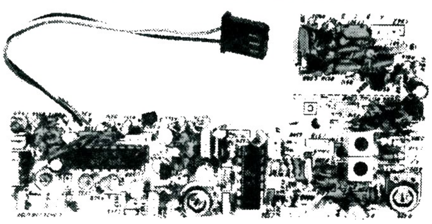
10W POWER AMPLIFIER MODULE

Mullard LP1173 Amplifier module. Needs 24v DC Supply to give 10 watts into 4 ohm speaker. Size 112×70×29mm. Complete with heat sink .... **Only £2.40** complete with Data

ALPS FF317U FM FRONT END

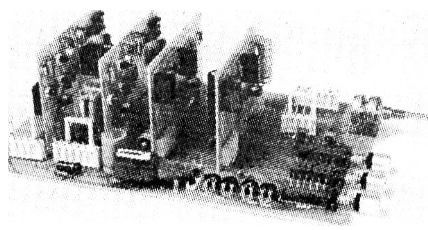
Beautiful precision made High Quality variable capacitor tuned FM Front End with Dual-gate MosFet. Covers full FM range of 87 to 109MHz. 12v supply .... **ONLY £8.90**
Circuit if required 35p

CAR RADIO FM IF AND STEREO DECODER



Miniature PCB with 10.7 MHz ceramic filters, 2 transformer ratio detector. AX010 noise suppression IC and TCA4500A advanced stereo decoder IC. Only needs front end to make FM tuner or car radio. Complete with circuit. Incredible value................................Only £1.99

LINSLEY-HOOD CASSETTE RECORDER CIRCUITS



Complete record and replay circuits for very high quality low noise stereo cassette recorder. Circuits are optimised for our HS16 Super Quality Sendust Alloy Head. Switched bias and equalisation to cater for chrome and ferric tapes. Very easy to assemble on plug-in PCBs. Complete with full instructions.

Complete Stereo Record/Play Kit **£33.70**
VU Meters to suit **£2.30 each**
Reprints of original Articles ...... **75p no VAT**
860X Stereo Mic Amplifier ... **..£8.70**

LINSLEY HOOD 300 SERIES AMPLIFIER KITS

Superb integrated amplifier kits derived from John Linsley-Hoods articles in 'HiFi News'.
Ultra easy assembly and set-up with sound quality to please the most discerning listener. Ideal basis for any domestic sound system if quality matters to you. Buy the kit complete and save pounds off the individual component price.

K300-35. 35 Watt. Discount price for Complete Kit . **£98.79**
K300-45. 45 Watt. Discount price for Complete Kit **£102.36**
RLH4&5. Reprints of Original Articles from 'Hi-Fi News' **£1.05 no VAT**

LINSLEY-HOOD SYNCHRODYNE AM RECEIVER

Very high quality kit for this recent design featured in 'Wireless World'. This unit represents the first attempt to make a much needed HIGH QUALITY AM Tuner since pre-FM days. This will give you Radio 4, or even 1 in better quality than your Eastern 'Tranny'. Advanced construction system, approved by the Author, uses 3 double sided PCBs in a stacked layout for total stability, ease of construction and minimal wiring. This module will form the AM section of an ultra high quality AM/FM switched bandwidth tuner to match our 300 series amplifiers. Power supply and tuning gang will be included
£59.95

HIGH QUALITY REPLACEMENT CASSETTE HEADS

Do your tapes lack treble? A worn head could be the problem. Fitting one of our replacement heads could restore performance to better than new! Standard mountings make fitting easy and our TC1 Test Cassette helps you set the azimuth spot-on. We are the actual importers which means you get the benefit of lower prices for prime parts. Compare us with other suppliers and see! The following is a list of our most popular heads, all are suitable for use on Dolby machines and are ex-stock.
HC20 Permalloy Stereo Head. This is the standard head fitted as original equipment on most decks **£7.66**
HS16 Sendust Alloy Super Head. The best head we can find. Longer life than Permalloy, higher output than Ferrite, fantastic frequency response **£14.86**
HQ551 4-Track Head for auto-reverse or quadrophonic use. Full specification record and playback head........ **£14.60**
Please consult our list for technical data on these and other Special Purpose Heads. **MA481 Latest version Double Mono (2/2) Record/Play head.**
Replaces R484 .... **£13.35**
SM166 Standard Mounting 2/2 Erase head. Compatible with above or HQ551 4-Track Head **£8.85**
H524 Standard Erase Head. Semi double gap, high efficiency .... **..£2.25**
H561 Metal Tape Erase Head. Full double gap **£7.35**

HART TRIPLE-PURPOSE TEST CASSETTE TC1

One inexpensive test cassette enables you to set up VU level, head azimuth and tape speed. Invaluable when fitting new heads. Only **£4.66** plus VAT and 50p postage.
Tape Head De-magnetiser. Handy size mains operated unit prevents build up of residual head magnetisation causing noise on playback **£4.54**
Curved Pole Type for inaccessible heads **£4.85**

Send for your free copy of our LISTS. Overseas please send 2 IRCs to cover surfae Post or 5 IRCs for Airmail.

Please add part cost of post, packing and insurance as follows:

INLAND
Orders up to £10 – 50p
Orders £10 to £49 – £1
Orders over £50 – £1.50

OVERSEAS
Please send sufficient to cover Surface or Air Post as required.

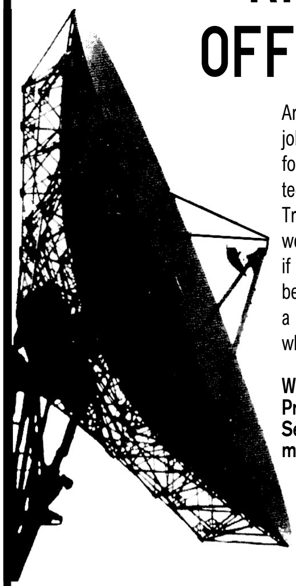
Personal callers are always welcome but please note that we are closed all day Saturday

24hr SALES LINE (0691) 652894

ALL PRICES EXCLUDE VAT UNLESS STATED

HART ELECTRONIC KITS LTD
4 PENYLAN MILL
OSWESTRY, SHROPSHIRE
SY10 9AF

TRAINEE RADIO OFFICERS



Are you looking for a secure shore-based job which offers a rewarding career in the forefront of modern Telecommunications technology, then consider joining GCHQ as a Trainee Radio Officer. Training involves a 32 week residential course, (plus 6 weeks extra if you cannot touch type) after which you will be appointed RADIO OFFICER and undertake a variety of specialist duties covering the whole of the spectrum DC to light.

We offer you: Job Security, Good Career Prospects, Opportunities for Overseas Service, Attractive Salaries and much more.

To be eligible you must hold or hope to obtain on MRGC or HNC in a Telecommunications subject with an ability to read Morse Code at 20 wpm.

Anyone with PMG, MPT or 2 years relevant radio operating experience is also eligible. The Civil Service is an equal opportunities employer.
Salaries: Starting pay for trainees is age pointed to 21 years. For those aged 21 or over entry will be at £6,572. After training an RO will start at £9,758 rising by 5 annual increments to £14,387 inclusive of shift and weekend working allowance. Write or telephone for an application form to:-

GCHQ

THE RECRUITMENT OFFICE, GCHQ, ROOMA/1108, OAKLEY, PRIORS ROAD, CHELTENHAM, GLOS GL25 5AJ OR TELEPHONE (0242) 32912/3

FREE 100 PAGE CATALOGUE

1000's Major & Minor Electronic components
Audio, Hi-fi, Car Radios, Amps, Kits, Computer Bits, Meters scopes, Test Gear, Transistors, Disco, Hardware Tools.
write or phone:

SMITH ELECTRONICS
157 CHAPEL STREET, LEIGH,
LANCS WN7 2AL Tel:(0942) 606674

ELECTRONICS & COMPUTING

INDIVIDUALS You don't have to continue working on things you don't believe in, with people who'd want you locked up if they knew what you really thought....

Promoting Equality of Opportunity. For businesses and people who want a say in how their technology is used. EFP Ltd., 28 Milsom St., BATH BA1 1 DP (0225) 69671

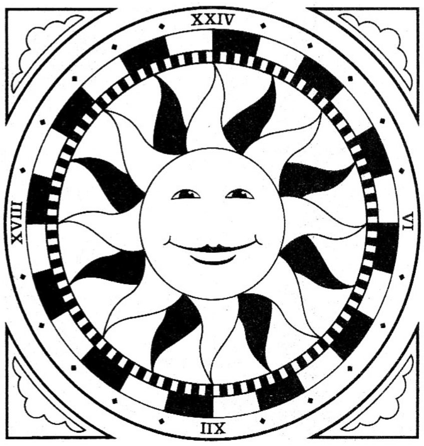
EXCHANGE RESOURCES

RECRUITMENT AGENCY
& BUSINESS CONSULTANCY

BUSINESSES How would you like to try an agency that rewards you for ethical decisions? And deal with businesses which respect your views?

BATH 0225 69671

READ/WRITE



Gno Hope

I am sorry to have to report an unfortunate deficiency in your normally exemplary standards of technical nomenclature.

I am referring, of course, to the central, raised part in your 24 Hour Sundial project. Surely it was unnecessary to introduce the ugly neologism 'shadow caster' for a component which has been known for centuries (as anyone with pretensions to a proper education would tell you) by the generally accepted term 'gnomon'.

I have more sympathy with your nameless colleague, though, who in suggesting the helicopter variation obviously had in mind a new meaning for 'tempus fugit'.

Terry Richter
Fareham, Hants.

We had gno idea our readers were so gnowledgable in the art of sundial construction. Gnext time we shall gnow better.

Anyway, 'Gnomon' is really meant to describe a shadow caster (there's that awful phrase again) formed like a leant-over L shape. The ETI Sundial uses a much more elegant swept curve. (That's our excuse and we're gnot going to budge!).

Hoodwinked

You asked for it. The world is going to pieces (Read/Write March 1987). You could help prevent it by insisting John Linsley Hood presents an up-to-date cassette deck project

With the design of analogue recording circuitry about to become an arcane art, it behoves you to see that everyone has at least a chance of building (not to mention understanding) a cassette deck of the quality with which JLH is normally associated.

I have built a number of his designs, including the ETI 100W MOSFET amp. I doubt I am alone in according totally with him when he claims it to be the best he has yet heard.

Please, then: a cassette deck which can be connected to such an instrument without fear of committing heresy.

Ivor Colwill
Haywards Heath, Sussex.

Give the man a chance. JLH is already working on an updated MOSFET amp and a new integrated amp for us. Not to mention a couple of other projects too. We promise that as soon as he has finished that little lot we'll try to persuade him of the joys of a truly hi-fi cassette deck. Meanwhile, have patience and make do with current heretical models.

The Right Rate

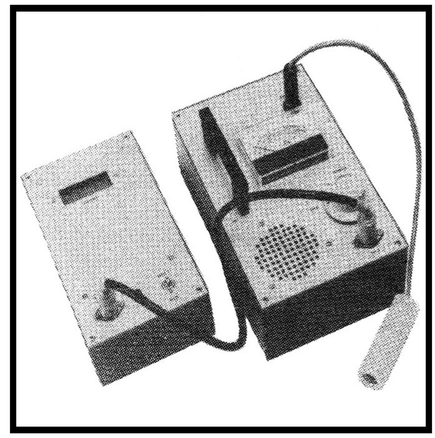
Referring to your article 'Geiger Ratemeter and Counter' in the February and March 1987 issues of ETI, I think readers should be warned that testing foodstuffs for contamination is not as simple as suggested.

It is not just a matter of applying the probe to, say, a joint of meat and, because there is no count rate increase, assuming all is well. The meat tissues could still be dangerously contaminated with alpha particles which are not detected because they can travel only a very short distance through tissues (less than 1mm).

The official method of testing a carcass is to burn it to ashes and test the ashes with a wide area gas flow type monitor.

Alexander Turner
Richmond, Surrey.

Thanks for the information. The ETI Geiger meter project will still find (accurate) uses for many readers in other types of radiation testing.



Virtuous Virtuoso

I read with interest the letter from D.W. McDonald in the April issue concerning his desire for a complete set of audio equipment in kit form from John Linsley Hood. His ideas echo plans formulated by Audiokits over the last 15 months.

In a short period we have introduced two preamps, a power amp and an integrated amplifier all of which can be built in standard or 'upgraded' versions. Since ETI published our Virtuoso preamp last year we have received many calls and letters from delighted customers all over the world.

The cases we supply are to the same quality as those we supply to specialist hi-fi shops.

I can assure Mr. McDonald that Audiokits is doing the things he is seeking and has many other exciting developments in the pipeline.

Graham Nalty, Audiokits
Borrowash, Derby.

ETI hopes to publish the Virtuoso Power Amplifier to accompany last year's preamp and also from Graham Nalty, in the near future.

ETI is pleased to receive your letters on any topic—past, present or future. If you want to know something or think we should be told of something, don't hesitate, write in to the ever-open arms of the ETI post room. Write to:

Electronics Today International
1 Golden Square
London W1R 3AB

THE TELEPHONE SYSTEM

You may not believe it but the UK telephone system is the best in the world. Keith Brindley explains why.

There are two main different switching methods used in wired telecommunications systems. The type used in all analogue public switched telephone systems is called 'circuit switching'. A transmission circuit or channel is set up between the caller and whoever is being called by switching together whatever individual transmission links are required in the system to form the channel. The channel remains set up throughout the call and only ends when one or both users hang up.

For interest the other main type of switching method is message switching. Here each block of communication is sent over the system individually, making its own way from caller to receiver via whatever transmission links are necessary.

Every new block makes its own way and so it is conceivable that many different transmission paths will be used to make up the whole communication. No single channel exists between the two users. A derivative of message switched telecommunications systems is British Telecom's 'Packet Switch Stream' (PSS) used for digital computer data communications.

Large circuit switched systems like the Public Switched Telephone Network (PSTN) must be hierarchical in nature. That is, switching centres (usually called exchanges) must exist at different levels in the system so that a user at one point in the system can call another user by linking together whatever exchanges are necessary to form the circuit.

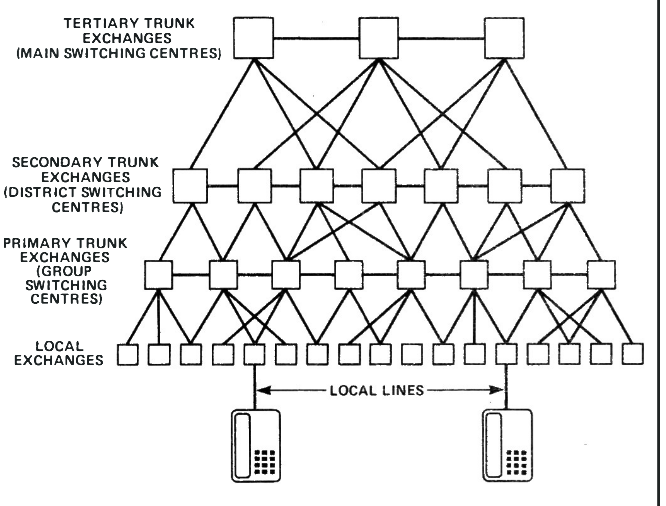


Fig. 1 A hierarchical telephone system layout showing local lines terminating at user telephones and exchanges at different levels.

Figure 1 shows the layout of a hierarchical telephone system where exchanges are layered to allow any two telephones in the system to communicate. The bracketed term after each exchange type is the commonly used name in the UK system. Larger telephone systems, such as the North American system, may use a further layer of exchanges above tertiary exchanges (quaternary trunk exchanges).

Although a hierarchical system with so many interconnections between different levels of exchanges may seem unnecessary, there is a reason why PSTNs are so constructed. If an exchange between two users is busy (fully utilised with no spare lines) as a call is set up, the call is easily redirected around that exchange and on to another.

Being busy is not the only reason why an exchange is unusable, of course, it may be faulty. Alternative routing ensures the PSTN we've considered still keeps working overall. I would venture to suggest this is the very reason why British Telecom's PSTN kept working during the recent BT telephone engineers' strike. It wasn't that faults weren't occuring. It was just that the system is so well designed as to keep working even with the faults.

In terms of numbers, there are something like 21 million or so local lines in the British PSTN and something over 6000 local exchanges. Of the local exchanges, about half are electromechanical 'Strowger' exchanges (you know: click, click, whirr, whirr, clatter, clatter, clatter!). About 2000 are reed relay exchanges which, although electromechanical, are at least computer-controlled. About 500 are crossbar electromechanical exchanges and (wait for it) *only about 500* are digital exchanges (and I said this is the best system in the world?).

X Rated

Of the digital exchanges about 150 are small rural exchanges while the remainder (only about 350) are so-called System X exchanges.

System X exchanges are now being commissioned at the rate of about one per week. That sounds pretty impressive until you work out at that rate it will take about 5500 weeks (105 years) to convert the rest of the system! Nevertheless, it's hoped to get rid of all Strowger local exchanges, replacing them with computer-controlled reed relay types at the very least, by 1992. Target for a completely digital PSTN (this includes user's telephones, as well as exchanges) is the year 2014.

In the trunk network, things are proceeding much faster. Of the 55 digital exchanges planned 54 have already been commissioned, so BT's target of a fully digital trunk network by 1988 should easily be met. Finally, to get out of the British PSTN, four digital international trunk exchanges are planned, of which two have been commissioned.

Traffic control

Now it's possible the average reader doesn't think much of the British PSTN! Nevertheless, an awful lot of thought and planning goes into the system which isn't immediately apparent. Even if you do reckon that too many calls don't get through, it's a fact that the actual *probability* of call failure due to blocking is very low. If you *do* have serious problems making calls it just may be that your problems lie in your telephone unit, or in your own fingers.

The main aim of any PSTN is to provide an acceptable telephone system at an acceptable price. Obviously, users want a system which works and which doesn't cost the earth. Any PSTN provider must therefore ensure sufficient amounts of exchange equipment are available to keep the probability of call blocking low enough for acceptability — without providing so much equipment that the service is too expensive.

We've used the term probability pretty loosely but it can be (and is) used in its strict mathematical sense to help calculate the amount of equipment required to provide an acceptable yet economic telephone system. If the system is considered as a number of distinctly separate parts as in Fig. 2 then the overall probability of a call being blocked between one user and another is given by:

$$P=1-((1-P_1)\ (1-P_2)\ (1-P_3)\ldots\ldots(1-P_n))$$

where n is the total number of parts used in the call and P_1,P_2, etc are the probabilities of calls blocking at each part of the system over which the call is routed. If the probabilities of blocking are very small (which hopefully they are) then this expression simplifies to:

$$P=P_1+P_2+P_3+\ldots\ldots P_n$$

This means the overall probability of a call being blocked can be directly broken down into the probabilities of each separate piece of equipment used in the call routing.

Simple enough, but we still need to relate the probabilities of call blockages to the numbers of calls which the system must cater for. Calculating the amount of calls made in a PSTN is an important aspect in planning the system and the usual method of doing it measures telephone usage in terms of *traffic* — the average number of calls over a given period of time.

A Danish mathematician, Agner Erlang, did a significant amount of work in calculating telephone traffic, and his name is used as a dimensionless unit of traffic. So, an average of 100 concurrent calls is known as 100 erlangs of traffic.

If, say, n calls are made during a period of T seconds, and the durations of the calls are h_1, h_2, h_3,...h_n seconds then the use of the system is:

$$\sum_{i=1}^{i=n} h_i \qquad \text{(call-seconds)}$$

The traffic (the amount of calls per unit time) is thus:

$$E = \frac{\sum_{i=1}^{i=n} h_i}{T} \qquad \text{(erlang)}$$

From this we can calculate what is known as the mean holding time (the average call length) given by:

$$h=\frac{\sum_{i=1}^{i=n} h_i}{n} \qquad \text{(seconds)}$$

If we refer to the average rate at which new calls appear as a calls per second, then a much more useful

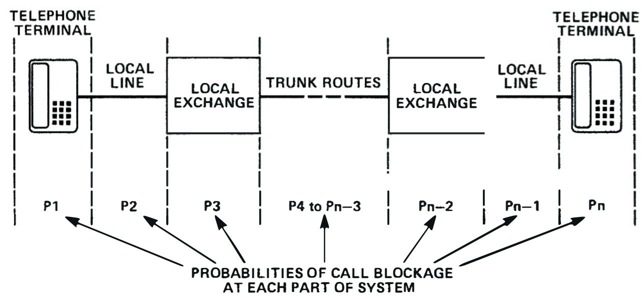


Fig. 2 Calculating the overall probability of a call being blocked.

expression for traffic is given by:

$$E=ah \qquad \text{(erlangs)}$$

Now we can relate traffic with blocking probabilities to calculate the exchange equipment required to maintain an acceptable service. If there are K calls in progress and N pieces of exchange equipment each of which can handle one call then the probability of calls blocking is given by:

$$P=\frac{E^N / N!}{\sum_{k=0}^{k=n} E^k / k!}$$

which means that we can now calculate the number of pieces of exchange equipment to maintain any desired probability, knowing the traffic which the exchange has to handle.

Fortunately, it's not necessary to work with these expressions every time an exchange is being planned or updated. Once the ideal numbers have been calculated for any desired probability, straightforward look-up tables may be constructed which relate the two. Table 1 gives examples of the numbers of pieces of exchange equipment required to maintain a probability of call blockage of less than 0.01 for a number of different values of traffic.

Terminals and Local Lines

Local lines within the PSTN (lines between the users' premises and the local exchange) are twisted pairs. The

Traffic (in erlangs)	Pieces of exchange equipment
0.1	2
0.5	4
1.0	5
5.0	11
10.0	18
50.0	63
100.0	117

Table 1 Number of pieces of exchange equipment required to maintain a probability ofcall blocking less than 0.01 for various levels of traffic.

characteristics of any pair of wires carrying analogue signals are determined by the constants of capacitance, resistance, inductance, and conductance. Further the transmission properties can be represented by a wire pair's characteristic impedance and propagation constant. All constants are related by the complex mathematical expressions:

$$Z_0=((R+j\omega L)/(G+j\omega C))^{1/2}$$

$$\gamma=((R+j\omega L)(G+j\omega C)^{1/2}$$

where: Z_0=the characteristic impedance, R=the resistance per unit length, ω=the angular frequency of the applied signal, L=the inductance per unit length, G=the conductance between the two wires per unit length, C=capacitance between the two wires per unit length, and γ =the propagation constant.

These expressions allow us to define the various constants of the wires for any particular frequency. Local lines, with only a few exceptions, use audio frequencies and so their transmission properties are fairly well classified although variations do exist.

Local lines comprise a single twisted pair. This means that incoming and outgoing speech signals are imposed on the same line. At the exchange and at the user's telephone these signals must be separated. If no separation occurred at the telephone, the signal produced by the handset microphone would be fed to the earphone in a process known as 'sidetone'.

However, a small amount of sidetone is desirable, so the user does not feel the system is 'dead'. Figure 3 shows the basis of a typical circuit used in telephones to separate the two directions of signals on the local line while maintaining some sidetone. While some modern telephones use more complicated versions, this shows in principle how signals are split and combined.

In the end

As far as the user is concerned, local lines are terminated inside the user's premises, at a network termination point usually called a 'master' socket. At present, plugging into the master socket is the closest a user may officially get to the local line but it's just possible that this situation may change in the future. For now, it's the network provider's responsibility (that is, British Telecom for the national PSTN, Mercury Communications in the case of its telephone network and the Kingston-upon-Hull Telephone Department in the Hull telephone network) to terminate the local line. However, from 1st of December last year, extension socket wiring may be undertaken by people (including users) other than the network providers.

It's important to note, though, that any extension wiring undertaken by non-network providers *cannot be hard-wired into the master socket.* It can only be plugged in! Figure 4 shows this diagrammatically. It is, in fact, illegal to tamper with a master socket, or extension sockets wired by the service provider, in any way except by plugging in to them.

This means that a user who does not yet have a master socket fitted and who wants to plug in an extension circuit, first must ask the network provider to fit a master socket — at a fee (BT currently charges £10 & VAT, plus a visit charge of £15 + VAT if no other chargeable work is carried out at the time of conversion).

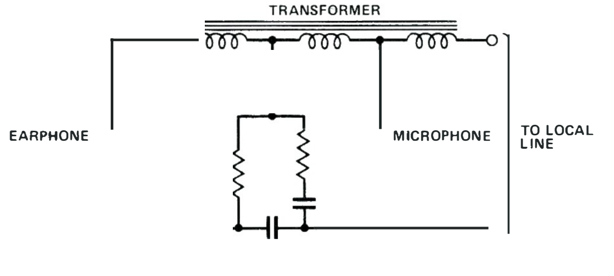
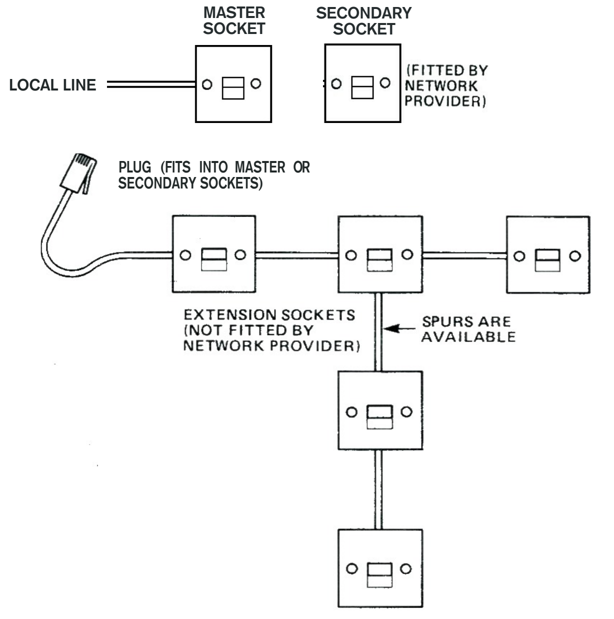


Fig. 3 Typical telephone speech circuit, which separates the incoming signal to the earphone, from the outgoing signal from the microphone, and combines both onto the twisted wire pair local line.



.Fig. 4 Extension sockets may only be fitted by a non-network provider following this arrangement, where sockets are plugged into an existing master or secondary socket

Toeing The Party Line

Incidentally, if a user has a party line (a line shared with another user) sockets cannot be fitted to the line. This does not mean the user with a party line can't have sockets. The network provider is under an obligation to provide them. In such a case it is up to the network provider to replace the party line with a standard non-party local line and fit the sockets.

So, if you have been forced to have a party line, and you don't want one, simply ask for sockets to be fitted. It'll cost you the £25 + VAT conversion charge but it's one way of getting your own back on BT. There's nothing BT can do to make you keep the party line!

Master sockets and extension (technically known as 'secondary') sockets are identical in outward appearance and contain a printed circuit board onto which the socket itself is fastened. Master and extension sockets, in fact, usually contain the same circuit board, but extensions do not have all the components present in the master. Figure 5 shows the basic circuit of the master socket, how the socket is connected to the twisted pair local line and how the network provider will hard-wire connections to any extension which it provides.

Capacitor C1 is known as the 'bell' capacitor. Before the era of sockets this was housed in each telephone. It provides the simple function of isolating the bell inside any telephone connected to the master or extension sockets from the local line, as far as DC is concerned. For the majority of the time the bell is effectively unconnected. When a call is placed to a user and the bell is to ring, the local exchange transmits an AC signal which is passed by the bell capacitor and so rings the bell.

Resistor R1 is known as the 'out-of-service' resistor. This has two main functions. First, if a call is placed, the out-of-service resistor maintains a circuit even if all telephones are unplugged. To the user trying to call, the ringing tone is still heard. Second, if a user is in

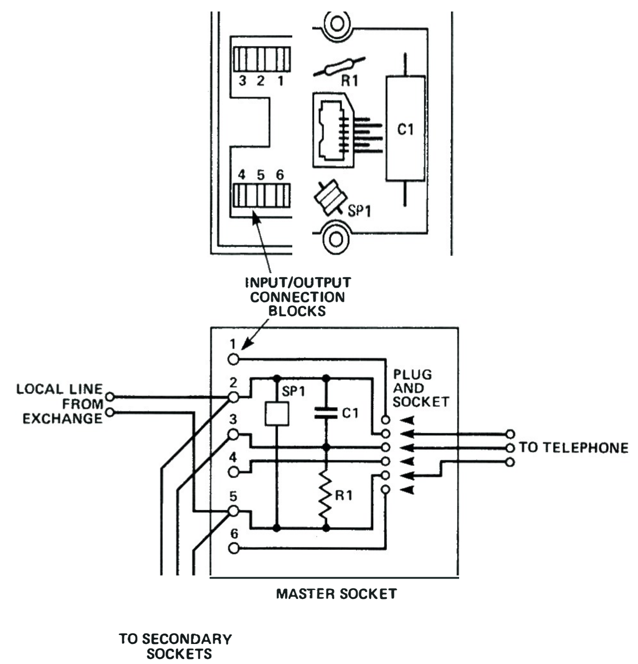


Fig. 5 Basic circuit of a master socket showing local line connections, hard-wired extension socket connections and plug and socket connections to a telephone terminal.

communication with another user but wishes to take the call in another room, the telephone may be unplugged and taken to another socket. The out-of-service resistor maintains the circuit and thus holds the line open until the telephone is plugged in again.

Component SP1 is a 'surge arrester' to prevent incoming high voltage peaks on the line from getting to the telephone and outgoing high voltage peaks getting onto the line.

Tinkle, Tinkle, Little Star

Having the bell capacitor present in the master socket gives a number of benefits.

The main one is that extension telephones to be used are merely connected in parallel (via extension sockets). If you did this on a local line terminated without the master socket, all telephones would 'tinkle' when one telephone is dialing out.

The master socket's internal bell capacitor allows a third 'anti-tinkling' connection to be made to each telephone. When one telephone is to be used to dial out, it short-circuits the bell capacitor and tinkling simply cannot occur. A further benefit is that the capacitor is not now needed inside the telephone — helping to reduce telephone cost.

All sockets have six connections, although only three of these are used in standard telephone wiring. You may wish to use the others in baby alarm or intercom type applications, but to do this you'll need to wire extensions with six-core cabling, instead of the standard four-core cabling usually used. Table 2 relates the colour coding of the wires of the cable to the socket connection numbers.

Although it doesn't particularly concern us here, it's interesting to note that above local exchange level in the PSTN hierarchy, single twisted pairs aren't used for transmission. Instead, a four-wire link is used (two wires for one direction of signal, two wires for the other direction) all in a twisted form (twisting is used to minimise interference). Above this in the hierarchy, trunk routes use multiplexed signals (multiplexed in either frequency or time) on four-wire links, coaxial cables, optical fibres, or sometimes microwave radio links.

Dialing out

Having considered the local line and the termination points at the user's premises, it's only right we now look at the signals which are transmitted *along* a local line to and from the master socket. The majority of telephone terminals (the actual devices you make and take calls with) in use in the British PSTN are presently known as loop disconnect signal terminals. This refers to the dialing method the phones use.

Figure 6 shows a typical terminal connected via a local line to the local exchange, together with basic internal circuits within the exchange. The master socket is also shown with its internal bell capacitor.

Although the device used to dial a number is shown as an old-fashioned rotary dial, most modern phone terminals use a push-button dial which provides exactly the same function: the dial breaks the circuit once for every value of each digit dialed. So, if the digit five is dialed, the circuit is broken five times. If digit two is dialed the circuit is broken twice. Slightly misleadingly, if digit zero is dialed, the circuit is broken ten times.

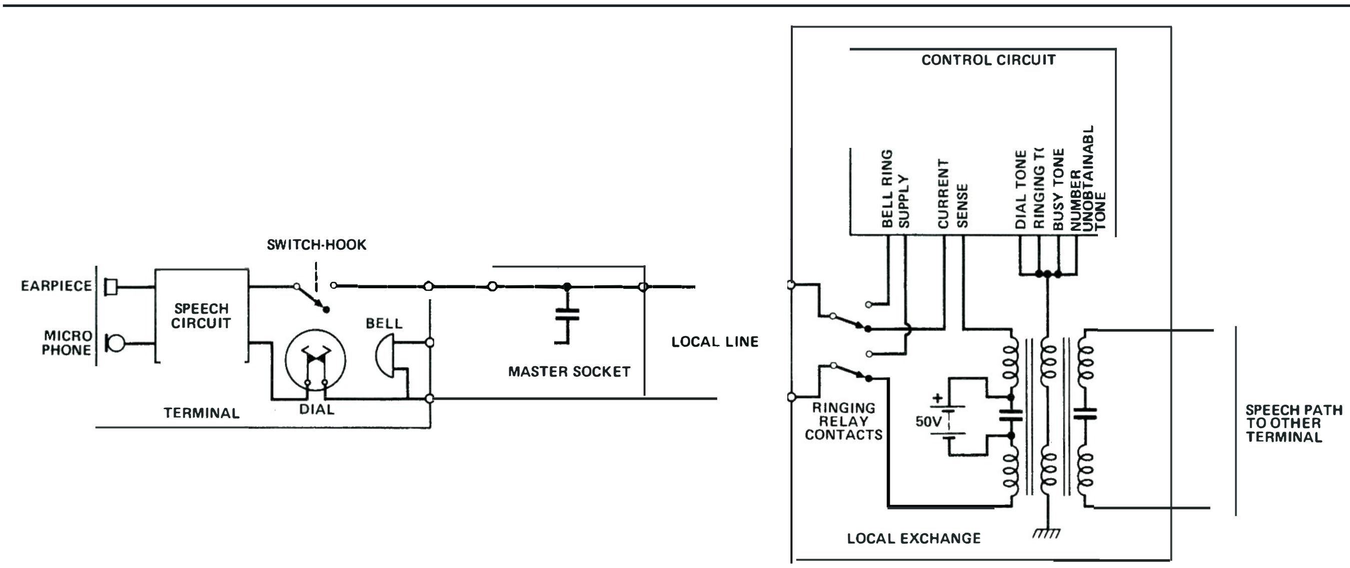


Fig. 6 A typical connection between a terminal and a local exchange.

That's why the name 'loop-disconnect signal' is used for this method of dialling.

The circuit is also broken when the telephone handset is replaced on the switch-hook and that's where we'll start the description of operation. With the handset on the switch-hook the circuit is broken and no direct current can flow from the local exchange. As soon as the handset is lifted the circuit is closed, and the speech circuit of the terminal is connected across the local line.

The speech circuit has a fairly low resistance (in the order of 100 ohms) and so direct current flows in the local line via the 50 volt DC power source and speech transformer T1. The current is sensed by the control circuit and is interpreted as a 'call-request' signal. In response to the call-request, the control circuit injects a tone supply corresponding to the dialling tone through the central coil of transformer T1. The tone is thus inserted onto the local line, resulting in the same tone being heard in the earphone at the user's phone terminal.

On hearing the dialling tone the user starts to make the call, dialling the number required digit by digit. The control circuit senses each time the circuit is broken during a digit and counts the breaks to calculate which digit has been dialled. The period of these breaks is not usually too critical — somewhere around 10 breaks per second (normally called 10 pulses per second, or 10pps) is typical. The length of time *between* breaks is important. If, say, a time of greater than about 200ms occurs, the control circuit is able to sense what is interpreted as an 'inter-digit pause' — the circuit senses that one digit has ended and the next is about to start.

When the call is routed through to the receiving telephone terminal, a ringing tone is obtained from the receiving terminal's local exchange. It's interesting to note, though, that the ringing tone is produced, as we'll see soon, by the other user's local exchange and not by the user's phone being rung. So, just because you can hear a ringing tone, it doesn't mean the other phone is actually ringing! There may be a fault between the other user's local exchange and that terminal or the terminal may be unplugged from its socket.

Two other tones may be sent to the calling terminal from the control circuit. Number unobtainable or busy tones may be sent if either of these conditions occur when the call is made.

Socket connection	Wire colour (principal colour first)
1	green/white
2	blue/white
3	orange/white
4	white/orange
5	white/blue
6	white/green

Table 2 Telephone wire colour coding with reference to telephone socket terminal connections.

It's For You-hoo

The local exchange also has a great deal to do with signals going to a telephone terminal. When a terminal is to be called, for example, the control circuit at the local exchange first senses if current is flowing in the local line. If it is, then the terminal is in use. That is, the terminal is busy and the call cannot proceed. If not, then the control circuit can ring the terminal's bell by operating a relay whose contracts break the local line from the speech transformer and instead connect them to a bell ringing supply. The bell ringing supply is of an interrupted AC form at a frequency of 17Hz and of 75 volts. The AC ringing signal is passed by the bell capacitor in the user's master socket, causing the terminal bell to ring.

The control circuit senses the bell ringing (if current is flowing, the bell is assumed to be ringing) and injects a ringing tone onto the speech path via the central coil of transformer T1. This informs the user making the call that the called terminal is ringing. As soon as the terminal handset is lifted, however, the control circuit senses the call has been answered and de-energises the ringing relay, re-connecting the local line to the transformer, and so completes the speech channel between the two telephone terminals.

Them Tones, Them Tones...

Although loop-disconnect signalling is currently the most common form of digit signalling in the British PSTN, this is only because most local-exchanges are of Strowger or similar electromechanical types. Newer digital exchanges can cope with other forms of signalling, one being 'dual-tone multi-frequency signalling' (DTMF, for short). DTMF phones are push-button but unlike loop-disconnect types of push-button phones they don't break the circuit to indicate digits. Instead a combination of two tones is transmitted down the local line from the terminal to the local exchange for each digit pressed. The tones are detected at the local exchange and the digit is consequently calculated.

Figure 7 shows the tones standardised by the CCITT for DTMF signalling. Each row and each column of the set of push buttons is allocated a particular tone so that when a button is pressed, the tones corresponding to the row and the column the button is part of, is transmitted down the line.

DTMF signalling allows a considerable increase in the speed with which a call can be set up. In the loop-disconnect system pulses are transmitted at about 10pps, so a typical telephone number of seven digits can take anywhere between about 700ms and 8.4s to transmit between terminal and local exchange. In the two extremes, the number could be any between the shortest possible (1111111), and the longest possible (0000000). Also, the inter-digit pause, typically 200 ms, has to be added to every digit dialled.

Different numbers dialled by the DTMF method, on the other hand, do not affect the time taken for signal transmission. Instead, the time depends largely on the speed with which the user can push the buttons!

Hanging On The Line

There are five basic categories of equipment of interest to the house telephone user which can be plugged into a telephone socket. Any equipment must be approved by the British Approvals Board for Telecommunications (BABT) and must comply with certain standards and regulations.

To show that equipment is approved and complies with all standards and regulations, any device will carry a 'green circle' approval sticker or label. If no 'green circle' is present, it is illegal to plug the device into your telephone sockets, so beware. The five categories of equipment which can be used on the PSTN are:

- Simple extension telephones. Ordinary, basic phones with no extra features.
- Telephones with loudspeech, monitor, or modem facilities. The type of phone with simple VDU characteristics used for connecting to viewdata services, etc.
- Cordless telephones.
- Telephone answering/recording machines.
- Modems, or non-speech equipment which incorporates a modem.

The important British Standards which relate to all equipment connected to telephone lines are BS6301, BS6305, and BS6317. Any equipment containing a modem must also comply with BS6320. Any equipment requiring a mains power supply must also comply with BS6484. The plugs used to connect the equipment to a telephone socket must themselves comply with BS6312. These standards are by no means exhaustive but provide a starting point for approvals purposes.

Onwards, Ever Onwards

Recently, unless you lived in the Kingston-upon-Hull district, you could only have a telephone through British Telecom. Since liberalisation — choices have begun to appear. Cellular telephones, for example, provide a means whereby mobile telephone communications independent of BT can be obtained.

Of greatest significance in the long run is the telephone network provided by Mercury Communications. Still in its infancy now, this network will rapidly become a national PSTN service and a real alternative to BT's PSTN.

Initially, at least, home users will be able to connect to the Mercury network via existing local lines and a special Mercury network when making a call. A rental for the BT-owned local line will be due, however, whether or not users actually make calls via the BT PSTN.

The Mercury network itself is digital, so offers greater quality than BT's network. But linking via existing local lines to the Mercury network limits quality to that of the BT analogue local line. Eventually, BT's own network and local lines will be digital and Mercury may offer its own local lines to customers. Whatever happens improved services are on the way.

The problems of waiting for a digital service do not occur for certain users. Existing business telephone users may already be able to access the Mercury network directly, via cable, fibre optic, or microwave link. Likewise BT can link business users directly into its digital trunk network. So high quality digital telephone communications are already possible.

Whatever you think of our telephone communications system — it *is* the best in the world. What's more, it can only get even better!

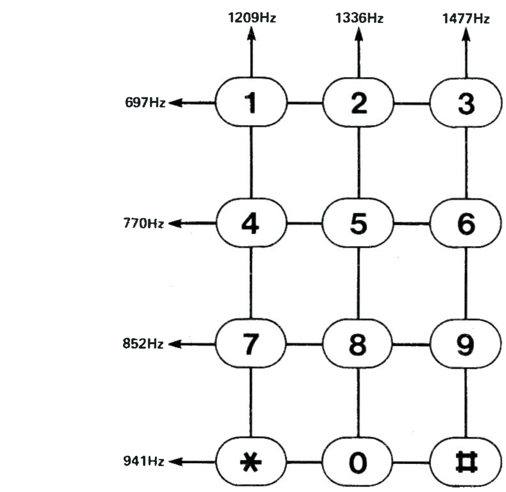
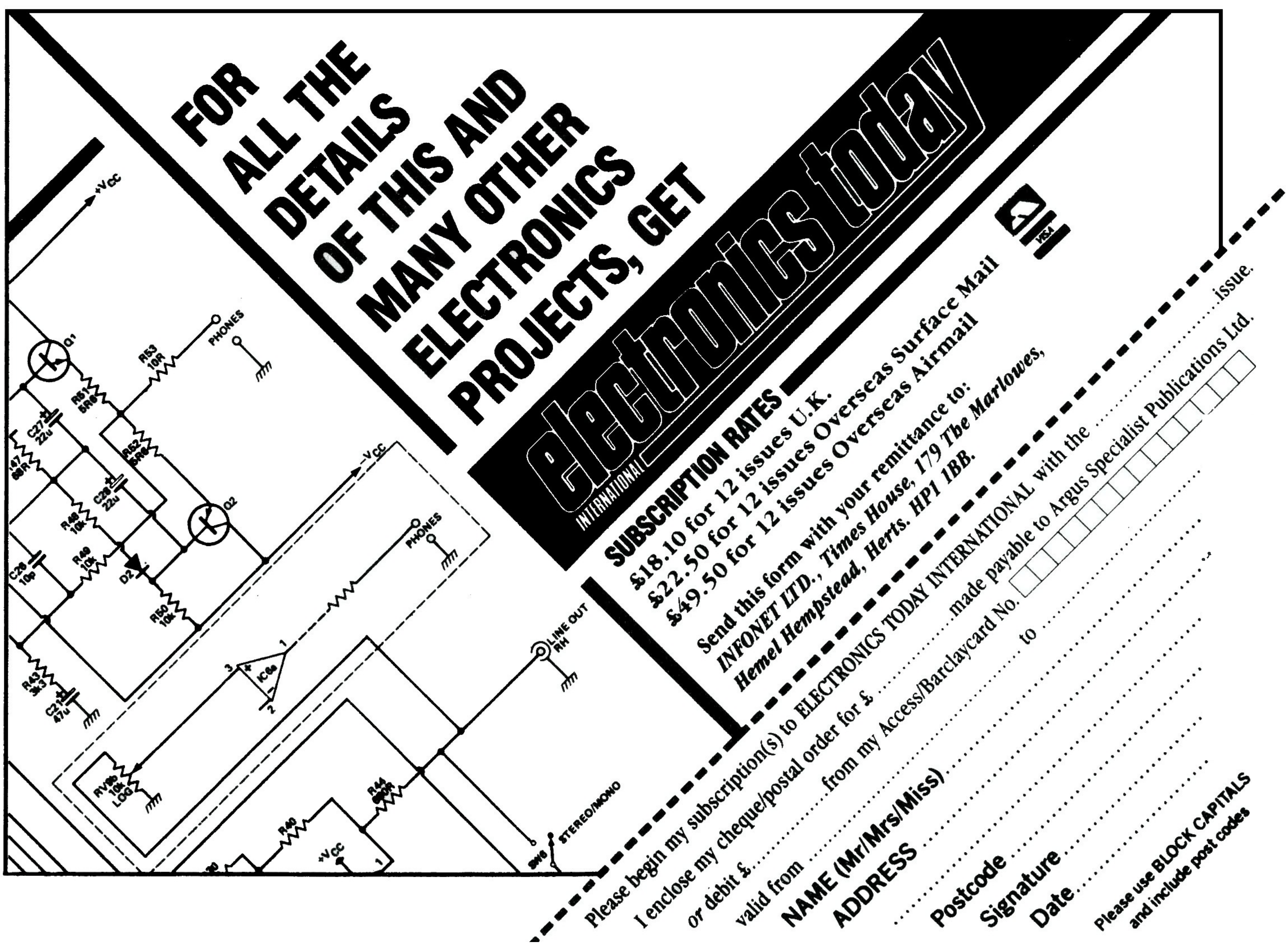


Fig. 7 Dual tone multi-frequency dialing tones.



HARDWARE DESIGN CONCEPTS

Mike Barwise polishes off the design of his pulse generator with a look at the control board and an algorithm to run the whole system.

Now that we have designed the pulse generator itself, the time has come to consider how to program and control it. A simple solution is to use a conventional eight bit microprocessor addressing a bank of storage registers attached to the programming bus of the generator boards.

There is also a need for some kind of convenient user input and display, so that the required information can be passed to the pulse generator in a *convenient* manner. The general circuit schematic is shown in Fig. 1.

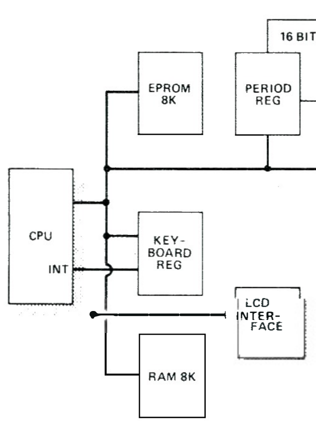


Fig.1 Block schematic diagram of the pulse generator microprocessor controller.

Automating Parameter Settings

The simplest pulse generator with only one range has no settability problem. There is only one possible setting of the control registers for a given output. Remembering that each generator stage adds a clock cycle to its time on top of the set modulo and that each following stage takes a clock cycle to respond to its predecessor's start request, we simply arrange to subtract three from the entered parameter for Delay and one from those for Period and Width to provide perfect settability.

The pulse generator which switches range on Period Delay and Width simultaneously (in other words, with all three parameters always set to the same range) has a slight settability problem. If, as in our design of pulse generator, the adjustment ratio (1:4095) exceeds the range spread (1:10), there are already several alternative setting parameters which could yield the same output (where the ranges overlap).

One solution to automation is always to pick the settings which require the fastest possible range, thus maximising setting *resolution.* Aside from this, the same calculations apply as to the single range system.

However, we have given ourselves a somewhat greater probiem by allowing the Period, Delay and Width to be independently range switched. The additional cycles detailed earlier still have to be added to the timing chain but the question now is how long is each additional cycle.

Once the period, delay and width are set to different ranges, each has a clock cycle of different duration. We must therefore identify the relevant clock for each additional cycle and add *time* rather than *cycles* to our parameter definition.

In practice, the same approach of going for the fastest range possible is still probably the best as it maximises setting resolution. However, the assessment must now be made for each element individually rather than globally for the system.

An outcome of this which may not be immediately apparent is that what you ask for may not be exactly what you get. The pulse generator may be forced to choose the nearest setting to your selection if it is not able to accomplish the absolute setting.

This should be considered when designing the user input and display handling. Should you ignore discrepancies, thereby providing inaccurate results but boosting user confidence, or do you report setting discrepancies, yielding high reliability but resulting in a less 'user friendly' system?

Direct Control

The third alternative is for all parameters to be directly controlled by the user from the keyboard. This is the most flexible and precise method but demands such a high level of user awareness of the pulse generator mechanism that it is not really practicable. No one but the designer would be able to use the system!

To sum up then, we will be automatically selecting the fastest range possible for each parameter (Period, Delay, Width) and will display (although this is just my preference) the actual parameters used by the system. This means that what you enter at the keyboard and what you get at the output and on the front panel display will sometimes be a little different but the discrepancy is both predictable and documented.

The general algorithm for input to actual conversion is as follows and is shown in Fig. 2.

Starting with pulse width, choose a range, then program the width registers with one less than the required modulo to allow for the stage characteristic. Establish the delay range and modulo, then subtract one from the modulo for the stage characteristic and one for the start cycle. The result is the modulo to be programmed into the delay register. Remember that the real delay will be greater by *one width range* clock period, due to the Width start cycle.

Finally, establish the Period range and modulo and subtract one cycle for the stage characteristic.

The only parameter which will be subject to discrepancies will therefore be the Delay. Note though that even when the zero Delay option is in use, the start cycle will still cause a minimal delay.

The user display should reflect these small discrepancies, so the user will know what is *actually* happening. The discrepancies will in fact be very small in most cases.

The worst case is when working at the fastest end of three adjacent ranges, such as Width 200 nanoseconds, Delay 2 microseconds, Period 20 microseconds where the delay may depart from ideal by up to 10%. It will, however, be totally stable, precise and repeatable. The same discrepancy will always be present.

This amounts to a limitation on 'settability', rather than precision, and should prove quite acceptable in practice.

Implementation

There are many alternative approaches to the microprocessor control. I have selected my own favourite devices although I'm sure that other people will prefer different solutions and can convincingly argue for them. This is a good area for experimentation as the microprocessor setup is comparatively slow and simple.

I chose my old faithful favourite, the 6502 (the 1MHz version is all you really need here), using a hardware scanned keyboard and a Densitron intelligent LCD display module (available from RS and, of course, Electromail) as user input and output devices.

The keyboard circuit is shown in Fig. 3. A binary counter drives an active low output decoder (least significant two bits) and an eight-to-one multiplexer (most significant three bits).

The decoder outputs form the rows of the key matrix and the multiplexer inputs (pulled high) form the columns. Pressing a key connects a decoder output to a multiplexer input and when the counter gets round to the mutual selection point of the connected input and output, the multiplexer input goes low.

This signal is used to stop the counter and the current count is then passed to a CPU mapped register. A delayed interrupt generator allows for switch bounce before flagging the CPU to read the key code.

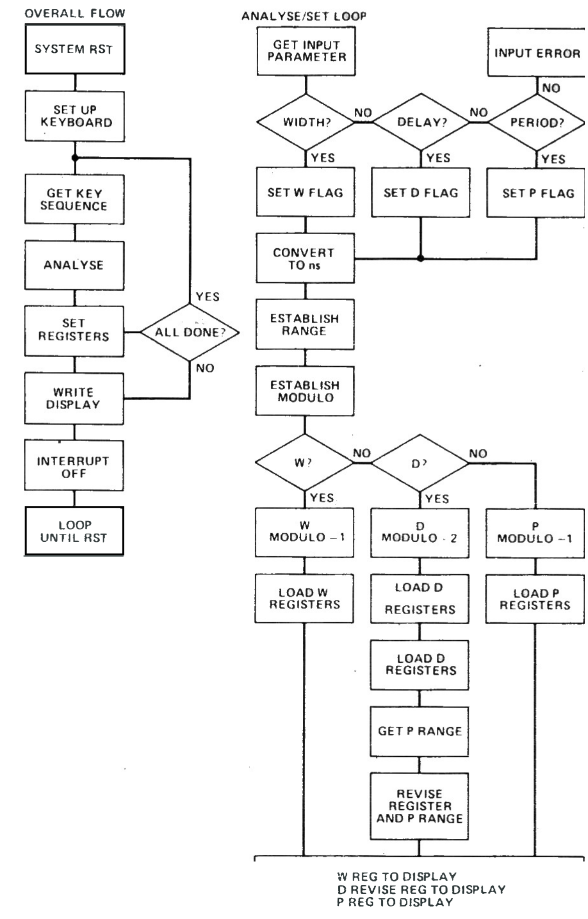


Fig. 2 The algorithm for calculating parameters for the pulse and range boards.

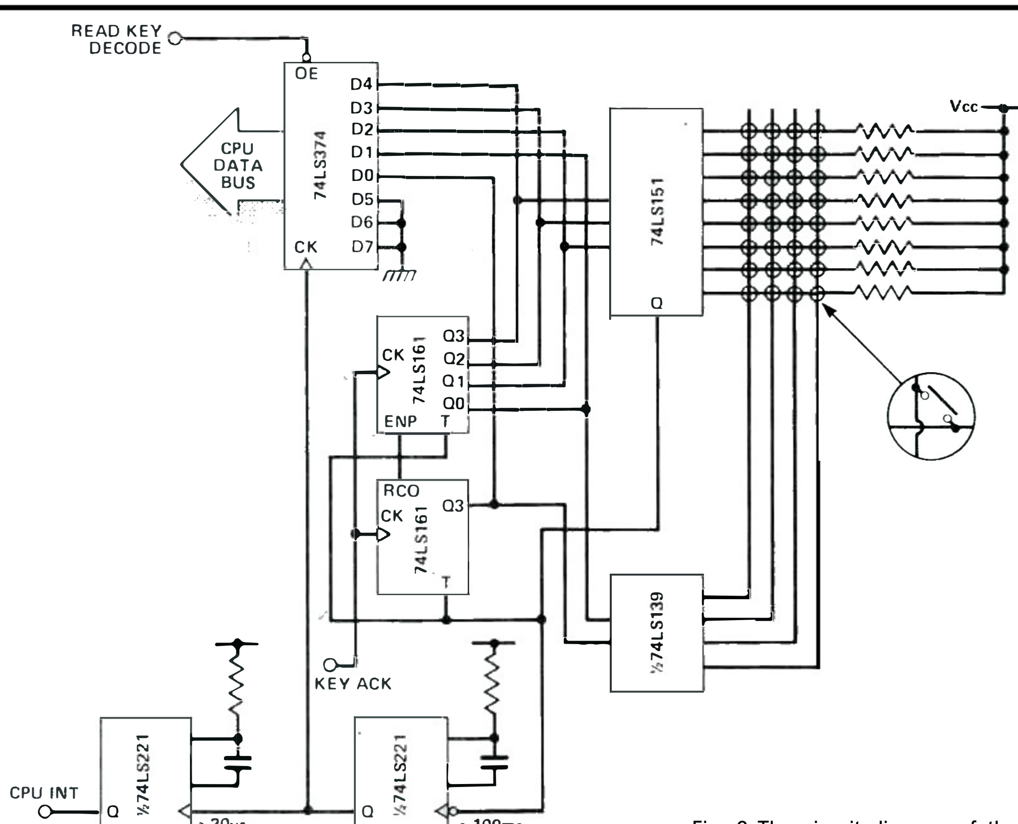


Fig. 3 The circuit diagram of the keypad decoder.

Each time the switch bounces, the counter will rescan the matrix and stop at the same key code as before. If the stop signal were simply piped through to the CPU interrupt, although the key code would be valid, it would be read an arbitrary number of times.

The answer is to delay the generation of the interrupt until the key has stopped bouncing. The simplest way to do this is to use a pair of non-retriggerable monostables. The first closure of the key starts the first monostable which then ignores further triggers until it has timed out. If its time period is in the order of 100ms, the key can be guaranteed closed and stable before the period ends.

The trailing edge of the first monostable pulse clocks the counter data into the keyboard interface data register and also starts the second monostable, which generates the CPU interrupt.

No attempt has been made to convert the keyboard output to ASCII. We only need about 20 keys and so the key code can be used as an entry to a ROM based lookup table.

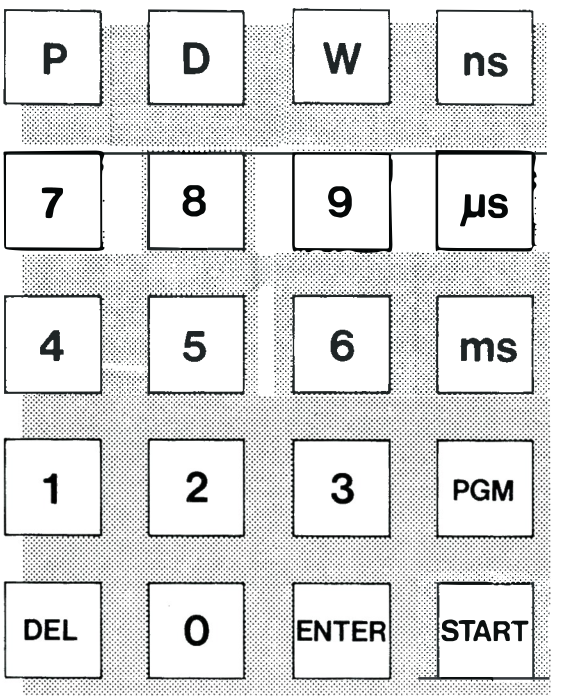


Fig. 4 The suggested keypad layout.

The recommended keys are: **0-9** plus **Delete** and **Enter** for decimal input, **nS, uS, mS** for input scaling, **P, D, W,** for period, delay and width and finally **PGM** to halt the generator for reprogramming and **Start** for restarting after programming. The suggested keypad layout is shown in Fig. 4.

The PGM key is not on the scanned matrix. It is in fact the CPU reset button. This is because it is a good idea to turn off the CPU interrupts (thus disabling the keyboard) while the pulse generator is running. Reset is then used to attract the attention of the CPU for reprogramming. The CPU is in fact just idling at all times except while programming.

Display

The display driver is the simplest possible solution. The Densitron display requires an eight bit data byte and a strobe while data is valid (rather like a Centronics printer interface on a microcomputer). There are, however, two internal registers — data and command. As we are only interested in seven bit data (ASCII alphanumerics), I have used the eighth bit as the register select.

This means that commands are sent as straight ASCII and data for display are negated with (bit 7 set). This limits the display versatility a little, but greatly simplifies the interface.

Referring to Fig. 5, data bit 7 (MSB) is grounded at the display, and the display Read/Write pin is strapped to Write. Data 0-6 are supplied from a latch together with the RS (register select) which replaces D7 of the incoming data byte.

Timings are fairly critical as these displays are quite slow. Note the use of a transparent latch (74LS373) rather than an edge triggered register for data storage. This allows us to meet the long data setup time required by the display and still generate the enable strobe directly from the register write signal.

The only remaining unfamiliar element is the pot across pin 3. This is a bias voltage to adjust the display contrast. Anything in the 10K region is about right but a padder resistor could be needed at the top end. For more detail on this and for the actual programming codes, I refer you to the manufacturer's data sheet.

The final point to mention about the display is that it is most easily read from just *below* its normal axis, so clever mounting may be needed.

This more or less wraps up the pulse generator design. I have been less specific about the control end of the unit as I feel this is much more likely to be familiar to you. The real aim has been to guide you through the design process, rather than just run a pulse generator project, but I hope some of you give it a go and build one. It's back to pure concepts next month with a thorough investigation of programmable logic.

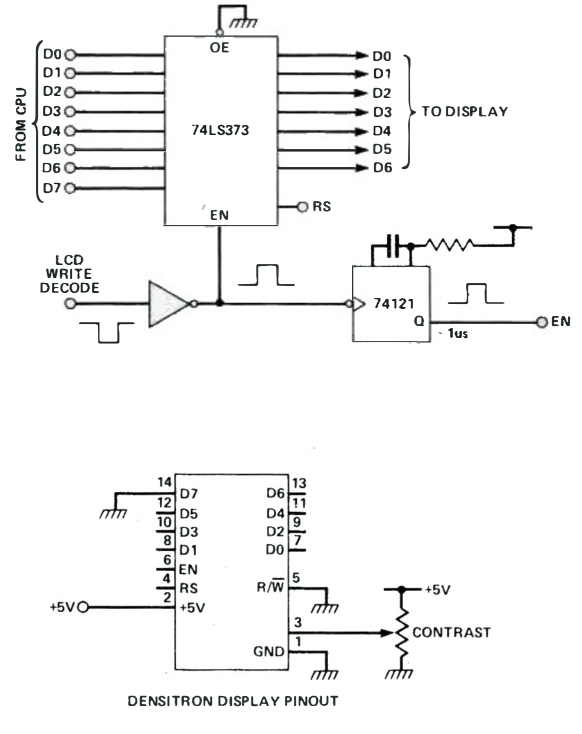


Fig. 5 Interfacing the Densitron display.

CIRCUIT THEORY

Paul Chappell gets into some pretty heavy mathematics to explain the workings of the ·Fourier series.

The Fourier series is no more mysterious or complicated than the Taylor or Maclaurin series expansions which you will remember from your school days. Instead of expressing a function as an infinite polynomial, it is expanded into a series of sine waves.

Figure 1 shows how this works with a square wave. The building begins with a sine wave of the same frequency as the square wave we are trying to make. At point A a smaller sine wave at three times the frequency is added, at point B yet another sine wave at five times the frequency of the original is added.

With each addition the rise becomes steeper, the top becomes flatter and the resulting waveform becomes closer and closer to a square wave. The process continues with addition of 7th harmonic, then 9th, and so on.

The Fourier series has the form:

$$f(x) = a_0 + \sum_{n=1}^{\infty} (a_n\cos(nx) + b_n\sin(nx))$$

At the moment this doesn't express any kind of mathematical truth. It's really more like a wish. We hope that, given a function f(x) we can choose values for the coefficents (a_n and b_n) to make the two sides of the equation identical, in which case we will have found the Fourier series for f(x).

Whether this can be done for any function or just for some we don't yet know. There clearly are functions for which the expansion *does* hold because we can take the process the opposite way around. If coefficients are selected at random and f(x) is made equal to the result, then f(x) is its own Fourier expansion! (There's no need to choose an infinite number of coefficients. As soon as you get bored, the rest can be set to zero!)

Take another look at the form of the Fourier series. If the summation sign is alien to you, it's just a shorthand way of saying:

$$f(x) = a_0 + a_1\cos(x) + b_1\sin(x) + a_2\cos(2x) + b_2\sin(2x) + \ldots$$

Since all the sines and cosines vary about zero, the a_0 is needed to represent the mean level (the DC component if we're thinking about voltages). The reason for having both sines *and* cosines is to give the relative phase of the various components. For instance, adding equal quantities of sin(x) and cos(x) will give a wave 45° out of phase with each.

To find the values of the coefficients it is convenient to make use of a property of sines and cosines known as orthogonality.

Orthogonality

This is the name for a special disappearing trick that sines and cosines perform. If you draw a graph of sin(x) over the interval 0 to 2π (one complete cycle), I think you'll agree that the area above the axis exactly matches the area below. So, if you integrate between these limits, the two areas 'cancel out' and leave you with zero, right? Exactly the same thing applies to a cosine, over the same interval.

Draw a graph of sin(2x) over the interval 0 to 2π (two complete cycles) and the area above matches the area below the axis. Integrate and you get zero. How about cos(9x) over the same interval (9 complete cycles)? Integrate, and that vanishes too. Sin(566,344,890x) over the same interval? You guessed it — integrate and it vanishes.

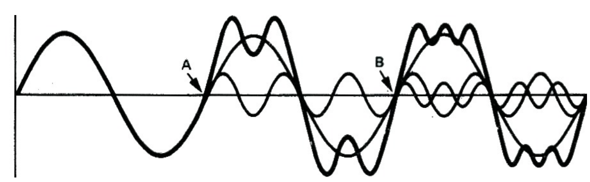


Fig. 1 Approximating a square wave with one, two and three sine waves.

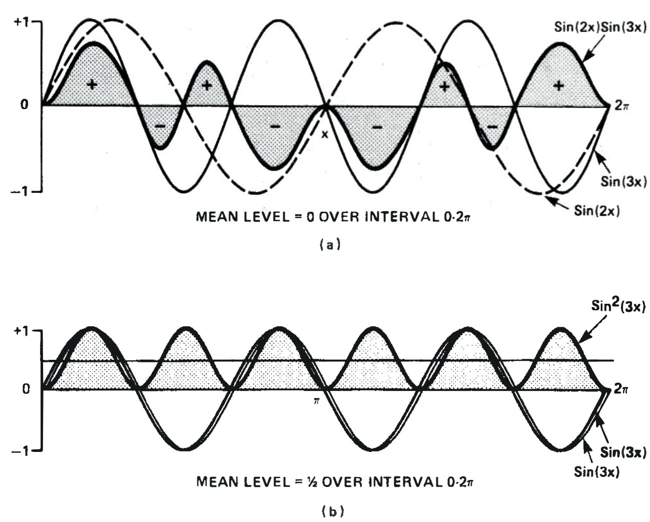


Fig. 2 (a) The product of two sine waves of different frequencies will have a mean value of zero (b) The product of two sine waves of the same frequency will have a positive mean value.

Now let's try something else. Take a sine wave, let's say sin(2x), and multiply it by another. Sin(3x), for example. The result of this particular multiplication is shown in Fig. 2a. It's not certain from the drawing but it looks very much as if the two larger areas above the axis match the two larger areas below and similarly with the smaller areas. It looks as if this might disappear when integrated as well!

In fact, this is exactly what happens. It's beginning to seem as if just about any combination of sines and cosines will vanish over 0 to 2π. The exception occurs when two sines or two cosines of the same frequency are multiplied together. Figure 2b illustrates this for sin(3x) × sin(3x). Since the resulting waveform is always positive, integrating will give a positive result.

This can all be summed up as follows:

$$\int_0^{2\pi} \sin(mx)dx = \int_0^{2\pi} \cos(nx)dx = 0 \qquad \text{(for all m, n)}$$

$$\int_0^{2\pi} \sin(mx)\cos(nx)dx = 0 \qquad \text{(for all m, n)}$$

$$\int_0^{2\pi} \sin(mx)\sin(nx)dx = \begin{matrix} 0 \\ \pi \end{matrix} \qquad \begin{matrix} (\text{for } m \neq n) \\ (\text{for } m = n) \end{matrix}$$

$$\int_0^{2\pi} \cos(mx)\cos(nx)dx = \begin{matrix} 0 \\ \pi \end{matrix} \qquad \begin{matrix} (\text{for } m \neq n) \\ (\text{for } m = n) \end{matrix}$$

where m, n are integers >0

The results are quite easy to prove. Integrating the product of two functions is a perfect pain but by making use of the identity $\sin(mx)\cos(nx) = \frac{1}{2}(\sin(m+n)x + \sin(m-n)x)$ and similar identities for the product of two sines and of two cosines, the integrations can be performed without much difficulty.

The description 'orthogonal' (perpendicular) may seem an odd one to apply to sine waves. It arises from certain similarities between operations that can be performed on sines and operations that can be performed on vectors — in particular the scaler product of two vectors which vanishes when they are at right angles to each other.

The place where 'sine wave vectors' feel at home is called L_2. It's an abstract space with an infinite number of dimensions. It's one of a class of abstract spaces known as Hilbert spaces.

Imagine a set of axes, all at right angles to each other, each labelled sin(x), sin(2x), sin(3x), and so on. Now mark out on each axis the Fourier coefficient showing 'how much' of the sine wave of that particular frequency there is in the function of your choice. When you've finished marking out all the axes, you'll be able to place a point in the space which has just those co-ordinates (just like the x and y co-ordinates in the common or garden Cartesian system). So, each function with a Fourier expansion can be represented by a single point in L_2. Clever, eh? It's a fascinating place and we're taking holiday bookings now!

Fishing For Sines

The orthogonality property is not just an incidental part of Fourier analysis, it's the key to the whole process. In this issue you'll find a circuit which will perform Fourier analysis by orthogonality. It's called a hi-fi power meter but don't be fooled by that!

The input side of the circuit is not needed for this argument. Take the components from the multiplier onwards (Fig. 3). At one input to the multiplier there is the waveform to be analysed. At the other input is a sine wave signal generator. If the signal generator is set to a frequency not present in the 'unknown' waveform, the average output from the integrator will be zero (for the same reason that the mean level of Fig. 2a is zero). If the sine wave exactly matches the frequency of one of the components of the unknown waveform, the output will have a DC component which will register on the meter (Fig. 4).

If you want to try this, start fishing with a low frequency sine wave. Increase the frequency of the bait until you see the meter move, showing that you've caught a sine. The meter will move quite violently, so use a cheap one and set it to centre scale. The movement of the meter will first occur when you are within a few Hz of the fundamental frequency. When you hit it exactly, the movement will stop. The meter reading will depend on the relative phase of the 'unknown' waveform and the bait.

Continue up the scale and you can determine the frequencies of other sine wave components. You know roughly where to look — they will be multiples of the fundamental. With a square wave as the unknown, you won't find any even multiples. With other waveforms, other harmonics may be missing.

With some slight modifications to the integrator, and by displaying the output on a 'scope instead of a meter, you can determine the relative amounts of each harmonic. Setting the signal generator slightly off frequency will give 'beats' with an amplitude proportional to the 'amounts' of each component. If your signal generator has a sweep function and your scope an external trigger, you're in business with a complete spectrum analyser!

The sine wave and the 'unknown' should each have an amplitude of about 1V. To get satisfactory results on a sweep, the integrator will have to be replaced by a more suitable detector circuit. If you're not sure how to go about it, we hope to publish a complete spectrum analyser based on this principle sometime soon, so watch out for it!

The Fourier Coefficients

Back to the maths again. What needs to be done now is to apply the same process mathematically as we've just done electronically. First of all, a reminder of the form of the Fourier series:

$$f(x) = a_0 + a_1\cos(x) + b_1\sin(x) + a_2\cos(2x) + b_2\sin(2x) + \ldots$$

Now the bait. Suppose we want to know how much cos(2x) there is in f(x) (in other words, we want to find the value of a_2). Multiply the whole lot by cos(2x) and integrate from 0 to 2π:

$$\int_0^{2\pi} f(x)\cos(2x)dx = a_0 \int_0^{2\pi} \cos(2x)dx +$$

$$a_1 \int_0^{2\pi} \cos(x)\cos(2x)dx + b_1 \int^{2\pi} \sin(x)\cos(2x)dx +$$

$$a_2 \int_0^{2\pi} \cos(2x)\cos(2x)dx + b_2 \int_0^{2\pi} \sin(2x)\cos(2x)dx +$$

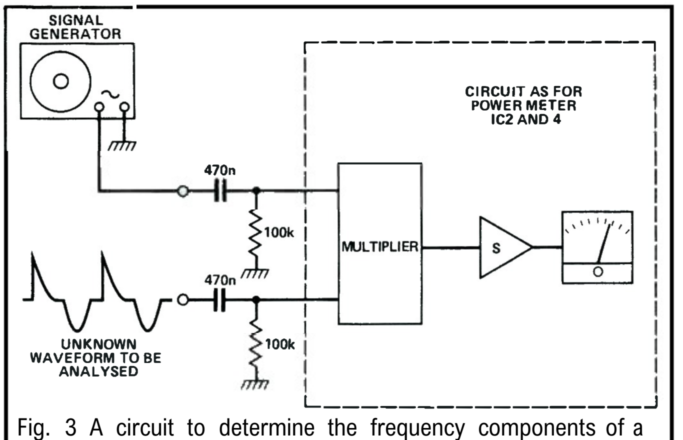


Fig. 3 A circuit to determine the frequency components of a waveform. For component values, see 'Hi-Fi Power Meter' project elsewhere in this issue.

On the right hand side, every single term apart from the one involving cos(2x) will disappear (check it out with the orthogonality integrals listed earlier). This is quite a relief as it means we don't have to do an infinite number of integrations! We are left with:

$$\int_0^{2\pi} f(x)\cos(2x)dx = a_2 \int_0^{2\pi} \cos(2x)\cos(2x)dx = a_2\pi$$

So the amount of cos(2x) in f(x) is given by:

$$a_2 = \frac{1}{\pi} \int_0^{2\pi} f(x)\cos(2x)dx$$

If you think about the right hand side of this equation for a moment, it's doing exactly the same thing as the

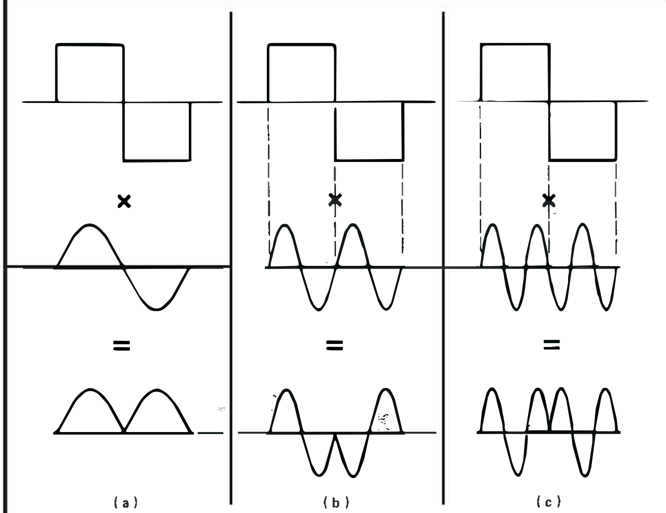


Fig. 4 Fishing for sines in a square wave. (a) Multiplying by the fundamental gives a positive 'output' on integration. (b) Multiplying by the second harmonic gives a wave with equal areas above and below the axis (there is no second harmonic present in a square wave). (c) Multiplying by the third harmonic gives a wave with more area above the axis than below — again, a positive output after integration.

multiplying circuit. If there is no cos(2x) in f(x), then multiplying and integrating will give no 'output' and so the value of a_2 will be zero. If there is some cos(2x) present, the 'output' will be equal (in this case) to the value we will give to a_2.

The other coefficients are calculated in exactly the same way:

$$a_n = \frac{1}{\pi}\int_0^{2\pi} f(x)\cos(nx)dx \qquad b_n = \frac{1}{\pi}\int_0^{2\pi} f(x)\sin(nx)dx$$

The only term not yet dealt with is a_0. To get this value, the Fourier series is integrated 'raw' — without multiplying it by anything — giving:

$$\int_0^{2\pi} f(x)dx = \int_0^{2\pi} a_0 dx$$

$$\text{so } a_0 = \frac{1}{\pi}\int_0^{2\pi} f(x)dx$$

This month's article has been rather heavy on the maths side. (You noticed?) The most horrifying thing about maths is the thought that someone may put you on the spot and actually ask you to *do* some. It brings back all the examination nightmares: Question 19. Do the most horrible double integral you can think of over an arbitrary surface with knobbly bits on, take away the number you first thought of and express the answer to 12 decimal places. Then keep doing it again 'till you get it right.

If you've forgotten most of the mathematical techniques for grinding out the 'right answers', don't worry. Next month there will be a practical example of how to 'do' a Fourier series. In the privacy of your own home you might find it easier than you think. Besides, if you get it wrong nobody will ever know!

For this month, if you have followed the ideas through, that's the main thing. If you have, we'd like to award you the ETI medal for dedication to your hobby above and beyond the call of duty. The only trouble is, the medal's in Hilbert space and we can't get it out!

SPECIAL OFFER

FOR SPECTRUM AND BBC MICRO OWNERS

Now your computer can take control for an affordable price. These tried and trusted interfaces from DCP Microdevelopments are offered at **£20 off** the normal price.

Both units are extremely easy to use from both Basic and assembler/machine code and are supplied ready built and complete with all the documentation you need.

To order by post fill in the form below (or a copy) and send it with your remittance to
ASP READERS' SERVICES (RO ET5/6)
9 Hall Road, Maylands Wood Estate,
Hemel Hempstead, HP2 7BH
Please make cheques payable to ASP Ltd.
Overseas orders add £5 (Interspec) or £10 (Interbeeb) for airpost.
Access and Visa card holders can also place their order by phone on (0442) 211882.
Allow 28 days for delivery.

Please supply..................... Interspecs (RO ET5) at **£29.95 plus £1.95 p&p per order.**
Please supply ...... Interbeebs (RO ET6) at £49.95 plus £1.95 p&p per order.

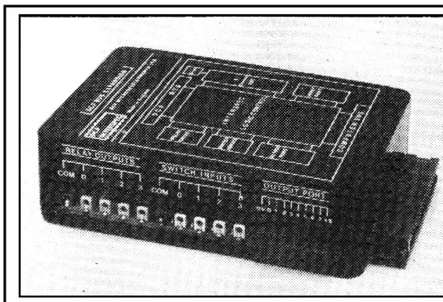
Name ....

Address ....

....

....

Please debit my ACCESS/VISA card No .... **to the sum of £** .... **Signed:** ....



INTERSPEC £29.95

The Interspec unit plugs directly onto the expansion edge connector of the Spectrum to provide a full range of interfacing facilities.

The unit is housed in a plastic case approximately 4½x3x1in which contains the top quality double sided PCB and interface connections.

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

All sections of the interface are I/O port mapped and designed for maximum compatibility with existing Spectrum peripherals. Power is supplied through the Spectrum edge connector.

The expansion bus provides all the data and address/control signals for the addition of further DCP modules or home-built devices. Connection is by multi-way PCB connector and all the information required

INTERBEEB £49.95

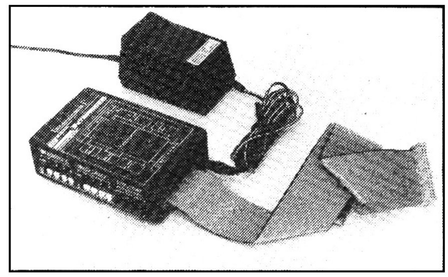
The Interbeeb unit connects to the BBC micro's 1MHz bus expansion connector and is supplied complete with its own power supply unit.

The interface unit is housed in a plastic case approx 4½x3x1in which contains the top quality double sided PCB and interface connectors.

- **8-bit input port**
- **8-bit output port**
- **four switch sensor inputs**
- **four relay-switched 12V 1A outputs**
- **eight channel multiplexed analogue to digital converter**
- **precision 2.5V reference**
- **external power supply**
- **15-way expansion bus**

All sections of the interface are memory mapped in the 1MHz expansion map for maximum ease of use and compatibility with existing peripherals.

The expansion bus provides all the data and address/control signals for the addition of further DCP modules or home-built devices. All the information required for using additional devices is included.



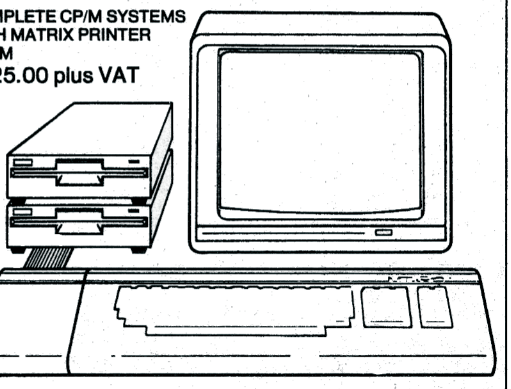
DISK DRIVES • COMPONENTS • CONNECTORS • ELECTRO-MECHANICAL, PCB AND CABLE ASSEMBLIES

Electro Mech Industries Limited

Unit 2, Wessex Industrial Estate, Station Lane, Witney, Oxfordshire. Telephone (0993) 75827 or 76605

MEMOTECH MICROCOMPUTER SYSTEMS

COMPLETE CP/M SYSTEMS WITH MATRIX PRINTER FROM £525.00 plus VAT



	Price	P+P
MTX512 80K Computer	60.00	5.00
DMX80 Dot Matrix Printer Equivalent to Panasonic KXP1090	122.00	5.00
Hantarex 12" Hi-Res Monitor Green Screen/Black Cabinet	75.00	7.00
Disc Controller (state for BASIC or CP/M)	48.00	7.00
1MB 5.25" Disc Drive Includes NewWord and O/S utilities	131.00	3.00
Kraft Joystick	8.70	1.00
80 Column CP/M Upgrade Includes plug in PCB, CP/M O/S, NewWord, SuperCalc, MTX BASIC plus manuals and leads	150.00	3.00

More Expansions available - please send for price list

PACKAGE OFFER

MTX512, Printer, Monitor, Disc Controller, One 1MB Disc Drive, 80 Column CP/M Upgrade with software, manuals and leads - Fantastic looks and performance -

only £525.00 plus VAT and P+P £20.00

SPECIAL OFFERS

UM1286 Modulator colour/sound Price Crash!	only 2.00	4116-3 200n/s 16K DRAM	0.50
Z80A CPU Incredible!	only 1.50	4864-2 150n/s 64K DRAM	0.90
Z80A CTC Amazing!	only 1.50	5×20mm Inline Fuseholders	0.20
PAL 14L4	1.00	2764-25	1.75
		27128-25	2.21
		6264LP-15	3.00

SWITCH MODE POWER SUPPLIES

Excellent Spec, British made with multiple outputs. Complies with International safety/RFI standards, full burn-in, from 35 to 100 Watts. Very Competitive Prices, eg:

40 Watt, +5v/+12v/−12v outputs only **£55.00!**

Applications include:

Microprocessor systems	Winchesters
Computer peripherals	Data Processing

Full Specs and Price List on request

74LS & 74

SN74LS00	0.17
SN74LS02	0.18
SN74LS03	0.18
SN74LS04	0.17
SN74LS08	0.18
SN74LS09	0.18
SN74LS10	0.18
SN74LS107	0.30
SN74LS109	0.30
SN74LS11	0.18
SN74LS112	0.30
SN74LS113	0.30
SN74LS114	0.30
SN74LS122	0.35
SN74LS123	0.40
SN74LS125	0.30
SN74LS126	0.30
SN74LS12	0.18
SN74LS132	0.35
SN74LS133	0.35
SN74LS136	0.28
SN74LS137	0.70
SN74LS138	0.30
SN74LS139	0.30
SN74LS13	0.30
SN74LS14	0.30
SN74LS145	0.80
SN74LS147	1.10
SN74LS148	1.00
SN74LS15	0.18
SN74LS151	0.30
SN74LS153	0.50
SN74LS155	0.40
SN74LS156	0.40
SN74LS157	0.30
SN74LS158	0.30
SN74LS160	0.50
SN74LS161	0.50
SN74LS162	0.55
SN74LS163	0.50
SN74LS164	0.50
SN74LS165	0.75
SN74LS166	0.75
SN74LS168	1.10
SN74LS169	0.80
SN74LS170	0.90
SN74LS173	0.40
SN74LS174	0.35
SN74LS175	0.40
SN74LS181	1.80
SN74LS182	2.00
SN74LS183	1.50
SN74LS190	0.55
SN74LS191	0.50
SN74LS192	0.50
SN74LS193	0.50
SN74LS194A	0.60
SN74LS196	0.60
SN74LS197	0.60
SN74LS20	0.18
SN74LS21	0.18
SN74LS22	0.18
SN74LS240	0.60
SN74LS241	0.55
SN74LS242	0.55
SN74LS245	0.70
SN74LS244	0.50
SN74LS245	0.50
SN74LS247	0.55
SN74LS248	0.90
SN74LS249	0.90
SN74LS251	0.40
SN74LS253	0.60
SN74LS256	0.80
SN74LS257	0.40
SN74LS258	0.50
SN74LS259	0.65
SN74LS26	0.18
SN74LS260	0.65
SN74LS266	0.30
SN74LS27	0.18
SN74LS273	0.50
SN74LS279	0.50
SN74LS280	1.50
SN74LS283	0.50
SN74LS290	0.70
SN74LS293	0.70
SN74LS295	1.00
SN74LS298	0.95
SN74LS299	2.00
SN74LS30	0.18
SN74LS32	0.18
SN74LS322	3.00
SN74LS323	2.50
SN74LS33	0.25
SN74LS352	1.00
SN74LS353	0.80
SN74LS365	0.35
SN74LS366	0.35
SN74LS367	0.35
SN74LS368	0.35
SN74LS37	0.18
SN74LS373	0.50
SN74LS378	0.75
SN74LS38	0.18
SN74LS390	0.50
SN74LS393	0.50
SN74LS395A	0.90
SN74LS40	0.18
SN74LS42	0.30
SN74LS47	0.30
SN74LS48	0.60
SN74LS49	0.85
SN74LS51	0.20
SN74LS54	0.20
SN74LS541	0.90
SN74LS55	0.20
SN74LS640	1.20
SN74LS641	1.20
SN74LS642	1.20
SN74LS643	1.20
SN74LS644	1.20
SN74LS645	1.20
SN74LS668	0.80
SN74LS669	0.80
SN74LS670	1.00
SN74LS673	5.00
SN74LS674	5.00
SN74LS682	2.10
SN74LS684	2.75
SN74LS685	2.75
SN74LS686	5.00
SN74LS687	2.75
SN74LS689	2.75
SN74LS73	0.30
SN74LS74AN	0.22
SN74LS75	0.27
SN74LS76	0.27
SN74LS78	0.27
SN74LS83	0.40
SN74LS85	0.45
SN74LS86	0.20
SN74LS90	0.22
SN74LS92	0.30
SN74LS93	0.27
SN74LS95B	0.45
SN74LS96	0.65
TTL74	
SN7400	0.20
SN7401	0.20
SN7402	0.20
SN7404	0.25
SN7406	0.38
SN7407	0.38
SN7408	0.25
SN7409	0.25
SN7410	0.25
SN74100	1.90
SN74114	0.20
SN7412	0.25
SN74121	0.40
SN74123	0.60
SN7413	0.40
SN7414	0.50
SN74141	0.60
SN74147	1.25
SN74153	0.70
SN74155	0.70
SN74157	0.70
SN74159	1.50
SN74160	0.60
SN74161	0.80
SN74163	0.80
SN74165	0.90
SN7417	0.35
SN74170	1.50
SN74173	0.95
SN74174	0.90
SN74180	0.80
SN74181	1.20
SN74182	0.80
SN74184	1.55
SN74188	2.10
SN74190	1.00
SN74191	1.00
SN74193	1.10
SN7420	0.25
SN7422	0.30
SN74251	0.90
SN74284	2.25
SN7430	0.22
SN74367	0.65
SN7438	0.35
SN7440	0.25
SN7441	0.60
SN7442	0.60
SN7443	0.80
SN7446	0.90
SN7448	0.90
SN7450	0.25
SN7472	0.38
SN7474	0.35
SN7475	0.45
SN7476	1.00
SN7485	1.00
SN7486	0.40
SN7490A	0.50
SN7491	0.60
SN7492	0.50
SN7493	0.50
SN7494	1.00
SN7496	0.65

SPECIAL OFFER BBC DISK DRIVES

	1 OFF	2+
3.5" 500K DS/DD 40T Drive Cased with I/F cable and power lead	48.00	45.00
Uncased	40.00	37.50

BBC CASED DISC DRIVES

Carriage 3.00

5.25" Single	INC PSU	W/O PSU
100K 40T	113.00	80.00
400K 80T (40/80)	127.00	110.00
5.25" Dual		
400K 80T (40/80)	250.00	206.00
3.5" Single 400K 80T	139.00	115.00
3,5" Dual 400K 80T	214.00	190.00

All BBC Drives include Cables, Manuals and Utilities Disc

CASED/UNCASED DISC DRIVES

5.25"	1-OFF	2+	Carriage
500K DS/DT 40T	99.00	96.00	2.00
1MB DS/DD 80T	99.00	96.00	2.00
1MB DS/DD 80T Cased+*	124.00	–	3.00
1MB DS/DD 80T Cased only	108.00	–	3.00
3.5"			
1MB DS/DD 80T Slimline	88.00	85.00	2.00
1MB DS/DD 80T Cased+*	113.00	–	2.50
1MB DS/DD 80T Cased only	103.00	–	2.50
2×1MB DS/DD 80T Cased+*	199.00	–	3.00
1MB DS/DD 80T Cased only	189.00	–	3.00

* Cased+PSU+Leads available in 110/220 volt versions - please state which

DISC DRIVE ACCESSORIES

	Price	P+P
5.25" diskettes DS/DD	1.00	
3.5" Diskettes DS/DD	2.90	
PSU* uncased	9.50	
Cases Only		
5.25" – 1 H/H Drive	9.00	2.00
3.5" – 2 Slimline Drives	15.00	2.00
Drive I/F Cable	6.50	
Cases with PSU* and Leads		
5.25" – 1 H/H Drive	25.00	3.00
3.5" – 2 Slimline Drives	25.00	3.00

* available in 110/220volt versions - please state which

MODULATORS

UM1286	2.00
UM1233	3.00

HEADER PLUGS-DIL IDC

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

D type CONNECTORS

	9 way	15 way	25 way	37 way
PLUGS				
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

BT Telephone Connectors

LJU1/4A	Mini Master	3.05
LJU1/6A	Mini Secondary	2.40
LJU2/4A	Standard Master	3.10
LJU2/6A	Standard Secndry	2.45
LJU3/4A	Flush Master	3.05
LJU3/6A	Flush Secndry	2.35

Range of Dual Outlets, Cords, Connectors available

IDC CONNECTORS

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

CENTRONICS CONNECTORS

36way	Plug IDC	4.55
36way	Socket IDC	4.55
36way	Plug Solder	2.01

PRINTER LEADS

QL	6.85
Dragon	7.95
BBC	7.40
Memotech	8.50
Amstrad	8.80

DIL SWITCHES

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

ZENERS

C10-C9V1 400mW	0.07
C10-C47 1.3W	0.13

MONITORS

PHILIPS	12"	Green	70.00
PHILIPS	12"	Amber	74.00
PHILIPS	12"	RGB	185.00
HANTAREX	12"	Green/Black case	75.00

Carriage on Monitors 7.00

SEND FOR MORE DETAILS ON

Computer leads, slide/toggle/rocker switches, Soldering Irons/spares, general Service aids, Microvitec monitors, Telephone outlets/cords, connectors

LINEAR ICs

555	0.20
710	0.40
723	0.50
723T	0.80
741	0.22
741CT	0.55
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
BTT8124	3.00
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
CA3086	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
CA3193E	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
MC145106P	6.65
MC1460G	2.90
MC1463R	4.80
MC1469R	3.00
MC3357L	1.90
MFC4040	0.75
MFC6040	0.90
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
STK078	9.00
TA7204P	1.30
TA7205AP	0.90
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	0.55
LM311N	0.50
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	1.50
SG3524	2.50
STK431	4.00
STK460	11.00
TAA661A	2.20
TAA700	2.75
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
UA748CDP	0.60
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	2.93
MC8T28P	1.75
MC8T97P	1.50
MC8T98P	1.40
M5L8035LP	3.00
M5L8085AP	2.70
M5L8155P	3.00
M5L8156P	3.20
M5L8212P	1.75
M5L8216P	1.50
M5L8251AP-5	2.95
M5L8253P-5	2.70
M5L8255AP-5	2.55
M5L8279P-5	3.50
N8T26AN	3.50
UP88284AD	4.00
UPD8156C-2	3.50
UPD8243C	2.30
UPD8748HD	16.00
6821P	2.00
6850P	2.25
8086	17.00
8088	12.00
8228	5.00
8748D	13.00
7201	6.90
Z80ACTC	2.00
Z80ACPU	2.00
TMS9929	10.00
TMS9928	10.00
76489AN	5.00
MC6845SP	5.00
Z80ADART	6.50
Z80ADMA	7.00
Z80AP10	2.40
Z80AS10-0/1/2	7.00
VL4500A	13.00
8272	9.00
8272A	11.00
6551A	4.50
6800	2.50
6809EP	8.00
6809P	8.00
68809P	12.00
68000P8	20.00
1793	12.00
1691	12.00
9216	12.00
1770	12.00
8271	45.00
2793	20.00
2797	20.00
L203B/4 ULN2003	0.70
L204B/4 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
75109	1.20
75110	1.00
75112	1.60
75113	1.20
75114	1.50
75115	1.50
75121	1.10
75122	1.10
75150P	1.30
75154	1.30
75159	2.20
75160	4.50
75161	4.00
75162	4.50
75172	3.00
75182	1.00
75188	0.80
75189	0.80
75365	1.50
75450	0.60
75451	0.45
75452	0.45
75453	0.55
75454	0.55
75490	4.50
75491	0.60
75492	0.60

MEMORIES

2016AP12	2.95
2114-2	2.90
2716-350N/S	3.00
2732 450N/S	2.50
2732A 250	2.75
2764-200	2.50
2764-25	1.75
27C64-25	8.00
27128-200	3.00
27128-250	2.21
27256-25	7.00
4116-3	0.75
27C256-20	15.00
27512-25	36.00
27C512-25	49.00
4164P-15	1.50
41254-15	5.30
41256-15	3.00
41416-15	3.90
4864P-2 150N/S	1.50
50256-12	3.50
6116LP3 150NS	1.75
6116P4 200NS	1.50
HM 58064P-25	18.00
HM6264LP12	3.40
HM6264LP15	3.00
HM62256P-12	63.00
HM65256P-15	17.00
MB85101-A-10	46.00
TC5501P	4.00
TC5514AP3	2.95
TC5516APL2	2.90
TC5517BP	2.95
TC5565PL15	3.55
TMM2018D	6.85
TMM416P-3	2.95
UPD41464C-15	8.00
UPD43256C-15L	55.00

DIODES

AA19	0.08
AA129	0.20
1N4001	0.04
1N4002	0.04
1N4003	0.05
1N4004	0.05
1N4005	0.05
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
6A600	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
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 KHz	2.00
2.0 MHz	2.10
2.4576 MHz	1.90
2.5 MHz	1.80
3.0 MHz	2.10
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	1.00
4.9152 MHz	1.20
6.00 MHz	1.30
6.144 MHz	1.30
6.4 MHz	1.30
6.5536 MHz	1.50
7.159 MHz	1.30
7.3728 MHz	1.50
8.0 MHz	1.40
10.0 MHz	1.70
12.00 MHz	1.50
15.00 MHz	1.80
16.0 MHz	2.00
18.432 MHz	1.50
20.0 MHz	1.50
32.00 MHz	1.30
36.00 MHz	1.30
48.00 MHz	1.30

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	

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	.60

CMOS

4000B	0.18
4001B	0.18
4001UB	0.18
4002B	0.18
4002UB	0.18
4006B	0.50
4007UB	0.18
4008B	0.50
4009UB	0.25
40103B	3.00
40104B	0.75
40105B	1.50
40107B	0.40
40108B	2.35
40109B	0.87
4010B	0.25
40110B	1.85
4011UB	0.18
40114B	2.10
4011B	0.18
4012B	0.18
4012UB	0.18
4013B	0.25
40147B	0.85
4014B	0.40
4015B	0.40
40160B	1.25
40161B	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	0.60
40194B	0.60
4019B	0.35
40106B	0.35
40208B	2.10
4020B	0.50
4021B	0.50
4022B	0.50
4023B	0.18
4023UB	0.18
4024B	0.30
40257B	1.50
4025B	0.18
4025UB	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
4069UB	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	0.40
4514B	1.00
4515B	1.00
4516B	0.40
4517B	2.25
4518B	0.40
4520B	0.40
4522B	1.10
4526B	0.45
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

FULL PRICE LIST AVAILABLE ON COMPETITIVELY PRICED TRANSISTORS, THYRISTORS, TRIACS, BRIDGE RECTIFIERS, FUSES, FUSEHOLDERS AND 74S SERIES

Please add £1.00 P&P to all orders unless otherwise stated

All prices are EXCLUSIVE OF VAT – please add VAT to **total cost including P&P**

Please send cash, cheque, money order or postal order to:

All items are **Brand New and fully guaranteed** • **Export Orders** – carriage at cost

Government and Educational orders welcome • Stock items dispatched by return

All prices subject to change without notice

MAIL ORDER ONLY

ElectroMech Industries Limited

Unit 2, Wessex Ind. Est. Witney, Oxon.
Telephone (0993) 75827/76605

RIAA EQUALISATION

Even with the advent of CD, analogue records are far from dead. Wilfred Harms explains how to design RIAA networks that will accurately replay your discs.

RIAA equalisation is an important feature of any amplifier designed to reproduce music from analogue disc. Suitable circuit designs can be found in any number of published sources.

Unfortunately, the circuits contained in many handbooks, electronics journals and even inside some expensive pieces of audio equipment are often inaccurate. Incorrect designs are often repeated without question and the original requirements are simply forgotten.

This is a pity because it doesn't cost any more to use a resistor and capacitor of the correct value and the results are well worth the extra time and trouble. The purpose of this article is to show why RIAA equalisation is important and how to go about choosing the right filter components when designing disc equalisation networks.

In The Groove

From the earliest days of electrical recording it has been standard practice to modulate record grooves using a constant-velocity recording characteristic and to replay the signal with a velocity-dependent pickup. The maximum velocity is set at a certain value and the amplitude of the signal voltage is varied with frequency so this maximum is always achieved.

The system is illustrated in Fig.1. The maximum velocity is represented by the greatest rate of change of signal voltage, the steepest part of the waveform slope. On a sine-wave this will always occur at the zero-crossing points.

On lower frequency signals, the maximum velocity will be less as the rising edge of the waveform is less steep. If, however, the amplitude of lower-frequency signals is increased, a point will be reached at which the rising edge is as steep at that of a higher frequency signal with lower amplitude. This is the principle on which constant velocity recording works, the maximum velocity remaining constant across the audio band while the amplitude varies according to the signal frequency.

The main drawback with this system is that bass frequencies require a very large amplitude. The result would be wide groove spacing and correspondingly little recording time on each disc. In addition, the comparatively small amplitude at high signal frequencies would yield a poor signal-to-noise ratio.

To overcome these problems, the basic constant velocity characteristic is modified to a constant-amplitude characteristic over certain parts of the frequency range by means of a corrective network.

In the early days this was done very much at the whim of individual record manufacturers and a number of different replay characteristics grew up side by side. In order to handle the different recording characteristics correctly amplifiers were fitted with a number of switch-selectable equalisation networks. For example, the Leak Point One Plus valve preamplifier of the 1950s had no less than four disc replay settings.

The situation was eventually rationalised by agreement. British Standard 1928 (issued in 1955 and re-issued without changes in 1965) recommends a recording characteristic similar to that put forward by the Comité Consultatif International des Radiocommunications (CCIR) in Europe and the Recording Industries Association of America (RIAA). The latter term is the one most commonly used today.

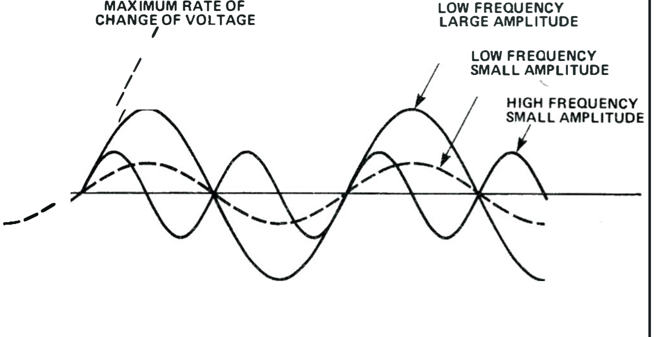


Fig. 1 For optimum modulation of the record groove when a velocity-dependent pick-up is being used, all signal frequencies should have the same maximum rate of change of voltage. The achieve this, lower frequencies are recorded . with a correspondingly greater amplitude so as to give a steeper rising edge.

Changing Shape

The RIAA characteristic modifies the basic constant-velocity characteristic to a constant amplitude characteristic at two points in the audio frequency band.

At very low frequencies the constant-velocity characteristic is retained so that the gain does not go on increasing right down to the lowest recorded frequencies. Using a constant-amplitude characteristic here would emphasise turntable rumble and vibration.

At bass frequencies the characteristic changes to constant-amplitude to limit groove pitch before switching back to a constant-velocity characteristic for the middle frequencies. At high frequencies the characteristic again becomes constant amplitude and remains so to the limits of the audio band.

These four distinct regions give the RIAA characteristic its familiar flat-steep-flat-steep shape. The shape is sometimes shown instead as a series of angular lines but these are merely asymptotes to the curves. Provided the recording and replay networks are as near identical as possible, the exact shape of the response does not make a lot of difference. It therefore makes sense to use a series of curves which can easily be replicated to a high level of accuracy rather than an idealised, sharp-cornered response which could only be approximated with difficulty.

Calculated Curves

The response shape is described in terms of three curves (flat becoming steep, steep becoming flat and flat becoming steep again) which 'turn over' at frequencies of 50.05Hz, 500.5Hz and 2.115kHz. The slope of the curves is that given by a first order (6dB/octave) filter network comprising one resistor and one capacitor.

The RIAA replay characteristic is the exact opposite of the recording characeristic and is shown in Fig. 2. The complete characteristic can, in theory, be reproduced using three capacitors and three resistors in series and parallel pairs, although this is not necessarily the best way of doing it as we shall see later.

The actual values of the resistors and capacitors used will vary according to the individual circuit configuration, but the CR time constant for each filter curve is determined solely by the turn-over frequency and is therefore fixed. For this reason, it is usual to define the three curves in terms of CR time constants.

The values required must, at the frequency concerned, give CR values which result in C and R having equal impedances. This can be determined from the formula:

$$CR \quad \frac{1}{2\pi f}$$

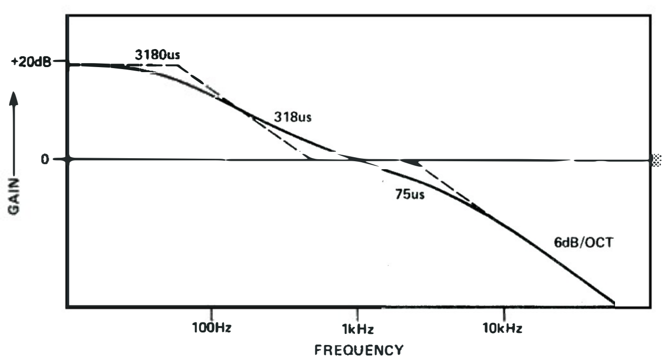


Fig. 2 The RIM replay characteristic.

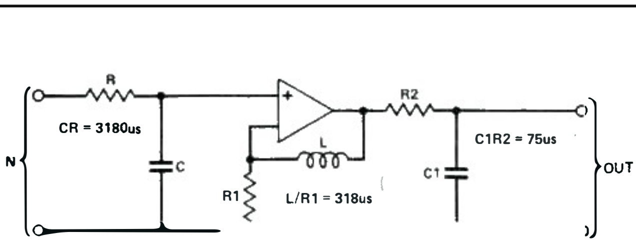


Fig. 3 A simple replay equalisation circuit using separate filter networks tor each of the three time constants.

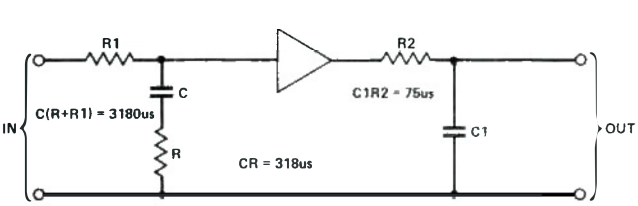


Fig. 4 A two-stage replay circuit in which one compound filter stage provides two of the time constants.

and for the RIAA characteristic gives time constants of 3180, 318 and 75 microseconds. These time constants are, incidentally, the period of one radian of one cycle at the frequency concerned.

Figure 3 shows a simple equalisation network which uses three separate stages to realise the RIAA characteristic. This will work but a much better approach is to merge two of the networks in the way shown in Fig.4.

In practice, all three stages are usually combined into a single network and some examples are shown in Fig.5. All of these circuits give similar results but in each case there will be a degree of interaction between the three time constants and this will affect all four circuit components.

The response curves for an RIAA network are defined in terms of a single reference frequency, 1kHz. Taking the circuit of Fig.4 as an example, the output level from the 318/3180μs section (the network comprising R, R1 and C) will be 11.17% of the input signal level. Similarly, the output from the 75μs section (the network comprising R2 and C1) will be 90.46% of the its input level.

Taking these two together, the final output level from the circuit at 1kHz will be (0.1117 x 0.9046 =) 0.10103 times the input level or 10.103%. Therefore the input or zero-frequency response for the network should be set at (1/0.10103 =) 9.898 times the reference response at 1kHz.

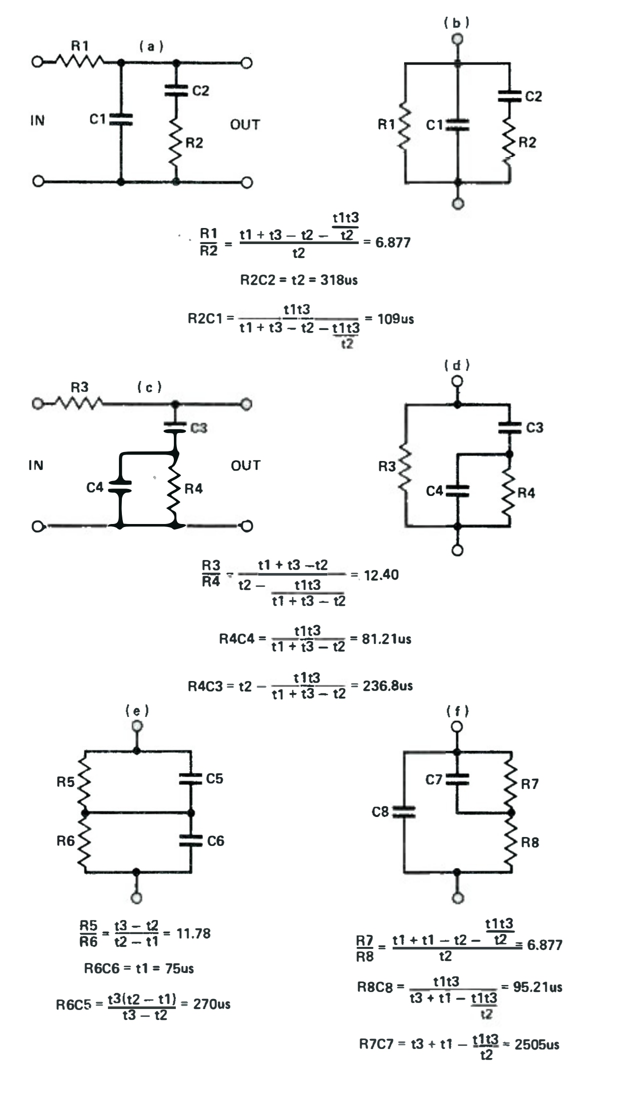


Fig. 5 Some examples of RIM replay networks in which all three time constants are set using a single network.

	VLF	50kHz	150kHz	1kHz	10kHz	30kHz
Accurate RIAA replay response	19.91	16.95	10.27	0	−13.73	−23.12
Fig.6 response	19.20	16.07	9.37	0	−13.51	−22.89
deviation	0.71	0.68		0	0.22	0.23
Fig.7 response	19.00	15.62	8.70	0	−12.51	−21.84
deviation	0.91	1.33	1.57		1.22	1.28

Table 1

Network Design

Designing a network of the type shown in Figs. 2 and 3 is quite straightforward but the single networks of Fig.4 require a different approach.

For those who want to go into the mathematics of it all, the figure for output level/input level of an RIAA network is given by

$$\frac{(1 + st_2)}{(1 + st_1)(1 + st_3)}$$

where t is the period of the CR time constant and s = $j\omega$ (ω, of course, is shorthand for $2\pi f$). Taking the circuit of Fig.4a as an example, the output level/input level at a given frequency will be equal to

$$\frac{(1 + sR_2C_2)}{1 + s(R_1C_1 + R_2C_2 + R_1C_2 + s^2R_1R_2C_1C_2)}$$

The two expressions can be equated and the component ratios determined.

Thankfully, there is little need to go through all of this because a full set of data has been available for nearly thirty years. In Wireless World in 1957 W. H. Livvy of EMI Studios presented a set of formulae which allow the ratios between resistor and capacitor values to be determined accurately for different time constants. Two of the networks, he suggested, were suitable for passive de-emphasis but all could be used in feedback circuits because the overall impedance/frequency variations were in accordance with the RIAA requirements.

The data is presented in an even simpler and more readily-useable form in a technical paper written by Peter Baxandall. Entitled 'Pick-Up Equalisation' it appears in the Radio, TV and Audio Technical Reference Book edited by S. W. Amos (Newnes-Butterworth, 1977). Baxandall uses formulae for the component ratios based on the original 1957 data and describes the operation and use of several types of network. The article is just five pages long yet it covers not only the networks but also such questions as where the equalisation should be placed, the problem of inverted feedback, aspects of pick-up response correction and sensitivity and the minimum levels of gain in feedback circuits.

Network Accuracy

If the accuracy of an RIAA network is to be assessed against the published standard it is helpful to be able to calculate the response figures in decibels. The formula for any frequency, f, is

$$10_{\log} \frac{441.18\,(r^2 + 0.2505)}{(100r^2 + 0.2502)(r^2 + 4.503)} \text{ dB}$$

where r = f/1000. If it is desired to check the characteristic of one network against another, the impedence must first be determined at any frequency and compared with the impedance at 1kHz to give

$$20_{\log} \frac{Z}{Z_{1k0}}$$

Unfortunately, the calculations are far from easy!

Design Misconceptions

Figure 6a shows a type of network which is frequently used, and component values in similar proportions will be found in many RIAA. circuits.

The zero-frequency impedance is 1M1 whilst the impedance at 1kHz is 122k which is too high. The result is a loss in response below 1kHz of up to 1dB.

Here R_5C_3 = 75μs and R_6C_4 = 3300μs which is acceptable. The error is in the false assumption that R_5C_4 should equal 318μs. A check with the basic formulae in Fig.4(e) shows that R_6R_5 = 11.78, and to meet this, R_6 must be increased to 1M2 and C_4 reduced to 2n7.

Readers may spot that this network appeared in ETI March 1986 in connection with the free PCB for use as a pre-amplifier with RIAA equalisation. The notation here agrees with the original diagram for recognition.

Figure 6b shows another commonly used RIAA network, and again it is possible to find component values in similar proportions in many other networks. As with the previous circuit, the impedance at 1kHz is high resulting in a loss in response at both lower and higher frequencies. Since R_5R_3 = 3300, R_4C_3 = 330 and R_4C_2 = 72.6 what is wrong?

In this case everything because interaction affects all values. Fig.4(d) requires that R_5C_3 = 2937μs, R_4C_2 = 81.2μs and R_t/R_4 = 12.40 and three components must be changed. If it is desirable to retain the 33k resistor, then suitable values for the others would be R_2 = 2.7k, C_2 = 30n and C_3 = 91n.

Readers may recognise this network because it appeared in a clever valve pre-amplifier in ETI August 1986, and again the notation agrees with the original. A similar network for use with transistors by the same author appeared in ETI September 1986, and this can be modified in a similar fashion.

Out of interest, I have calculated the deviations from the RIAA standard found in the circuits of Figs. 6 and 7 and these are shown in Table 1.

The noticeable common error in faulty networks is that one of the two larger resistors is ten times the other, a circumstance which cannot arise if it is correctly designed.

The ratios of component values in Fig.4 in terms of time constants (t_1 = 75μs, t_2 = 318μs, t_3 = 3180μs) are those originally given by EMI Studios which have been checked and evaluated to facilitate their use. The theoretical differences appropriate to a feedback circuit are within the normal component tolerances (1% recommended) provided the 1kHz gain exceeds 65.

In conclusion, one must realise that the final design of any RIAA replay network depends upon the equalisation circuit as a whole and particularly upon the impedances associated with it. But perfection cannot be obtained without an understanding of the underlying principles.

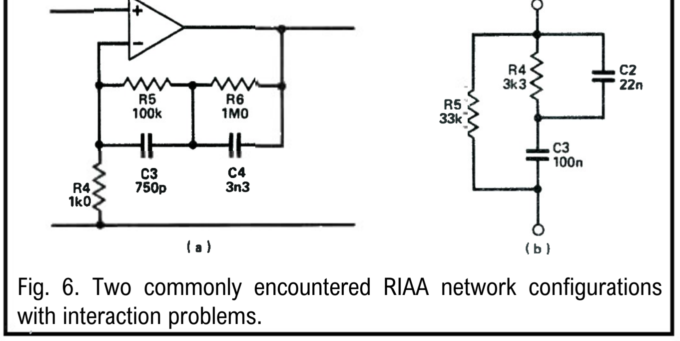


Fig. 6. Two commonly encountered RIAA network configurations with interaction problems.

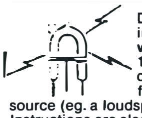
For KITS & COMPONENTS Choose the easy way – with TK

Send 50p & SAE for CATALOGUE

(refundable with first order)

ORDERS: RING (01) 567 8910 - 24 HRS

POWER STROBE KIT



Designed to produce a high intensity light pulse at a variable frequency of 1 to 15Hz this kit also includes circuitry to trigger the light from an external voltage source (eg. a loudspeaker) via an opto isolator. Instructions are also supplied on modifying the unit for manual triggering, as a slave flash in photographic applications or as a warning beacon in security applications. The kit includes a high quality pcb, components, connectors, 5Ws strobe tube and full assembly instructions. Supply: 240V ac. Size: 75x50x45

XK124 STROBOSCOPE KIT £12.50

HIGH SECURITY LOCK KIT

Designed for use with our lock mechanism (701 150) this kit will operate from a 9V to 15V supply drawing a standby current of only 50uA. There are over 5000 possible 4-digit combinations and the sequence can be easily changed. To make things even more difficult for an unauthorised user an alarm can be sounded after 3 to 9 incorrect entries – selectable by means of a link. The alarm can sound for a few seconds to over 3 minutes during which time the keyboard is disabled preventing further entries. A latched or momentary output is available making the unit ideal for door locks, burglar alarms, car immobilisers, etc. A membrane keyboard or pushbutton switches may be used and a beep sounds when a key is depressed. Kit includes high quality PCB, all components, connectors, high power piezo buzzer and full assembly and user instructions.

XK121 LOCK KIT	£15.95
350 118 Set of Keyboard Switches ...	£4.00
KB12S 12-Way Membrane Keyboard	£9.98
701 150 Electric Lock Mechanism ..	£16.50

VERSATILE REMOTE CONTROL KIT

This kit includes all components (+ transformer) to make a sensitive IR receiver with 16 logic outpots (0-15V) which with suitable interface circuitry (relays, triacs, etc - details supplied) can be used to switch up to 16 items of equipment on or off remotely. The outputs may be latched (to the last received code) or momentary (on during transmission) by specifying the decoder IC and a 15V stabilised supply is available to power external circuits.

Supply: 240V AC or 15-24V DC at 10mA.

Size (excluding transformer) 9 x 4 x 2 cms.

The companion transmitter is the MK18 which operates from a 9V PP3 battery and gives a range of up to 60ft. Two keyboards are available MK9 (4-way) and MK10 (16-way), depending on the number of outputs to be used

MK12 IR Receiver (incl. transformer)	£14.85
MK18 Transmitter	£7.50
MK9 4-Way Keyboard	£2.00
MK10 16-Way Keyboard .	£5.95
601 133 Box for Transmitter	£2.60

PROPORTIONAL TEMPERATURE CONTROLLER KIT

Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators wine-making, etc. Max. load 3kw (240V ac) Temp. range up to 90°C. Size: 7x4x2.5cms.

MK4 **£7.10**

DISCO LIGHTING KITS

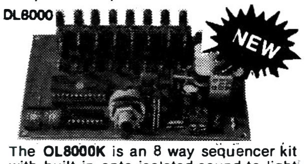
DL1000K This value-for money 4-way chaser features by-directional sequence and dimming. 1kW per channel. **£17.50**

DLZ1000K – A lower cost uni-directional version of the above. Zero switching to reduce interference. **£9.85**

Optional opto input allowing audio 'beat'/light response (DLA/1) **70p**

DL3000K –3-channel sound to light kit features zero voltage switching, automatic level control and built-in microphone. 1kW per channel. **£14.25**

DL8000



The **OL8000K** is an 8 way sequencer kit with built in opto-isolated sound to light input which comes complete with a pre-programmed EPROM containing EIGHTY - YES 80 different sequences including standard flashing and chase routines. The KIT includes full instructions and all components (even the PCB connectors) and requires only a box and a control knob to complete. Other features include manual sequence speed adjustment, zero voltage switching, LED mimic lamps and sound to light LED and a 300W output per channel. And the best thing about it is the price: **ONLY £28.50.**

ELECTRONIC GUARD

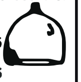
NEW

One of the best deterrents to a burglar is a guard dog and this new kit provides the barking without the bite! The kit when assembled can be connected to a doorbell, pressure mat or any other intruder detector and will produce a random series of threatening barks making the would be intruder think again and try his luck elsewhere. The kit is supplied complete with high quality PCB, transformer, all components and instructions. All you need is a mains supply, intruder detector and a little time. The kit even includes a horn speaker which is essential to produce the loud sound required. The "dog' can be adjusted to produce barks ranging from a Terrier to an Alsation and contains circuitry to produce a random series of barks giving a more realistic effect.

XK105 Complete kit of parts **£21.95**

HOME LIGHTING KITS

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



TDR300K	Remote Control Dimmer ...	£16.45
MK6	Transmitter for above	£4.95
TD300K	Touchdimmer	£8.50
TS300K	Touchswitch	£8.50
TDE/K	Extension kit for 2-way switching for TD300K	£2.70
LD 300K	Light Dimmer	£4.35

TK ELECTRONICS
13 BOSTON RD
LONDON W7 2SJ
Tel: 01;567 8910

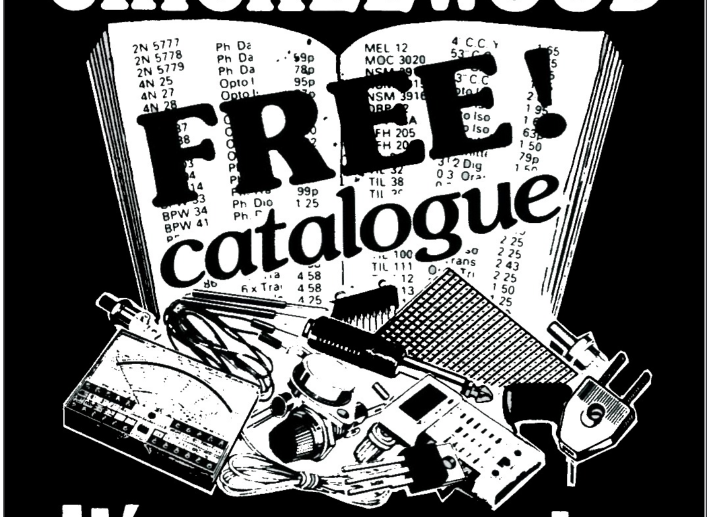
SEND 9x6" S.A.E. AND 50p FOR CATALOGUE
OR CALL AT SHOP
MON–FRI 9–5 pm
SATURDAY 10–4 pm

ORDERING INFORMATION:
ALL PRICES EXCLUDE VAT

FREE P&P on orders over £20 (UK only), otherwise add 75p + VAT. Overseas P&P: Europe £2.75. Elsewhere £6.50. Send cheque/PO/Barclaycard/Access No. with order. Giro No. 5293 14002.

LOCAL AUTHORITY AND EXPORT ORDERS WELCOME
GOODS BY RETURN SUBJECT TO AVAILABILITY

CRICKLEWOOD ELECTRONICS LTD



It's no secret...

...that. there is a real difference at Cricklewood Electronics. That's why you should never be without the FREE CRICKLEWOOD ELECTRONICS COMPONENT CATALOGUE, for sheer variety, competitive prices and service from the U.K."s number one 100% component shop. No gimmicks·, no gadgets or computers. just components. millions of them. all easily available by mail order. calling or credit card telephone orders. Just pick up the phone (or a penl to get your FREE copy now (no SAE required):You have nothing to lose.

CRICKLEWOOD ELECTRONICS LIMITED
40 Cricklewood Broadway, London NW2 3ET
Tel: 01-450 0995/01-452 0161
Telex: 91 4977

VISA

CCTV CAMERAS FROM ONLY £69.50 EACH!

PLUS CARRIAGE & VAT

We are now able to offer CCTV cameras, from as little as £69.50 + VAT and carriage. These cameras have been refurbished to a high standard in our own workshop and come with a standard lens and a 3 month guarantee. They produce a standard composite output of 1volt pp and will work with any video recorder having the video input sockets, digitiser, monitor or with a domestic TV with the addition of a modulator which is available separately. These cameras are powered from the standard 240v AC mains supply. This model employs a vidicon rack and will allow focusing from infinity down to an inch or two.

The standard lens supplied is a 1:1.6f = 16mm non iris TV lens. The lens boss is the standard c mount (1" diameter by 32 thread per inch) and will thus allow a very wide range of camera lenses to be accommodated.

The sensitivity of the cameras is in the order of 110 lux which allows their use in the domestic environment. Pictures can be produced with as little light as 2.5 lux but with a lower signal to noise ratio. Low light versions of this camera are available giving sensitivities of 0.1 lux which is equivalent to half moonlight. Typical cost is approx. £350 + VAT and carriage. Many alternative lenses are available from stock please ask for details. Mounting of these cameras is by standard tripod bush, (1/4" Whitworth Thread). Many of these cameras are available from stock but reconditioned and new. Brand new mini 12 volt camera at only £80 + (VAT & carriage) lens etc.

We are also able to offer servicing facilities for any make of camera/monitor. We also supply camera and monitor tubes for a wide range of models, as well as scanning yokes for a wide range of cameras. Currently on offer is a professional drive board and tube to make a superb 12" professional green paneled tube monitor at £34.50. This would normally cost well over £200. Buy 10 of them and they will only cost you £24.50 each incl. Be sure to ask us to quote for any or your camera/monitor requirements we will never be beaten on price.

MOST MAJOR CREDIT CARDS ACCEPTED

CROFTON ELECTRONICS ☏ 05448 557

KINGSHILL, NEXTEND, LYONSHALL, HEREFORDSHIRE HR5 3HZ

FLAT ALARM

No, not a warning for punctures. Barry Thurlow's device is a full specification, but compact and cheap security system for a flat or small house.

Most burglar alarms on the market are aimed at the industrial market, a fact that is amply reflected in their price. Many commercial alarms also suffer from the problem that they are difficult to set. The user either has to wait for a fixed time to be sure the alarm is set or he is given no indication at all that the device has been successfully 'armed'.

This design attempts to solve this problem at a low cost and provides an alarm bell with all the required features. The prototype has been in use for over a year and has proved both effective and reliable for all this time.

Features

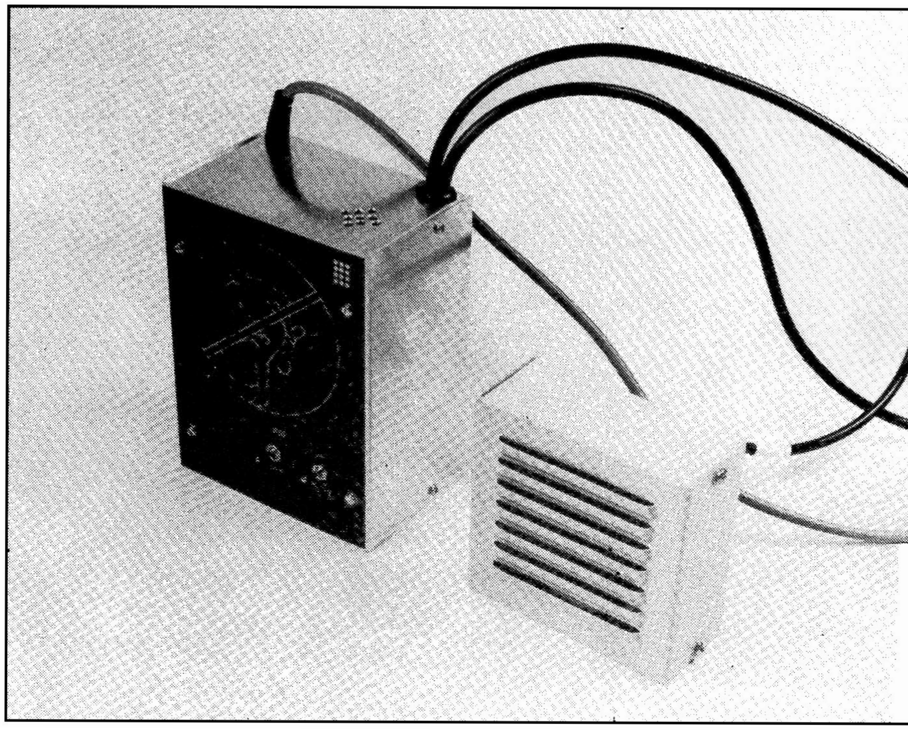
The features offered are summarised as follows:

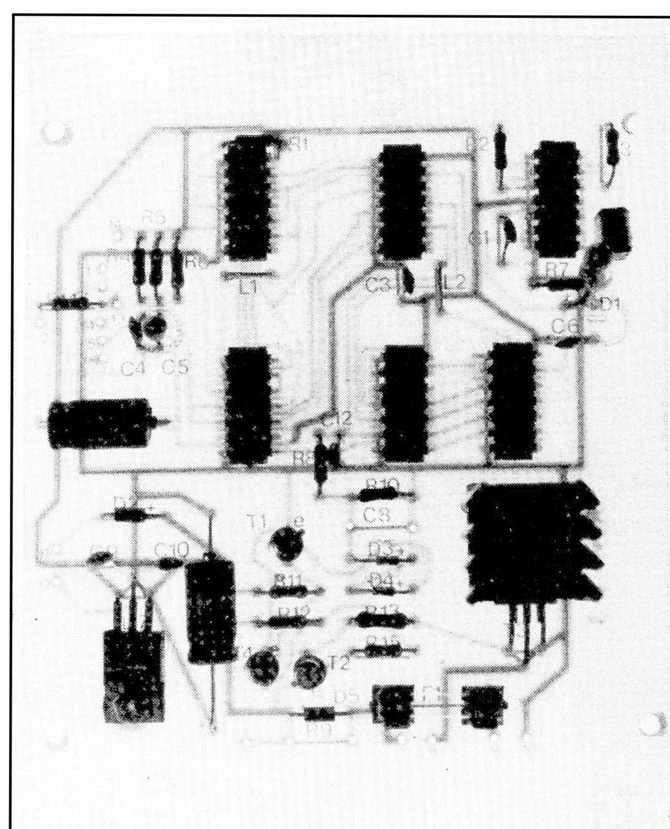
- LED flash to indicate operation of the timing circuit.
- Audible signals for setting. The warning buzzer sounds when the door is opened to leave the premises and stops immediately the circuit is completed.
- 42 second entry delay giving time to reset the system.
- Siren cancelled after 24 mins.
- Battery backup to prevent disabling by cutting mains.
- Facilities to include both normally open and normally closed type detectors.

The Flat Alarm uses two detector circuits: one of normally closed contacts in series and (optionally) one of normally open contacts in parallel. Either breaking the normally closed circuit or closing the normally open one will activate the alarm.

The detector switches can be any number of a variety of different types. Everything from simple sprung door switches to floor pressure mats and window foil strips are easily available and can be connected to the system.

The switches designed for a car courtesy light, operated by the door can provide a useful and cheap source for both door and window detectors.





Above: the complete Flat Alarm with the 12V siren.

Right: the Flat Alarm PCB ready for wiring up in the case.

All wiring to the detector switches can be simple 'bell' cable and should be kept concealed as it runs around doors and windows to discourage tampering. In case a particularly ingenious intruder cuts the mains supply before attempting access, the Flat Alarm has a backup battery power supply.

Unlike most alarm systems the Flat Alarm uses no arming switch requiring a mad dash for the front door after it is closed. Instead this system has a simple on/off switch. In the on position ('armed') the detector switch on the front door acts as the alarm set.

Once the door has been opened and then closed (as you leave) the alarm is armed. An internal buzzer indicates that the alarm is set while the door is open. Any further break in the circuit will trigger the siren (after a 42 second pause for resetting the system for when the 'break-in' is actually you returning).

The siren is also turned off 24 minutes after starting for the sake

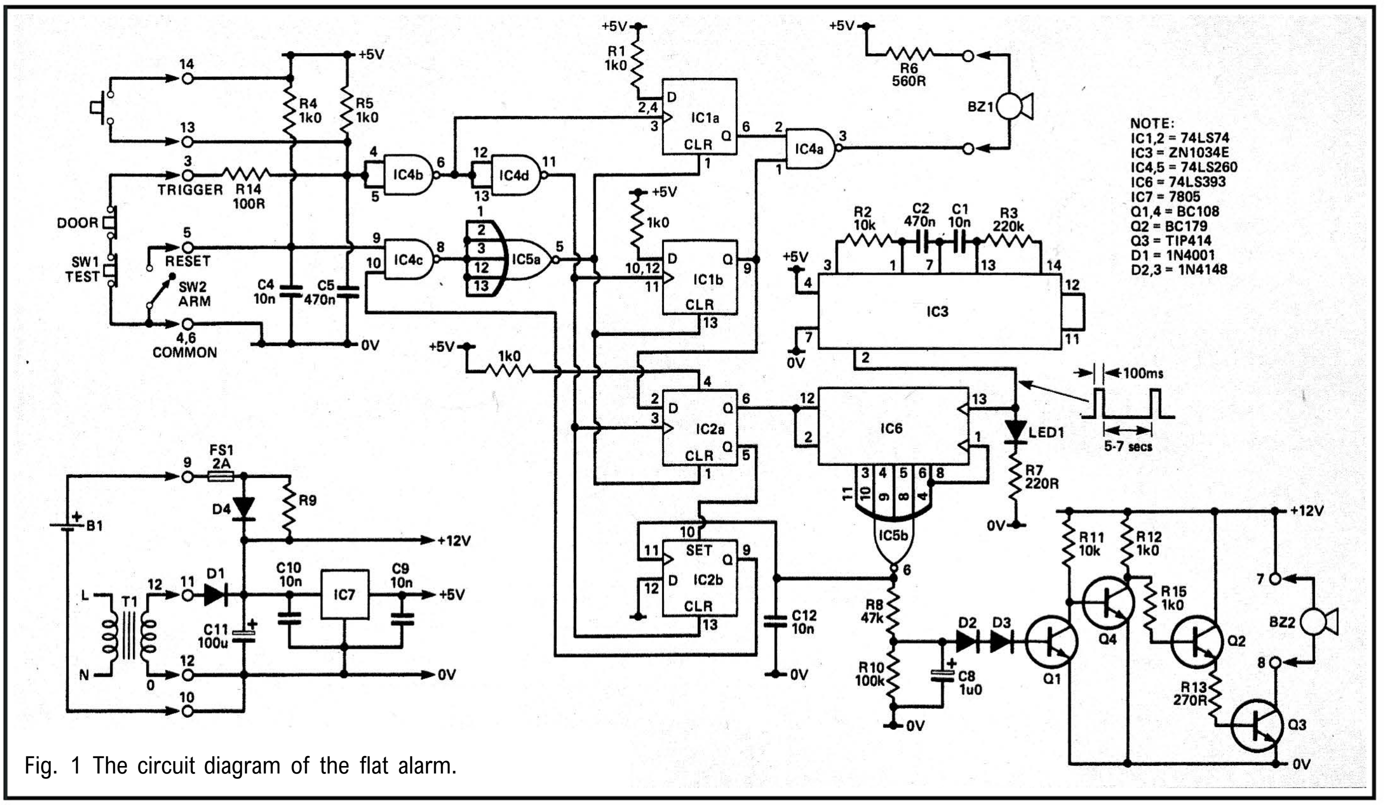


Fig. 1 The circuit diagram of the flat alarm.

HOW IT WORKS

The circuit is shown in Fig. 1 and may be considered In a number of blocks.

The transformer, T1, D1 and C11 form a simple unregulated 15V supply. This supply is regulated by IC7 to supply 5V to the logic. D4 allows current to be supplied from the battery to power the siren and, if the mains Is off, IC7 as well. R9 provides the charging current for the battery while the mains supply is on.

C4 and C5 are for noise suppression on the trigger inputs.

Three flip-flops IC1a, IC1b and IC2a form an escapement trigger mechanism. When the detector (assumed to be a normally closed switch, across terminals 3 and 4 of the PCB) is opened (the owner opening the door to leave) a rising edge is presented on pin 11 of IC1b. This clocks a high to the output pin 9 which passes through the NAND gate (IC4a) to sound the warning buzzer, BZ1.

The rising edge on IC2a pin 3 only serves to keep IC2a in the same state since the level on Its input (pin 2) at the clock time was a low.

When the detector is closed (the owner leaving) a rising edge is presented on IC1a pin 3. This clocks the high on its input to the inverted output (pin 6) as a low. This sets the output of the NAND gate to high, silencing the buzzer.

If the detector is open again (the owner returning or a burglar entering) a rising edge on pin 3 (IC2a) clocks the signal at its input(now high) to the outputs. The resultant low on IC2a pin 6 enables the counter, IC6. IC6 provides the counting for the entry delay and the auto shut off after 24 minutes.

The basic timing for the alarm comes from IC3. This Is a free running R-C oscillator and 12 stage counter configured to provide a stream of pulses approximately 100ms in width at a rate of about one every six seconds.

The correctness of the timing pulses may be checked by viewing LED1 which pulses on in time.

The six second pulses are counted by an eight stage counter, IC6. The outputs of IC6 are decoded by the NOR gate ICS. Outputs A,B,C from the counter are not connected to the NOR gate and so the first seven pulses counted have no effect on the output. These seven pulses, amounting to some 42 seconds, con-stitute the entry delay.

If the reset switch is pressed within this time delay no further action will take place. Outputs D,E,F,G,H of the counter are decoded by the NOR gate so that any count between 8 and 255 will produce an output. This Is the time for which the siren will sound.

After 255 counts (around 24 minutes) the output pin 6 of the NOR gate will become high. This silences the siren and clocks the flip-flop IC2b producing a reset signal on IC2b pin 9. This sets the· circuit back to its initial condition.

The signal from IC5 pin 6 is amplified by the transistor circuit comprising Q1 to Q4 to provide about 500mA for the siren. To activate the siren the voltage IC5 pin 6 is taken low. Diodes D3 and D4 provide an offset to allow for the offset of the logic low signal from the gate Q1 will be switched off and current will now flow through R11 into the base of Q4 about 1mA is provided which keeps Q4 saturated whilst drawing about 10mA through R12 and 10mA from the base of Q2 via R15, The base current In Q2 keeps it saturated whilst providing. a base current for Q3 of 40mA. The. switching gain of Q3 is greater than 20. and so it will be held in saturation for a siren current of 5OOmA.

C8 is provided to start up the siren slowly and should be omitted if a bell is used instead of the recommended siren.

of the neighbours and in accordance with the recommendations of the noise abatement society. If the recommended electronic siren is used this feature will be much appreciated!

Construction

All the ICs and discrete components are mounted on the PCB. The warning buzzer, transformer and battery are mounted in the case with flying leads to the PCB. Connection to the detector circuits, siren and reset switch is also by flying lead although the constructor may wish to fit a terminal block to make connection more convenient.

Connections to the PCB are as follows:

1 warning buzzer negative.
2 warning buzzer positive.
3/4 detector circuit for normally closed type detectors.
7 siren positive.
8 siren negative.
9 battery positive.
10 battery negative.
11/12 transformer secondary.
13/14 detector circuit for normally open detectors.

The PCB is designed to be mounted on pillars facing the front panel of the case. In this position the LED may be made to show through the front panel by extending its leads. To mark the case for drilling place the blank PCB on the front of the case with the component side facing upward. Use a pin to mark

PARTS LIST

RESISTORS (all ¼W, 5% unless specified)	
R1,4,5,12,15	**1k0**
R2,11	**10k**
R3	**220k**
R6	**560R**
R7	**220R**
R8	**47k**
R9	**100R 1W**
R10	**100k**
R13	**280R 1/2W**
R14	**100R**
CAPACITORS	
C1,3,4,6,9,10,12	**10n**
C2	**470n**
C5	**4u7 16V tantalum**
C7,11	**100u 25V axial electrolytic**
C8	**1u0 25V axial electrolytic**
SEMICONDUCTORS	
IC1,2	**74LS74**
IC3	**ZN1034**
IC4	**74LS132**
IC5	**74LS260**
IC6	**74LS393**
IC7	**7805**
Q1,4	**BC108**
Q2	**BC179 or BC478**
Q3	**TIP41A**
LED1	**Red 0.2in LED**
D1,4	**1N4001**
D2,3	**1N4148**
MISCELLANEOUS	
B1	**12V 1.2amp-hour lead-acid battery**
BZ1	**High power piezo buzzer**
BZ2	**12V siren**
FS1	**2A fuse and PCB-mount holder**
SW1	**SPST push to break switch**
SW2	**SPST switch**
T1	**12V mains transformer**

PCB: NO and NC detectors; connecting wire; 10-way terminal block; TO66 heatsink; case; 20mm PCB standoffs; nuts, bolts and washers.

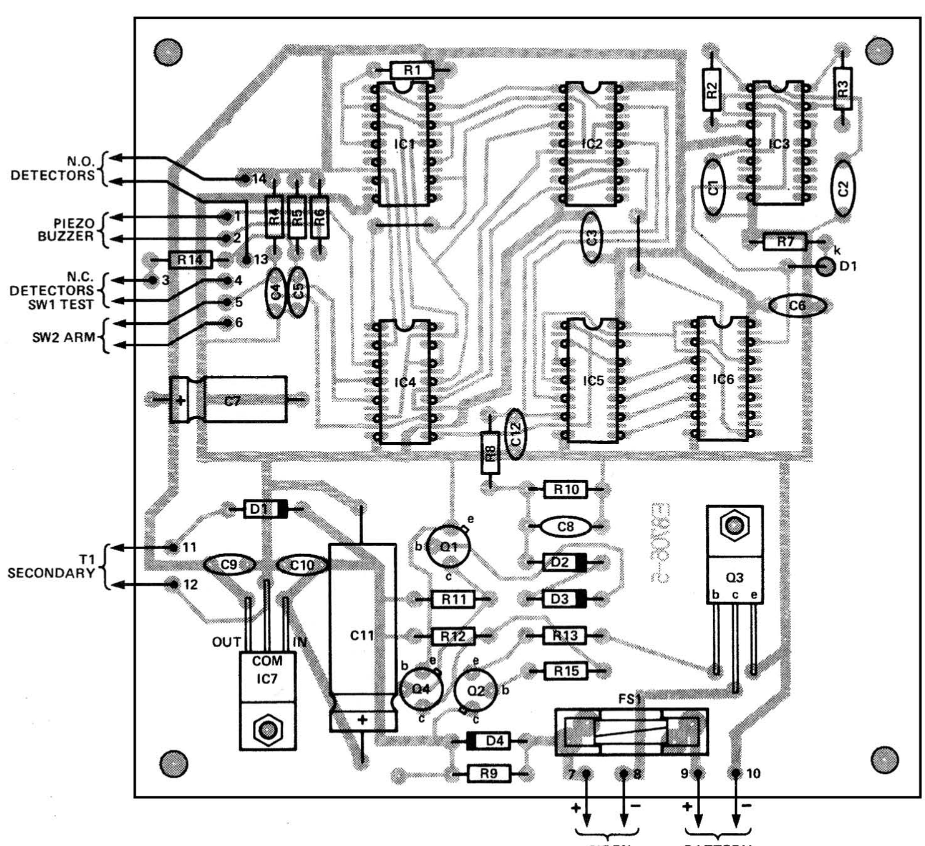


Fig. 2 The component overlay of the flat alarm.

through the four corner holes and through the two holes for LED1. Drill the corner holes with a 3mm drill centering the drill on the pin marks. Drill the hole for the LED using a 5.5mm drill. Centre the drill halfway between the two pin marks for LED1. When fitting the LED in, place an 18mm long sleeve over each of its leads to obtain the correct height. The PCB is mounted 22mm from the panel by the use of 20mm stand-offs and locking washers.

Installation

The burglar alarm may be used with a combination of normally open contact detectors and normally closed contact detectors by connection to the appropriate pin pairs on the PCB. If no normally closed contact detectors are fitted, pins 4 and 3 should be joined together with a wire. If only normally closed type detectors are used, pins 13 and 14 are left unconnected.

It is often a requirement to wire alarm detectors in zones. For example, if the lower doors and windows of a house are to be alarmed but the upstairs windows are to be left open, provision must be made to bypass the sensors in groups. For normally closed contact detectors, the detectors are wired in series and the bypass switch must be in parallel with the group. For normally open contact detectors, the detectors are wired in parallel and the bypass switch is placed in series with the group (see Fig. 3).

Note that no reverse voltage protection is provided for the siren output on the PCB. If you use an inductive sounder (such as a bell) it is advisable to fit a protection diode across the PCB terminals 7 and 8, with the anode connected to terminal 7.

Testing

First double check that all the components are correctly mounted. Check particularly for the polarity of the diodes and capacitors and for the orientation of the ICs. When this is done connect the transformer and power up the circuit.

Using a meter check the voltage on the power pins of the ICs. Pin 14 of IC1, IC2, IC4, IC5, IC6 and pin 4 of IC3 should be at +5V. Switch off and connect the battery taking care to get the polarity correct.

Connect the siren, warning buzzer, reset switch, and a sample detector. Use a normally closed type. Reset the circuit by closing the reset switch. Open the reset switch with the detector contacts closed. Check that the LED is pulsed about once every six seconds. Open the detector contacts and the warning buzzer should sound. Close the detector contacts. The warning buzzer should be silenced.

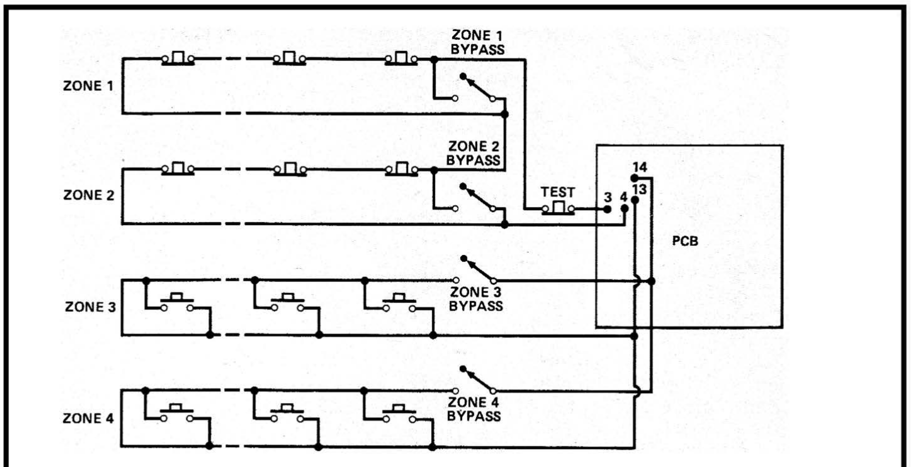


Fig.3 Connecting it all up. Installing the flat alarm.

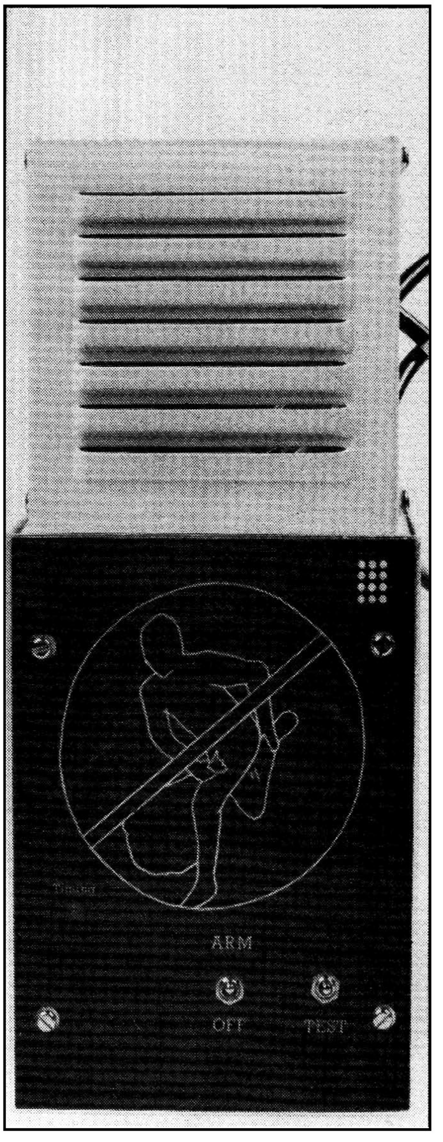
Wait 60 seconds to be sure that the alarm is armed and that the trigger has not been incorrectly activated. Nothing should happen. Open the detector contacts again and wait. After about 42 seconds the siren should go off.

If using the recommended siren this will be extremely loud so for testing it is advised that a pillow be placed over the siren to avoid ear damage!

After a further 24 minutes or so the siren should be silenced. If the detector is now closed and opened the warning buzzer will sound. This would indicate to the returning owner that the alarm has sounded and timed out while he was away. However this might only indicate that a window had been blowing in the wind and causing false alarms.

If the timings are not right check the components around IC3 for their correct values and positions.

If the siren does not sound or is weak although the warning buzzer worked as expected you may have a flat battery and this and the charging circuitry should be checked.



BUYLINES

The high power piezo buzzer is available from Maplin (number FK84F) as are the lead-acid battery (number YJ69A) and the siren (number XG14Q). The siren is supplied in its own waterproof case.

The box for the main PCB is not critical and can be any suitable case which is able to contain the PCB, battery and test and reset switches and can be hidden discretely near the door.

The PCB and the front panel label' shown on the prototype are available from the author for £9.95 and £4.45 respectively, plus 50p post and packing. Orders should be sent to B.J. Thurlow, 3 Broadway House, Bromley Road, Downham, BR1 4PA.

Project	Month	Year	Page
Metal locator, induction balance	Feb	1977	33
Metal locator, induction balance	Feb	1978	32
Micro Light intercom	May	1986	28
Micro Light Intercom Errata	Mar	1987	63
Microwave oven leakage detector	Nov	1979	85
Microwave oven leakage detector Errata	Dec	1979	13
Mini-drill speed controller	Jun	1981	89
Motor speed controller	Jul	1979	47
Motor speed controller Errata	Nov	1979	13
Motor speed controller Errata	Dec	1979	13
Musical doorbell	Dec	1980	60
NiCad battery charger	May	1974	52
NiCad charger	Aug	1979	29
NiCad charger/regenerator	Sep	1983	27
Noiseless power switch	Mar	1981	13
Optical communications circuits	Jun	1976	68
Opto-switch, slotted (ETI Memo			
Minder) (free PCB project)	Mar	1986	33
Panel meter, digital	Aug	1986	41
Panel meter, LCD	Mar	1978	26
Perpetual pendulum	Nov	1984	77
Pest control (Allez Cat)	Feb	1982	89
Polystyrene cutter	Jul	1982	73
Portable induction loop	Jul	1983	52
Power supply, switch mode part 1	Jun	1983	35
Power supply, switch mode part 2	Jul	1983	83
Programmable logic evaluation board	Mar	1986	37
Proximity switch	Oct	1978	75
Radiation monitor (Geiger counter) part 1	Feb	1987	35
Radiation monitor (Geiger counter) part 2	Mar	1987	39
Rain alarm	Apr	1978	62
Rain alarm	Dec	1979	35
Reaction timer (Alcohometer)	Dec	1981	79
Regulator, switch mode, 5V, 1A	Nov	1985	40
Remote-controlled power switch	May	1981	90
Remote control, FM mains	Oct	1981	56
Schmitt trigger with variable hysteresis			
(Free PCB Design Competition)	Oct	1986	26
Scoreboard, large-digit	May	1985	43
Soil moisture indicator	Aug	1977	19
Soil moisture indicator errata	Sep	1977	8
Soil moisture indicator	Jul	1979	67
Soldering iron controller	May	1981	24
Stethoscope for engineers	Mar	1981	63
Super selective music filter	Apr	1984	39
Switch mode power supply part 1	Jun	1983	35
Switch mode power supply part 2	Jul	1983	83
Switching regulator, 5V, 1A	Nov	1985	40
Switching regulator, 5V, 10A	Apr	1976	55
Tape/slide synchroniser	Jun	1972	48
Tape/slide synchroniser	Feb	1979	27
Telephone bell extender	Oct	1978	65
Telephone bell shifter/extender	Nov	1981	78
Telephone call meter (Buzby Meter)	Apr	1985	34
Telephone call meter, intelligent part 1	Aug	1986	36
Telephone call meter, intelligent part 2	Oct	1986	53
Telephone call meter, intelligent part 3	Nov	1986	53
Telephone call meter, intelligent part 4	Dec	1986	54
Telephone call meter, intelligent errata	Mar	1987	63
Torch finder	Jul	1978	31
Touch switch	May	1976	14
Touch switch	Dec	1979	93
Touch switch errata	Jan	1980	11
Touch switch (Free PCB project)	Oct	1982	30
Touch switch, TTL-level			
(Free PCB project)	Apr	1986	42
Trigger happy			
(Free PCB Design Competition)	Oct	1986	26
Troglograph VLF cave com system part 1	Jun	1986	38
Troglograph VLF cave com system part 2	Jul	1986	50
Two battery savers	May	1972	30
Twonky - MPU musical box	Feb	1979	79
Two-tone door bell (short circuit)	Feb	1977	50
Typewriter interface	Oct	1983	21
Typewriter interface errata	Mar	1984	25
Typewriter interface for the BBC	Aug	1985	41
UFO detector	Jul	1978	63

Project	Month	Year	Page
Ultrasonic switch	Feb	1978	62
Utiliboard breadboarding system	Nov	1975	58
Variable hysteresis Schmitt trigger			
(Free PCB design competition)	Oct	1986	26
Vertical speed indicator (Vario) part 1	Apr	1984	19
Vertical speed indicator part 2	May	1984	57
Vertical speed indicator errata	Dec	1984	71
VLF cave com system part 1	Jun	1986	38
VLF cave com system part 2	Jul	1986	50
Vogonoff mains failure alarm	Nov	1984	66
Watchdog power saver	Oct	1977	10
Wind speed indicator	Apr	1979	85

MODEL CONTROL

FM radio control	Oct	1980	15
FM radio control errata	Dec	1980	13
Model train controller	Nov	1976	16
Motor speed controller	Jul	1979	47
Motor speed controller errata	Nov	1979	13
Motor speed controller errata	Dec	1979	13
Radio control servo failsafe	Apr	1980	29
Radio control servo failsafe	Aug	1983	61
Radio control system part 1	May	1979	61
Radio control system part 2	Jun	1979	87
Radio control system errata	Aug	1979	13
Servo tester	May	1980	52
Slot car controller	May	1982	79
The Beast model train controller part 1	Nov	1979	42
The Beast model train controller part 2	Dec	1979	86
The Beast model train controller errata	Feb	1980	17
White line follower	Apr	1978	23

MOTORING

Accurate voltage monitor	Apr	1982	23
Alarm alarm	Jul	1977	29
Alcohometer	Dec	1981	79
Antenna extender	Jun	1981	78
Anti-theft auto alarm	Jan	1974	16
Auto Amp - car audio booster	May	1975	55
Automatic battery charger	Apr	1980	39
Automatic car theft alarm	Aug	1972	50
Autowipe	Jan	1986	50
Battery charger	Nov	1973	64
Battery charger, smart	Jul	1981	85
Battery indicator	Jul	1979	92
Bodywork checker	Dec	1981	54
Brake light warning	Oct	1972	44
Breakdown beacon	Sep	1976	52
Car alarm	Mar	1975	24
Car alarm errata	Jul	1975	68
Car alarm	Dec	1978	16
Car alarm	Nov	1981	94
Car alarm	Oct	1983	66
Car alarm errata	Nov	1983	96
Caravan lights checker (Reader's Design)	Apr	1981	100
Car immobilise	May	1979	89
Car security device	Apr	1980	50
Combined tacho-dwell	Jan	1987	62
Courtesy light extender	Feb	1975	51
Courtesy light extender errata	Apr	1975	71
Digital tachometer	Jan	1979	23
Electronic ignition	Sep	1973	36
Electronic ignition	May	1978	41
Electronic ignition system part 1	Apr	1975	10
Electronic ignition system part 2	May	1975	23
Electronic ignition system errata	Aug	1975	69
Engineer's Stethoscope	Mar	1981	63
Flip-flop flasher	Apr	1975	42
Fuel gauge	Jan	1983	46
Fuel level monitor	Sep	1979	53
Headlight delay	Mar	1979	27
Headlight reminder	Dec	1972	48
Headlight reminder	Mar	1975	34

Project	Month	Year	Page
Ignition timing light	Sep	1974	18
LED tachometer	Jan	1981	49
Light activated tachometer	Feb	1979	50
Light wand	Mar	1982	73
Meter beater	Feb	1975	28
Over speed alarm	Sep	1979	79
Parking meter timer	Jan	1982	29
Patch detector (Short Circuit)	Jan	1977	33
Revealer - body filler detector	Aug	1973	58
Rev monitor/counter	Dec	1977	37
Screen heater controller	Sep	1979	89
Smart battery charger	Jul	1981	85
Tacho / dwell, combined	Jan	1987	62
Tachometer	Jul	1977	32
Tachometer errata	Sep	1977	8
Tachometer, digital	Jan	1979	23
Tachometer, light activated	Feb	1979	50
Tacho timing light	Dec	1974	18
Trafficator flasher	May	1975	46
Turn indicator canceller	Apr	1973	70
Warning indicator monitoring System	Sep	1979	23
Wiper delay, automatic	Jan	1986	50

MUSIC AND EFFECTS

Project	Month	Year	Page
1024-note composer (synthesiser sequencer)	May	1981	36
Accentuated metronome	Feb	1978	17
Accentuated beat metronome	June	1979	21
Activator (aural exciter)	Jan	1986	30
Activator errata	Jul	1986	56
Audio phaser	Dec	1976	29
Audio visual metronome	Nov	1972	47
Auto chord rhythm generator part 1	Nov	1978	56
Auto chord rhythm generator part 2	Dec	1978	80
Better Flanger, the	Jan	1987	47
Better Flanger errata	Mar	1987	63
Black hole chorales	May	1980	90
Black hole chorales errata	Sep	1980	11
Bomb drop sound effect	Apr	1982	50
Bongo box	Dec	1986	43
Bongos, electronic	Aug	1977	24
CCD delay line effects board, ETI Sonneti	Apr	1985	57
CCD phaser	May	1978	57
CCD phaser errata	Jul	1978	7
Chorus / flanger	Jan	1984	33
Chorus unit	Nov	1985	48
Chorus unit errata	Jun	1986	55
Chorus unit (ETI Black Hole)	May	1980	92
Chorus unit (ETI Black Hole) errata	Sep	1980	11
Combo amplifier, ETI Sonneti	Mar	1985	22
Combo amplifier errata	Jul	1985	27
Complex sound generator (Mini Synth)	Oct	1978	17
Compression gate, direct inject	Dec	1985	46
CV adaptor for MIDI controllers	Jun	1986	29
Cymbal synth	Nov	1985	58
Cymbal synth errata	Jun	1986	55
Delay line, CCD	Apr	1985	57
Delay line, digital part 1	Dec	1984	16
Delay line, digital part 2	Jan	1985	62
Delay line, digital part 3	Feb	1985	24
Delay line, digital errata	Aug	1985	62
Digital sound sampler part 1	Nov	1985	63
Digital sound sampler part 2	Jan	1986	47
Digital sound sampler part 3	Feb	1986	42
Digital sound sampler part 4	Mar	1986	44
Digital sound sampler part 5	Jun	1986	48
Digital sound sampler part 6	Jul	1986	44
Digital VCO	Mar	1985	16
Digital VCO errata	Jul	1985	27
Direct inject compression gate	Dec	1985	46
Direct injection box	Sep	1985	43
Drum machine	Apr	1981	75
Drum sequencer for the Spectrum	Dec	1985	41
Drum synthesiser for the Commodore 64 (Bongo Box)	Dec	1986	43
Drum synthesiser (Cymbal Synth)	Nov	1985	58
Drum synthesiser (Cymbal Synth) errata	Jun	1986	55
Drum synthesiser, ETI Staccato	Jun	1980	84
Drum synthesiser, ETI Staccato errata	Aug	1980	13
Drum synthesiser, midi	May	1984	62
Drum synthesiser, midi errata	Aug	1984	66
Drum synthesiser, mini	Nov	1983	36
Drum synthesiser, mini errata	Apr	1984	62
Ezeko spring-line reverberation unit	Oct	1984	18
Electronic bongos (Short Circuit)	Aug	1977	24
Flanger / chorus unit	Jan	1984	33
Flanger, The Better	Jan	1987	47
Flanger, The Better errata	Mar	1987	63
Fuzz box (Short Circuit)	Apr	1977	48
Fuzz / sustain box	Oct	1980	53
Fuzz / sustain box errata	Sep	1982	57
Guitar attack delay unit	Jun	1973	30
Guitar effects unit	Apr	1979	97
Guitar effects unit errata	Jun	1979	9
Guitar note expander	Apr	1981	95
Guitar tuner	Jan	1982	41
Guitar tuner errata	Mar	1982	9
Guitar tuner errata	May	1982	11
Gunshot sound effect	May	1982	89
Hand-clap synthesiser	Aug	1981	68
Metronome, accentuated	Feb	1978	17
Metronome, accentuated beat	Jun	1979	21
Metronome and beat counter (ETI Rhythm ROM)	Nov	1985	33
Metronome and beat counter errata	Jun	1986	55
Metronome, audio visual	Nov	1972	47
Metronome (Free PCB project)	Nov	1980	56
Metronome (Short Circuit)	May	1977	39
Midi drum synth	May	1984	62
Errata	Aug	1984	66
MIDI-to-CV converter	Jun	1986	29
Mini drum synthesiser	Nov	1983	36
Mini drum synthesiser errata	Apr	1984	62
Mini Synth (complex sound generator)	Oct	1978	17
Multi-option siren	Jan	1981	22
Musical box	Apr	1981	50
Music box, MPU (ETI Twonky)	Feb	1979	79
Music board for the ZX81 part 1	Apr	1983	16
Music board for the ZX81 part 2	May	1983	54
Music board for the ZX81 errata	Jun	1983	15
Music processor	Nov	1981	38
Music processor errata	May	1982	11
New sound for your guitar	Jun	1973	30
Noise gate	Jul	1985	38
Noise generator	Dec	1979	67
Noise gate with compressor and DI box	Dec	1985	46
Organ, ETI Victory part 1	Feb	1983	19
Organ, ETI Victory part 2	Mar	1983	36
Organ, ETI Victory part 3	Apr	1983	56
Organ, ETI Victory part 4	May	1983	67
Organ, touch	Dec	1976	41
Phaser	Dec	1976	29
Phaser, CCD	May	1978	57
Phaser / explosion sound effect	May	1982	63
Phase / Waa unit	Jun	1981	24
Playmate guitar effects amplifier part 1	Aug	1982	28
Playmate guitar effects amplifier part 2	Sep	1982	16
Polyphonic keyboard controller	Jul	1979	36
Reverberation unit, solid state	Apr	1982	101
Reverberation unit, spring line	Dec	1974	46
Reverberation unit, spring line	Oct	1984	18
Rhythm Chip, the (ETI Rhythm ROM)	Nov	1985	33
Rhythm Chip, the (ETI Rhythm ROM) errata	Jun	1986	55
Sequencer for Spectrum (ETI Spec Drum)	Dec	1985	41
Simple echo unit (ETI Ezeko)	Oct	1985	18
Sonneti combo amplifier	Mar	1985	22
Sonneti combo amplifier errata	Jul	1985	27
Sonneti CCD delay line effects board	Apr	1985	57
Sorcerer string synthesiser part 1	Aug	1985	36
Sorcerer string synthesiser part 2	Sep	1985	48
Sorcerer string synthesiser part 3	Oct	1985	32
Sound bender (ring modulator)	Oct	1981	88
Sound effects 1: bomb drop	Apr	1982	50
Sound effects 2: steam train and whistle	Apr	1982	118

Project	Month	Year	Page
Sound effects 3: phaser/explosion	May	1982	63
Sound effects 4: gunshot	May	1982	89
Sound sampler, digital part 1	Nov	1985	63
Sound sampler, digital part 2	Jan	1986	47
Sound sampler, digital part 3	Feb	1986	42
Sound sampler, digital part 4	Mar	1986	44
Sound sampler, digital part 5	Jun	1986	48
Sound sampler, digital part 6	Jul	1986	44
Spec Drum sequencer	Dec	1985	41
Steam train and whistle sound effect	Apr	1982	118
String Thing (Transcendent DPX) part 1	Aug	1979	18
String Thing (Transcendent DPX) part 2	Sep	1979	62
String Thing (Transcendent DPX) part 3	Oct	1979	35
String Thing (Transcendent DPX) part 4	Nov	1979	64
Sustain fuzz box	Oct	1980	53
Sustain fuzz box errata	Sep	1982	57
Synthesiser, ETI 3600 part 1	May	1975	42
Synthesiser, ETI 3600 part 2	Jun	1975	32
Synthesiser, ETI 3600 part 3	Jul	1975	54
Synthesiser, ETI 3600 part 4	Oct	1975	41
Synthesiser, ETI 3600 errata	Jan	1976	84
Synthesiser, ETI 4600 part 1	Jan	1974	20
Synthesiser, ETI 4600 part 2	Feb	1974	24
Synthesiser, ETI 4600 part 3	Mar	1974	40
Synthesiser, ETI 4600 part 4	Apr	1974	44
Synthesiser, ETI 4600 part 5	May	1974	54
Synthesiser, ETI 4600 part 6	Jun	1974	24
Synthesiser, ETI 4600 part 7	Jul	1974	52
Synthesiser, ETI 4600 part 8	Aug	1974	58
Synthesiser, ETI 4600 part 9	Sep	1974	48
Synthesiser, hand clap	Aug	1981	68
Synthesiser, polyphonic part 1	Dec	1980	87
Synthesiser, polyphonic part 2	Jan	1981	77
Synthesiser, polyphonic part 3	Feb	1981	32
Synthesiser, polyphonic part 4	Mar	1981	27
Synthesiser, Project 80 - Dual VCA	Aug	1980	78
Synthesiser, Project 80 - monitor amplifier	Oct	1980	79
Synthesiser, Project 80 - noise generator	Apr	1981	59
Synthesiser, Project 80 - PSU, VCO and VCLFO	Feb	1980	62
Errata	Mar	1980	15
Synthesiser, Project 80 - VC envelope shaper	Jul	1980	88
Synthesiser, Project 80 - VC envelope shaper	Sep	1980	93
Synthesiser, Project 80 - VCF	May	1980	20
Synthesiser, Project 80 - VCM	Mar	1980	87
Synthesiser, Project 80 - VC state variable filter	Jul	1980	84
Synthesiser sequencer	May	1981	36
Synthesiser, string (ETI Sorcerer) part 1	Aug	1985	36
Synthesiser, string (ETI Sorcerer) part 2	Sep	1985	48
Synthesiser, string (ETI Sorcerer) part 3	Oct	1985	32
Synthesiser, Transcendent 2000 part 1	Jul	1978	38
Synthesiser, Transcendent 2000 part 2	Aug	1978	45
Temperature stabilising log converter	Jan	1979	62
Touch organ	Dec	1976	41
Transcendent DPX string synthesiser part 1	Aug	1979	18
Transcendent DPX string synthesiser part 2	Sep	1979	62
Transcendent DPX string synthesiser part 3	Oct	1979	35
Transcendent DPX string synthesiser part 4	Nov	1979	64
Transcendent Poly Synth part 1	Dec	1980	87
Transcendent Poly Synth part 2	Jan	1981	77
Transcendent Poly Synth part 3	Feb	1981	32
Transcendent Poly Synth part 4	Mar	1981	27
Tuning fork	Feb	1980	79
Twonky-MPU musical box	Feb	1979	79
Victory organ part 1	Feb	1983	19
Victory organ part 2	Mar	1983	36
Victory organ part 3	Apr	1983	56
Victory organ part 4	May	1983	67
Vocoder part 1	Sep	1980	58
Vocoder part 2	Oct	1980	40
Vocoder errata	Apr	1981	8
Voltage controlled digital oscillator	Mar	1985	16
Voltage controlled digital oscillator errata	Jul	1985	27
Waa-phase unit	Jun	1981	24
Waa-Waa unit	Jun	1976	16
Waveform multiplier (chorus)	Jan	1983	71

PHOTOGRAPHIC

Project	Month	Year	Page
Automatic contrast meter	Apr	1982	39
Automatic contrast meter errata	Jul	1982	35
Electronic flash trigger	Jun	1975	42
Enlarger exposure meter	Nov	1985	54
Enlarger timer	Oct	1981	78
Exposure meter	Feb	1976	46
Flash sequencer	Aug	1981	57
Flash sequencer	Jul	1983	63
Flash sequencer errata	Aug	1983	70
Flash trigger	Dec	1979	97
Flash trigger	Oct	1980	30
Flash trigger	Jul	1983	70
Photographic process timer	Aug	1972	38
Photo process controller	Feb	1987	41
Photo timer	Sep	1975	11
Printimer - 1½ - 3 minute timer	Nov	1974	44
Printimer - 1½ - 3 minute timer errata	Dec	1974	71
Process timer	Jan	1980	71
Shutter timer	Feb	1978	57
Slave flash	May	1972	48
Sound / light flash trigger	Aug	1976	46
Sound operated flash	May	1972	44

RADIO

Project	Month	Year	Page
80 metre direct conversion receiver part 1	May	1986	40
80 metre direct conversion receiver part 2	Jun	1986	44
Aerial matcher for SW receivers	Apr	1974	31
Antenna controller	Jun	1981	78
Air band converter	Dec	1979	76
AM/FM radio	Nov	1984	21
Errata	Jul	1985	27
Chipmunk FM / AM radio	Jun	1978	79
Chipmunk FM / AM radio errata	Jul	1978	7
Crystal calibrator	Mar	1981	39
Digital radio dial	Jan	1979	49
FM stereo tuner part 1	Feb	1987	46
FM stereo tuner part 2	Mar	1987	34
Headphone radio, AM	Aug	1976	34
Low distortion stereo decoder	Feb	1987	46
Marker generator	May	1976	25
One-chip radio	Jan	1973	16
RF attenuator	Sep	1976	62
RF power meter	Oct	1978	30
Speech compressor	Oct	1979	47
Star Trek radio	May	1978	62
Tic-Tac radio	Nov	1975	35
Two metre power amplifier	Sep	1976	19
Two metre VMOS power amplifier	Feb	1980	27
Versatile grid dip oscillator	Aug	1975	34

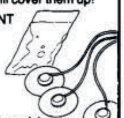
ROBOTICS

Project	Month	Year	Page
Digital PWM interface for the robot motor controller	Jun	1982	66
ETI Mobile 2 robot part 1	Aug	1982	82
ETI mobile 2 robot part 2	Sep	1982	25
Motor Interface	Jul	1986	34
Motor speed control for robots	Jul	1982	59
Proximity detector	Jun	1982	69

BIO-FEEDBACK ACCESSORIES

A METER MOVEMENT which can be built into your bio-feedback monitor to make it a completely self-contained instrument. Don't worry if you've already drilled the terminal holes – the meter will cover them up!

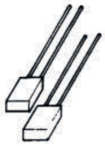
SENSITIVE METER MOVEMENT ONLY £1.90!



SPARE ELECTRODES AND GEL

5 sets of electrodes (10 electrode pads) and a sachet of conductive gel, all for £2.90.

LEDs



RECTANGULAR LEDs

Green rectangular LEDs for bar-graph displays.
50 for £3.50 100 for £6 500 for £25
1000 for £45

DIGITAL AND AUDIO EQUIPMENT LEDs

Assorted 3mm LEDs: red, green, yellow and orange. 25 of each (100 LEDs) for **£6.80**

PROJECT BOX

WITH BATTERY COMPARTMENT

As used in our tachometer and bio-feedback kits.
This attractive/and versatile case can be used to house the experimenter kit projects, or your own battery operated projects.

PROJECT CASE WITH PP3 BATTERY COMPARTMENT ONLY £2.60!

LEDSCOPE

FEATURED IN ETI JANUARY 1987

Tony Ellis's famous LED oscilloscope. The most important bench instrument for any electronics enthusiast must be a 'scope , and at this price anybody can afford one! The Ledscope also acts as a voltmeter and ohm-meter. It's got everything!

The complete parts set includes a smart brushed aluminium case, PCB, all components, pots, knobs, switches, and full instructions.

LEDSCOPE PARTS SET, WITH CASE

ONLY £59.95!

SUITABLE PROBE SET £7.95

BIO-FEEDBACK

FEATURED IN ETI DECEMBER 1986

A *complete* parts set for the ETI bio-feedback monitor. Previously offered at **£14.55**, the last few sets to clear at **£9.99!** We will also supply a free meter movement for the monitor.
The complete parts set includes case, PCB, all components, meter and full instructions.

YOUR LAST CHANCE

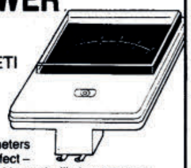
BIO-FEEDBACK PARTS SET ONLY £9.99!

~~£14.55~~ £9.99 ONLY UNTIL APRIL 30th

WITH *FREE* METER!

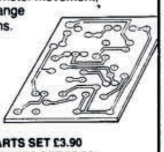
HI-FI POWER METER

FEATURED IN ETI MAY 1987



Measure the output power of your hi-fi with the ETI power meter. The meters can be back-lit for effect – the scale and 'power' legend will glow green to contrast with the red pointer. Two switched ranges give readings of 0-10W and 0-100W.

The parts set consists of meter movement, PCB, all components, range switch and full instructions.



MONO POWER METER PARTS SET £3.90
STEREO POWER METER PARTS SET £7.20
SUITABLE CASE £7.50

TACHOMETER AND DWELL METER

FEATURED IN ETI JANUARY 1987

MOTORISTS QUIZ

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!'

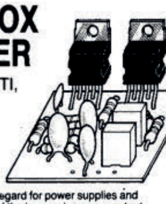
Do you:
a) Fit a £500 Pie-in-ear in-car stereo with digital flexi-woofers and 24-band ramification?
b) Buy a set of fluffy dice and sticker saying 'My other car is a Macaroni'?
c) Give your car in part exchange for a milk float/ invalid carriage/ tractor?
d) Tune your engine.

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.

TACHOMETER AND DWELL METER PARTS SET
£12.90 (with terminals for external meter)
£16.40 (with self contained meter)

MATCHBOX AMPLIFIER

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.

SINGLE IC 'MATCHBOX AMPLIFIER' SET (20W into 4 Ohms) **£6.50**
BRIDGE AMPLIFIER SET (50W into 8 Ohms) **£8.90**
L165V IC, with data, **£3.90**

Complete Parts Sets for ETI Projects

MAINS CONDITIONER

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!

Our approved parts set consists of PCB, all components, toroid*, enamelled wire, fixing ties, fast response VDR*, and full instructions.

ETI MAINS CONDITIONER PARTS SET ONLY £4.60!

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

CREDIT CARD CASINO

FEATURED IN ETI, MARCH 1987

This wicked little pocket gambling maching measures only 3"x2"x½". It will play all kinds of casino games, including:

- Roulette
- Craps
- Pontoon

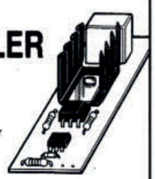
Our approved parts set comes complete with case; self-adhesive fascia; tinned and drilled printed circuit board; all components; hardware; full instructions and three different games to play!

CASINO PARTS SET ONLY £5.90!

SPECIAL OFFER Five extra games FREE with all orders received before ~~March 31st~~ April 30th

MAINS CONTROLLER

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?

The ETI Mains Controller is a logic to mains interface which allows you to control loads of up to 500W from your computer or logic circuits. An opto-coupler gives isolation of at least 2,500V, so the controller can be connected to experimental circuits, computers and control projects in complete safety. Follow your computer interface with a mains controller and you're *really* in business with automatic control!

The mains controller connects directly to most TTL families without external components, and can be driven by CMOS with the addition of a transistor and two resistors (supplied).

Your mains controller parts set contains: high quality roller tinned PCB; MOC3021 opto-coupler; power triac with heatsink, mounting hardware and heatsink compound; all components, including snubber components for switching inductive loads; transistor and resistors for CMOS interface; full instructions.

MAINS CONTROLLER PARTS SET £6.20

POWERFUL AIR IONISER

FEATURED IN ETI, JULY 1986

Ions have been described as 'vitamins of the air' by the health magazines, and have been credited with everything from curing hay fever and asthma to improving concentration and putting an end to insomnia. Although some of the claims may be exaggerated, there is no doubt that ionised air is much cleaner and purer, and seems much more invigorating than 'dead' air.

The DIRECT ION ioniser caused a great deal of excitement when it appeared as a constructional project in ETI. At last, an ioniser that was comparable with (better than?) commercial products, was reliable, good to build . . . and fun! Apart from the serious applications, some of the suggested experiments were outrageous!

We can supply a matched set of parts, fully approved by the designer, to build this unique project. The set includes a roller tinned printed circuit board, 66 components, case, mains lead, and even the parts for the tester. According to one customer, the set costs 'about a third of the price of the individual components' What more can we say?

Instructions are included

DIRECT ION PARTS SET £9.50

MATCH BOX AMPLIFIERS

20W Single IC parts set £6.50

50W Bridge Amplifier parts set £8.90

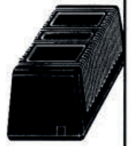
L165V Power Amplifier IC, with data, £3.90

LM2917 EXPERIMENTER SET

Consists of LM2917 IC, special printed circuit board and detailed instructions with data and circuits for eight different projects to build. Can be used to experiment with the circuits in the 'Next Great Little IC' feature (ETI, December 1986).

LM2917 Experimenter Set £5.80

RUGGED PLASTIC CASE,



suitable for mains conditioner and mains controller.

ONLY £1.65

SPECIAL OFFER

Our best selling ioniser kit is now available with an elegant white case.

WHITE IONISER PARTS SET ONLY £9.80!

Orders should be sent to Specialist Semiconductors at the address below including 60p towards postage and packing. Please allow up to 14 days for delivery. There is no telephone service at the moment, but all letters or requests for lists will be answered (at top speed if you send SAE!)

Specialist SEMICONDUCTORS
FOUNDERS HOUSE REDBROOK MONMOUTH GWENT

MIDI MASTER KEYBOARD

John Yau continues his MIDI keyboard with a description of the all-important CPU board and the front panel.

Having put the keyboard together, the major part of the MIDI Master Keyboard should be assembled — the controlling CPU and its associated electronics.

The CPU is a 6502A microprocessor and it looks after the entire keyboard (Fig. 1). The majority of the circuitry is on two boards — the CPU board and the Front Panel board. The latter is largely a base for all the front panel switches and displays. The CPU board is the most complex board and is a double sided PCB.

The MIDI Master Keyboard is implemented in a simple 6502 memory map (Fig. 2). All the interfaces for the keyboard itself, the front panel, the MIDI interfaces and so on are mapped into specific location in the memory map and the whole system controlled by a monitor program in ROM.

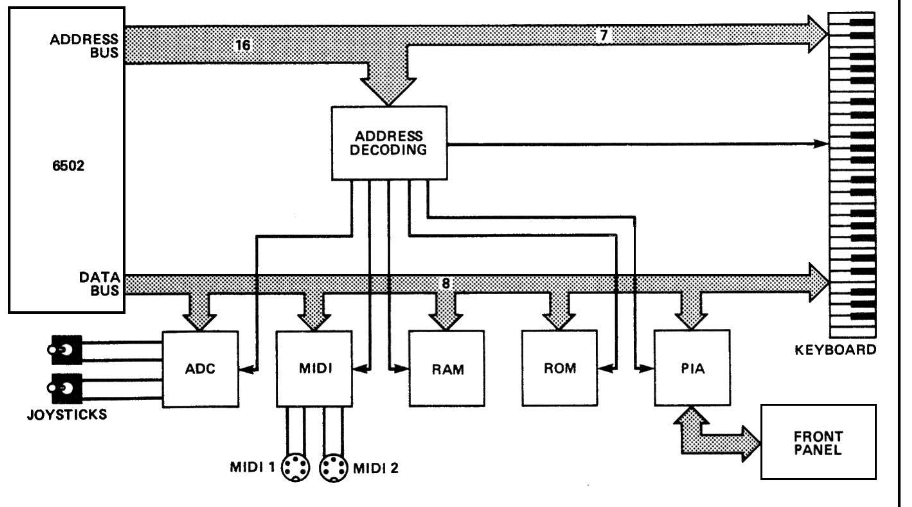
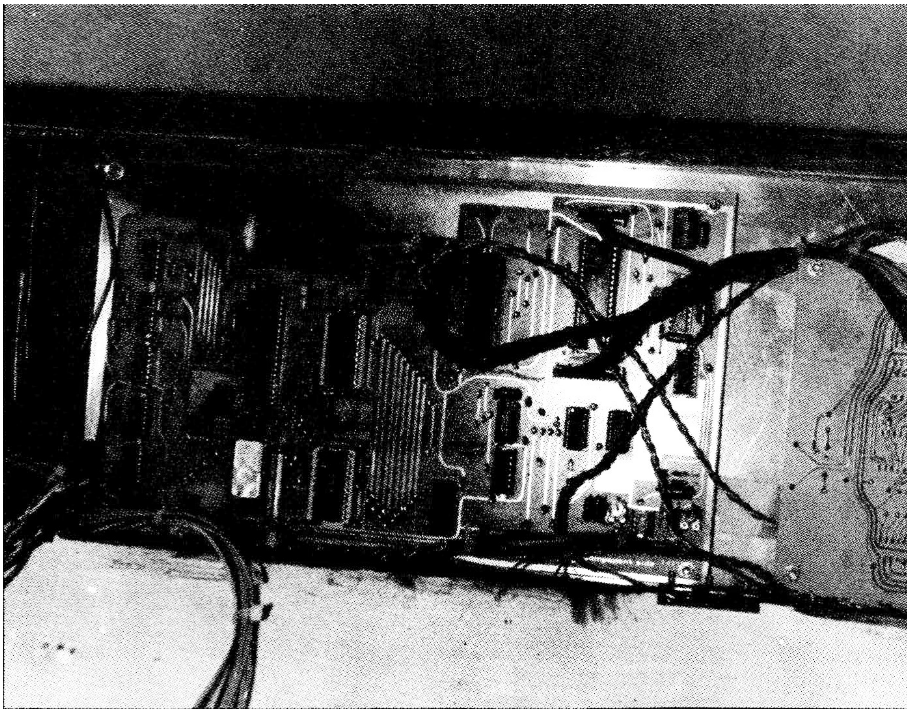


Fig. 1 The block diagram of the ETI MIDI Master Keyboard.

Construction

The CPU board is the most complex board as far as component count is concerned and with the added fact that it is double sided, it demands much care and attention if it is to be assembled correctly.

The first task is to insert and



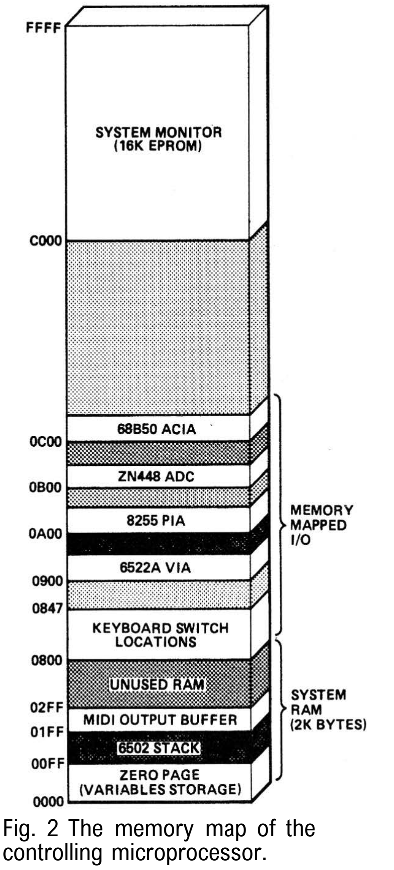


Fig. 2 The memory map of the controlling microprocessor.

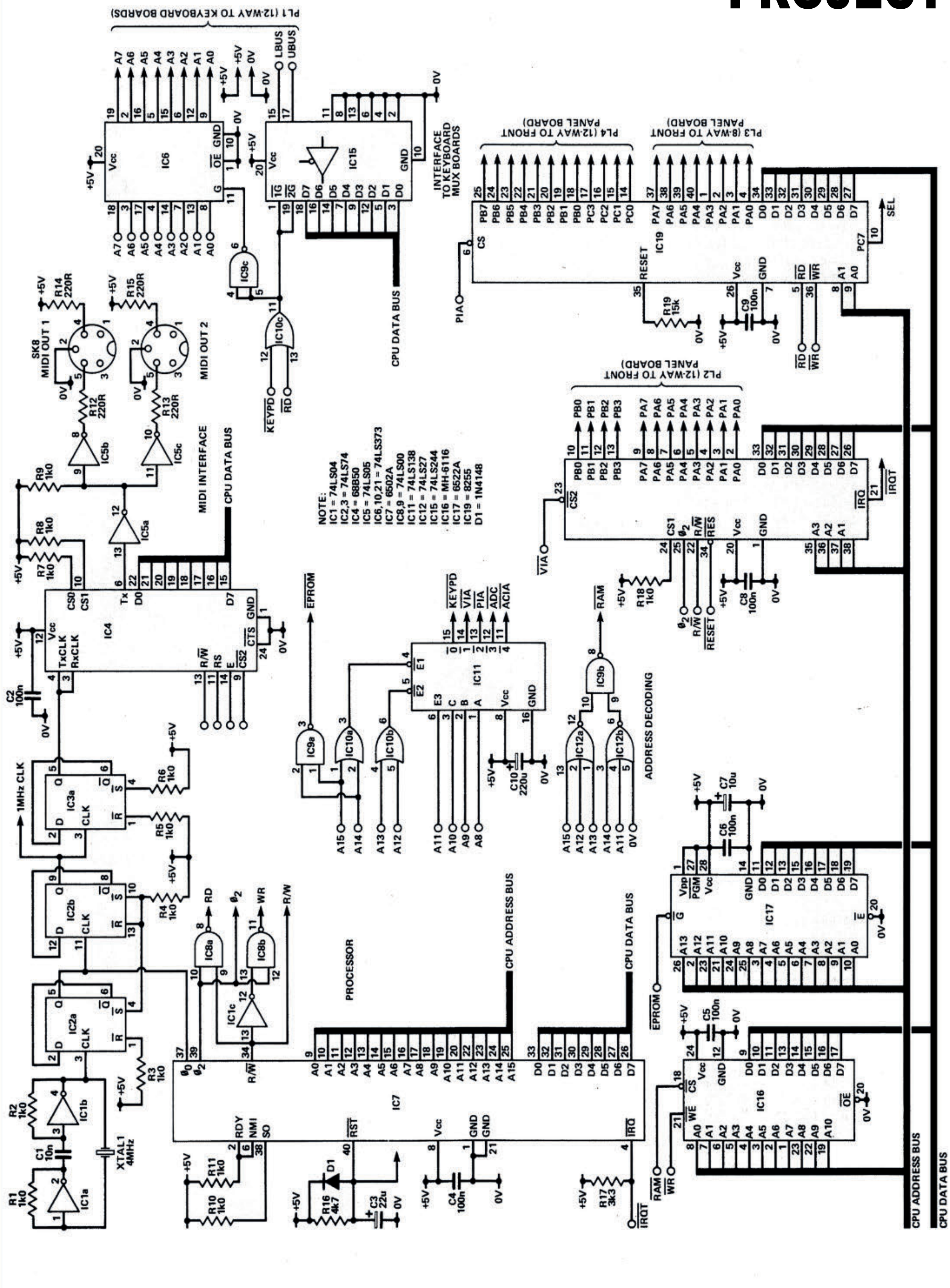


Fig. 3 The circuit diagram of the CPU board.

HOW IT WORKS - CPU

Figure 3 shows the circuit diagram for the CPU board. C3, R16 and D1 form a simple power up reset circuit that is used by the 6502A and also the 6522A VIA. IC1a and IC1b form a 4MHz crystal oscillator. IC2a divides the latter signal by two to form the 2MHz clock for the 6502A. Further division of the 2MHz clock signal is performed by flip flops IC2b and IC3a to obtain the 31.125kHz clock signal used by IC4, the 68B50 ACIA.

Address decoding for the CPU is performed by IC9, IC10, IC11 and IC12. The address decoding enables all the peripheral devices to be memory mapped within the 6502A's address space.

The monitor program for the processor resides permanently in EPROM, the device used being a 16K 27128 EPROM (IC17). A 6116 2K CMOS RAM chip provides the required RAM workspace. Since the size of the monitor program is only about 2.5K of 6502 code, using a 16K EPROM may seem a bit of an overkill. However, the larger EPROM was chosen to give scope for expansion (such as storage of voice dumps for particular synthesisers) and also because of the relatively small price difference when compared to smaller devices.

6522A VIA Functions

IC18 is a 2MHz version of the 6522 Versatile Interface Adaptor (VIA), the 6522A. The device takes up 16 locations in the 6502's memory address space and these are accessed when using the device's dual 8-bit ports and on-board timer. The 6522A is configured to perform two functions.

Scanning of the data entry and function push button key-pad is achieved by the two I/O ports. The 6522A's timer is responsible for generating the clock signal which interrupts the 6502A processor every 2ms. Virtually all the system software is interrupt driven, due to the demands of scanning the keyboard at the precise time intervals required for the key velocity sensing.

8255 PIA Functions

IC19 is an 8255 Peripheral Interface Adaptor (PIA) interfaced to the 6502A through four memory mapped locations. These addresses are the 8255's three 8 bit I/O ports and its control register.

The RD and WR signals for the device are derived from the 6502A's Phi-2 clock and R/W lines using IC1c, IC8a and IC8b. In use, the PIA is configured simply as three 8 bit output ports which are used to drive the LED displays of the MIDI keyboard.

The Keyboard

The multiplexer circuitry for the key scan hardware was described last month. In order to maximise speed and efficiency in the key scanning each key address is made to appear as a direct memory location in the 6502's address space (from 0800H to 0847H). The timing diagram for accessing the state of each key is shown in Fig. 5.

Two successive memory read cycles are required, the first being a dummy read that causes the address of the key to be latched at IC6, a 74LS373 octal latch. As there are only 72 keys to be addressed the most significant bit of the latched address will always be zero.

By the time the following read cycle occurs the two bit word describing the state of the key will be valid at the inputs of IC15, a 74LS244 tri-state octal latch whose output is connected to the processor data bus. It is necessary to latch the key address rather than to engage in a single read cycle because the CMOS multiplexer device outputs are unable to settle within the maximum 310ns access time of a single 6502A read cycle.

The MIDI Interface

Transmission of MIDI messages is achieved by IC4, a 68B50 Asynchronous Communications Interface Adaptor (ACIA). Note the device has to be a 'B' version in order to be compatible with the 2MHz 6502A. Only two memory-mapped locations are required for full communication with the device.

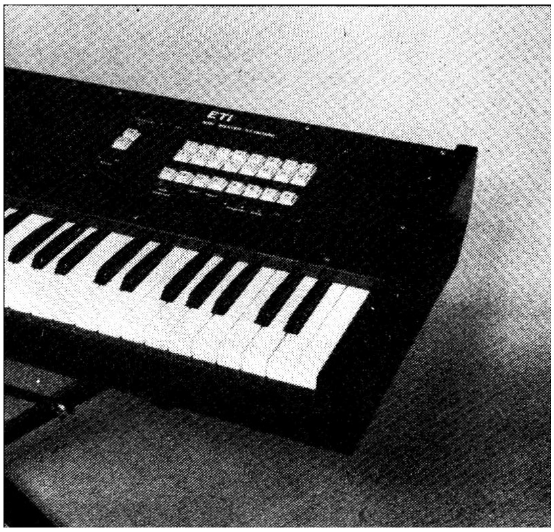
When a single byte of MIDI data is to be transmitted it is simply written to the 68B50's transmit data register by the 6502 processor. The 6502 can then resume its other tasks whilst the ACIA has the job of converting the parallel data to a serial output of one start bit, eight data bits and one stop bit at a baud rate of 31.125K — the standard MIDI data configuration.

Inverters IC5a, b and c are of the open collector type and are used to form the current loop required for the serial link with an external MIDI device. Both MIDI OUTs are identical, the dual output may be useful in avoiding having a large number of MIDI devices being daisy-chained from a single MIDI OUT. Using two MIDI OUTs in a star configuration, as was shown last month, greatly reduces the inherent delays in MIDI data propagating itself through the MIDI devices.

The receiver part of the ACIA is not used, since the keyboard does not make any use of the received MIDI data.

solder all the through-pins. Refer to the component layout diagram (Fig. 6) and use double sided veropins. Make sure that *both* sides are soldered. Making doubly sure that the through-pins are correctly soldered will save a lot of time and frustration later on. It only takes one side of a through-pin to be overlooked for the board to malfunction.

Solder in all the IC sockets next. Some of the tracks between the IC pins on the PCB are rather fine, so be careful not to accidentally bridge any of them



with solder when mounting the IC sockets.

Next, solder in the multi-way connectors. Ensure their orientation is correct and keep the contact with the soldering iron to a minimum, so as not to soften the plastic and bend the pins.

The other components can then be mounted, starting off with the resistors, followed by the capacitors, diode and presets. Make sure that the orientation is correct for the electrolytics and diode. Note that a few of the components require their leads to be soldered to the PCB on *both* sides.

Finally, insert all the integrated circuits and, as always, ensure correct orientation. Finish off by cleaning the board with flux remover and check thoroughly for any shorts which may be caused by stray blobs of solder.

Front Panel Board Assembly

The front panel PCB holds the display driver and display circuitry as well as functioning as a mounting base for the bank of push buttons.

First of all, solder in the links as shown in the layout diagram (Fig. 7). Follow this with the resistors, diodes and IC sockets, making sure the diodes are correctly orientated.

The dual 7 segment display plugs into a 24 pin DIL IC socket mounted on the PCB. Since the display device package only has 18 pins be sure that it is plugged into the socket correctly. It should occupy the leftmost position when the PCB is viewed from the component side.

The next components to be added should be the push buttons. To achieve best alignment

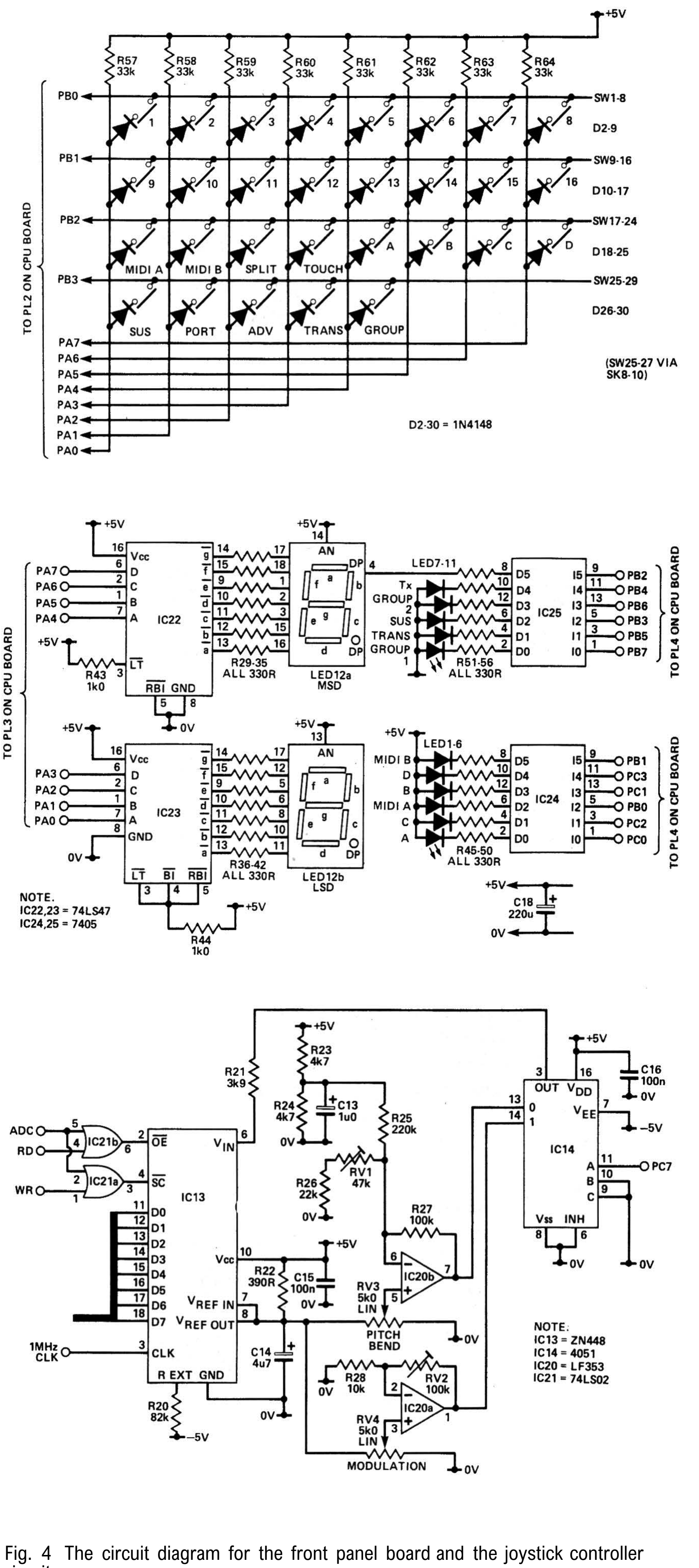


Fig. 4 The circuit diagram for the front panel board and the joystick controller circuitry.

HOW IT WORKS FRONT PANEL

Figure 4 shows the circuit of the front panel board and the joystick control section of the CPU board.

Scanning of the push button key-pad is achieved by the diode matrix circuit comprising D2-30, SW1-29 and R57-64. Port A of the 6522A VIA is configured to be an input port, and the low nibble of port B is configured for output. By reading the value of the data presented at port A, whilst one of the switch matrix rows is pulled low (strobed) by the relevant bit in port B, the state of all the switches in that row can be examined.

For example, if the binary number 11111101 was placed in port B, the second row of the switch matrix strobed and the value of data from port A were say 11110111, then it can be deduced that the numeric button '4' was being pressed.

Such circuits are commonly found in 'QWERTY' keyboards, but there are problems using this type of circuit for scanning the music keyboard as well. Full polyphonic scanning of the keyboard is awkward to achieve and the large number of diodes required would be undesirable.

The 8255 PIA on the CPU board drives the LED displays on the front panel. Port A data goes to the two 74LS47 seven segment display driver devices (IC22 and 23) on the front panel PCB, which in turn drives the dual digit display on the same board. Ports B and C drive the single LED displays via inverter buffers IC24 and 25, a pair of 7405s. To light up a LED, logic one has to appear at the relevant bit. The inverter then sinks the current required to illuminate the LED.

HOW IT WORKS - JOYSTICKS

Joystick Interface

The joystick interface has the task of enabling the 6502A processor to digitally read the positions of two joysticks. Both mechanical assemblies of the joysticks have 5k linear rotary potentiometers coupled to the joystick lever pivot points. The joystick assembly intended for the pitch bend has a self centering lever whilst the modulation joystick is of the ratchet type.

Since the full travel of the joystick assembly is only about 20% of the full potentiometer track there are added complications if we are to ensure that the maximum deviation of the joystick position will correspond to the maximum digitised value of 255 from IC13 (a ZN448 8-bit A/D converter).

The ZN448 is configured to use its own internal voltage reference of 2.5V. This voltage reference is also fed to the top end of the joystick potentiometer tracks. If the minimum joystick deviation corresponds to an output of 0V at the wiper then at the other extreme position the output voltage will be approximately 20% of the reference voltage — about 0.5V.

To utilise the full dynamic range of the A/D converter an input voltage of 2.5V is required when the joystick is at full travel. This is achieved by amplifying the wiper voltages before they are presented to the input of the A/D converter. IC20a and IC20b form two non-inverting voltage amplifiers with gains that can be fine adjusted by preset trimmers RV1 and RV2.

When the pitch bend joystick potentiometer on the prototype master keyboard was set to give a 0-0.5V range at the wiper it was found the neutral position did not correspond to the expected voltage of 0.25V, resulting in a slightly assymmetric deviation of voltages when moved from the centre to the extremes of travel. This is because the potentiometer track is not completely linear throughout the whole of its span. In order to minimise this non-linearity it was necessary to move the working part of the potentiometer track to roughly its middle region. In such a set-up the wiper voltage is in the range 1.0-1.5V when the joystick is at its lowest extreme of travel. The latter displacement voltage must be cancelled out so that the correct range of 0-2.5V appears at the A/D converter input. This is achieved by imposing a DC offset at pin 6 of IC20b, resulting in a voltage subtraction of approximately 1.2V at the output of the op-amp.

IC14 is a 4051 used as a two input analogue multiplexer. PC7 from IC19, the 8255 PIA, selects one of the two joystick voltages to be presented to the input of the A/D converter (pin 6). The A/D converter appears to the 6502A processor simply as a single memory mapped location (0B00H). Writing to 0B00H initiates a conversion start and after the conversion time span has elapsed (approx. 10us) the data can be read from the same location.

For a given joystick position the data read from the A/D converter should always be exactly the same in the ideal case. This would allow the software to transmit the relevant MIDI information only when the joystick position has just changed. However, in reality the least significant bit can fluctuate in successive readings for certain joystick positions due to the limited resolution of the A/D converter. A solution to this problem is to collect successive sample readings and take the average, thereby greatly reducing any occasional perturbations in the data. The software fix was found to be quite effective, although it effectively resulted in a reduction in the rate at which the joystick positions were scanned.

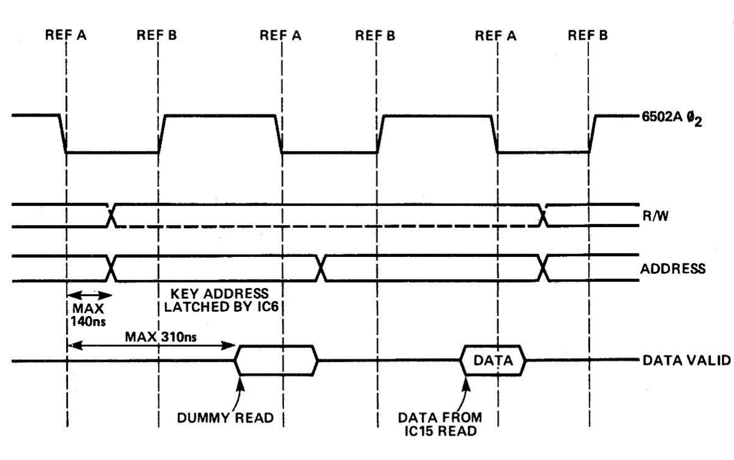


Fig. 5 Timing diagram for the keyboard scan.

of the push button bank, the switches should be soldered to the PCB fully assembled, complete with the key cap tops. Solder the push buttons one by one, making sure the positioning is straight and square.

There are three wiring harnesses which span from the front panel board to the CPU PCB. Each harness should be soldered directly onto the relevant pins and terminated with a female multi-way PCB connector. As with the keyswitch PCBs, the wiring has to be directly soldered onto the front panel PCB (rather than using multi-way connectors) due to lack of clearance when the board is mounted in position in the keyboard cabinet.

Follow the component layout diagrams of both the front panel board and the CPU board to ensure correct connector orientation. Cable length should be such that the wiring reaches the CPU board easily from the front panel board when the two boards are in their final mounting positions within the keyboard cabinet.

After plugging in the ICs, all that remains is the wiring of the two harnesses for the LEDs. Wiring should be direct to the board or via veropins. Be careful with the LEDs' orientation as it's very easy to get one of them wrong (see Fig. 7). Use solid insulated wire for the anode connection to give the LEDs a more definite mounting base and position the LEDs with the final front panel positions in mind (see Fig. 9).

That completes the construction of the CPU and front panel boards. Next month we shall look at the power supply board and wire up all the boards together. We shall also see what kind of cabinet is best suited to the MIDI Master Keyboard.

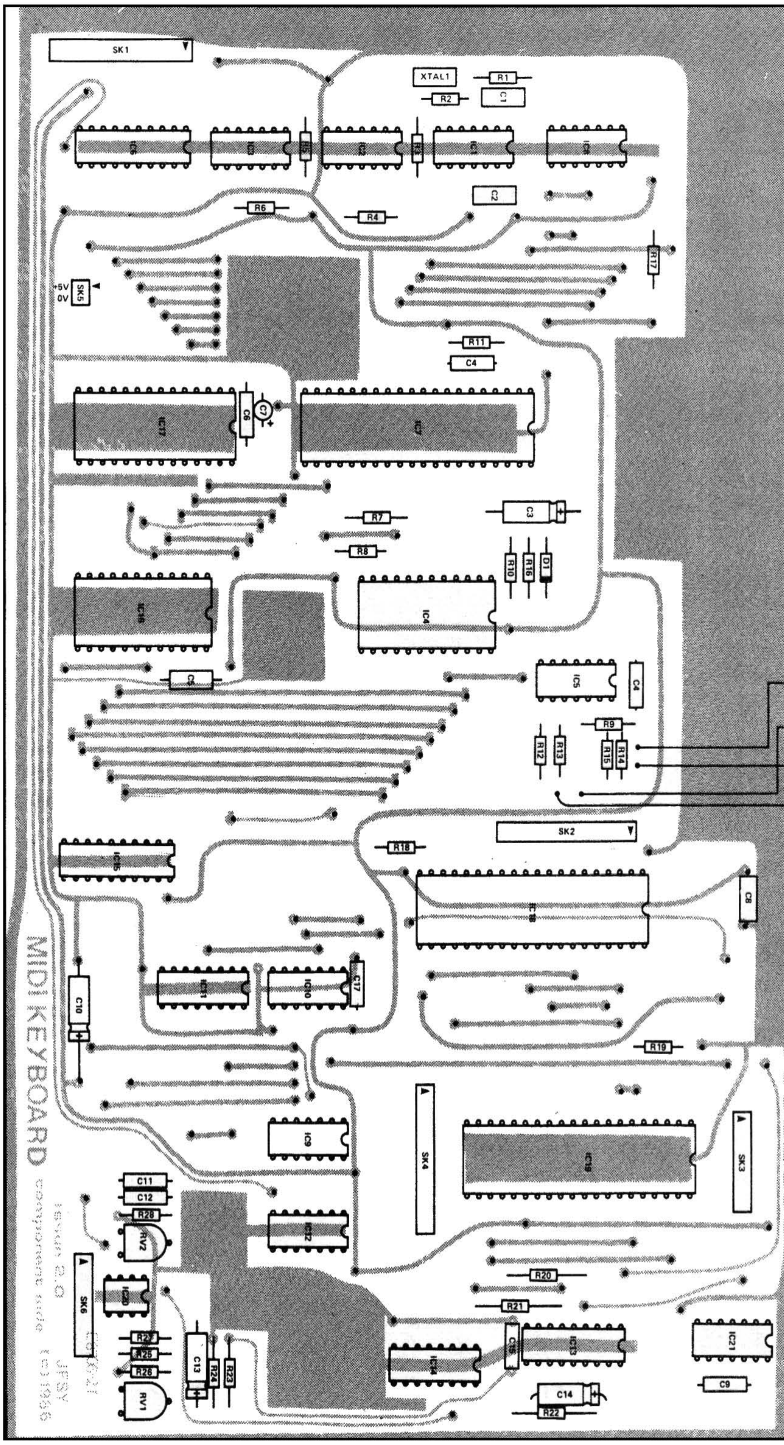


Fig. 6 The component overlay' for the CPU board.

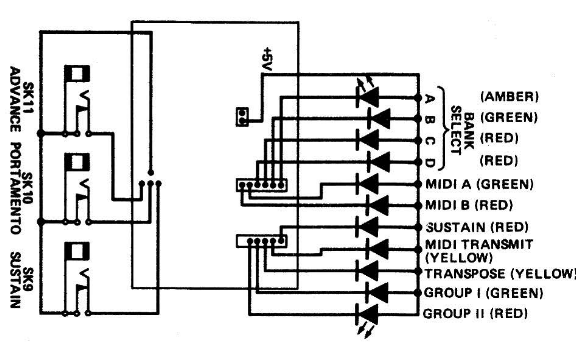


Fig. 7 Wiring the LED indicators and the foot switch sockets.

PARTS LIST CPU BOARD

RESISTORS	
R1-11, 18	1k0
R12-15	220R
R16, 23, 24	4k7
R17	3k3
R19	15k
R20	82k
R21	3k9
R22	390R
R25	220k
R26	22k
R27	100k
R28	10k
RV1	47k horiz. preset
RV2	100k horiz. preset
RV3	5k0 lin. single axis joystick (centre sprung)
RV4	5k0 log single axis joystick (rachet)
CAPACITORS	
C1	10n polycarbonate
C2, 4, 5, 6, 8, 9, 11, 12, 15, 16, 17	100n polyester
C3	22u 16V electrolytic
C7	10u 16V tantalum
C10	220u 16V electrolytic
C13	1u0 16V electrolytic
C14	4u7 16V electrolytic
SEMICONDUCTORS	
IC1	74LS04
IC2, 3	74LS74
IC4	68B50
IC5	74LS05
IC6, 10, 21	74LS373
IC7	6502A
IC8, 9	74LS00
IC11	74LS138
IC12	74LS27
IC13	ZN448
IC14	4051
IC15	74LS244
IC16	HM-6116
IC17	27128
IC18	6522A
IC19	8255
IC20	LF353
IC21	74LS02
D1	ln4148
MISCELLANEOUS	
SK1, 2, 4	12-way PCB connector
SK3, 6	8-way PCB connector
SK5	2-way PCB connector
SK7, 8	5 pin DIN
XTL1	4MHz crystal
PCB; IC sockets; nuts and bolts.	

BUYLINES

The joysticks used were from SLM. (Modes) Ltd., Chiltern Road, Prestbury, Cheltenham, GL52 5JQ. The other components should pose few problems. The PCB Is available from our PCB, Service.

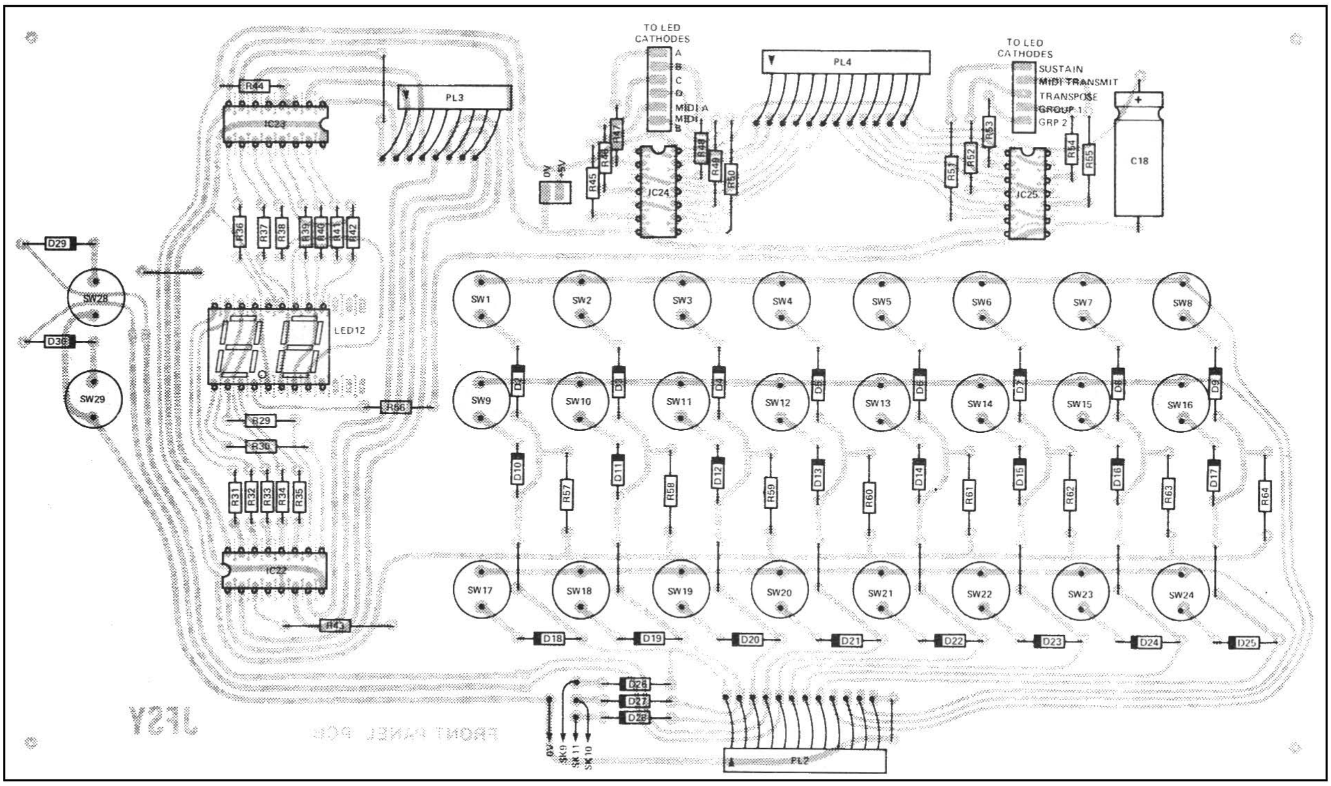
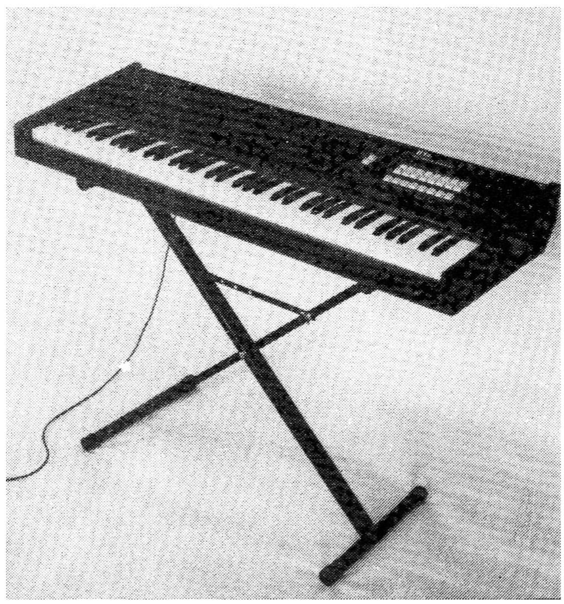


Fig. 8 The component overlay for the front panel board.

PARTS LIST - FRONT PANEL

RESISTORS		LED8, 11	Yellow LED
R29-42, 45-56	330R	LED12	Double digit 7 segment display (common cathode)
R43, 44	1k0		
R57-64	33k		
CAPACITORS		**MISCELLANEOUS**	
C18	220u 16V electrolytic	PL2,4	12 way PCB connector
		PL3	8 way PCB connector
SEMICONDUCTORS			
IC22, 23	74LS47	SW1-24, 28, 29	Push button switch
IC24, 25	7405		
D2-30	1N4148	SW25-28	Foot switch
LED1	Amber LED	SK9-11	¼in jack socket
LED2, 5-7, 9	Red LED	PCB; IC sockets; PCB through pins; nuts and bolts.	
LED3, 4, 10	Green LED		



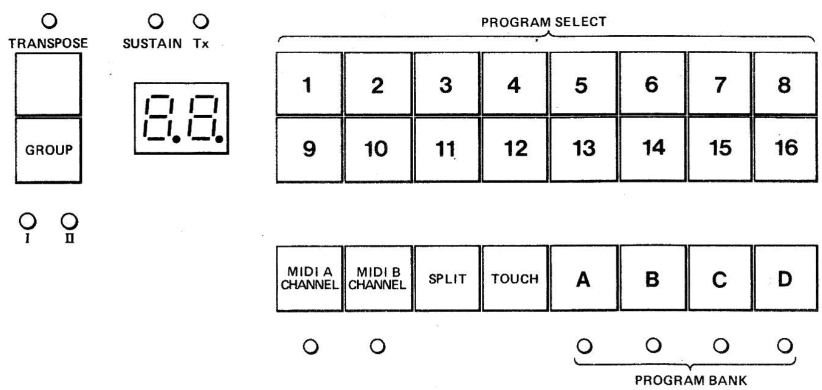


Fig. 9 The front panel layout.

FLAME SIMULATOR

Pretend arsonist Gary Hynes puts realism into electric fires, candle bulbs, and other pseudo-flames with this ingenious device.

There are many household appliances which require a simulated flickering flame. 'Olde' pseudo-candle lights (such as 'carriage' lamps) and many electric fires simulate flames either with bulbs using thermal cutout filaments (effectively glass-encapsulated car flasher units!) or by mechanical means consisting of complicated motorised reflectors.

The problems with both of the methods are twofold. First, these methods of flame simulation are unreliable. The mechanical means often jam and the reflectors soon lose their gleam inside an electric fire. The flicker filaments soon over-flick and die.

These flame simulators also suffer from a severe lack of realism! Both produce a pretty regular flicker — quite unlike a real flame.

This device is the all-electronic solution to these problems. The unit uses an ordinary mains bulb of 60W or less and flickers it in an apparently totally random manner. In between the flickers the bulb is still lit dimly and this also helps to more realistically imitate a flame's light dance.

Operation

A simplified block diagram of the circuit is shown in Fig. 1. The circuit is based around a pseudo random sequence generator (PRSG) which generates an apparently random sequence of bits (ones and zeros) at the speed of the clock oscillator.

The sequence is in fact not truly random. It actually follows a continually repeated set pattern. However, if the sequence is made long enough the repetition cannot be noticed and appears as random as a flame.

The PRSG is formed by a 20-stage shift register. Outputs from the 17th and 20th stages are fed to the inputs of an exclusive OR gate and the output from this is fed back to the input of the first stage.

The feedback connections are critical if the maximum sequence length is to be achieved. This is known as the maximal length.

The calculations for finding the connections necessary for maximal length are complicated and beyond the scope of this article. What's more they are usually avoided anyway, by repetitive interactive calculations giving a look up table.

The output from the EXOR gate is fed to the gate of a thyristor. During the negative half cycle of the mains the thyristor is turned off and the diode conducts, lighting the lamp dimly.

If the thyristor receives a one on its gate from the PRSG during the positive half cycle then it will conduct, lighting the lamp more brightly. When a zero is received the thyristor turns off during the positive half cycle and the lamp remains dimly lit.

The resultant effect is a lamp that flickers in a random manner. The flicker rate may be adjusted to give the most realistic flicker for the application by changing the oscillator frequency clocking the shift register.

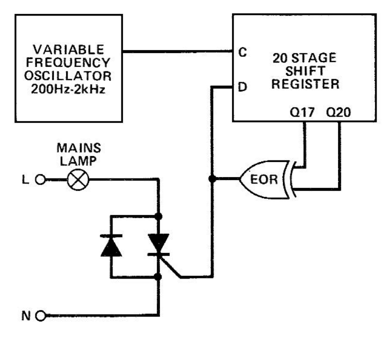


Fig. 1 Simplified block diagram of the flame simulator.

HOW IT WORKS

The circuit diagram of the flame simulator is shown in Fig. 2. The mains voltage is stepped down by transformer T1 to 6V AC, full wave rectified by diodes D1,2 and smoothed by capacitor C1 to provide a DC supply of about 7V to power the circuit.

Note that the 0V line is connected directly to the neutral of the mains. LED3 is connected across the supply to indicate the unit is on.

The 20 stage shift register is formed by two ICs. IC1 is a 4006 shift register that provides the first 18 stages while IC2 is a 4013 flip flop providing the 19th and 20th stages. The set and reset inputs are disabled by connecting them to 0V.

The outputs from the 17th and 20th are exclusive ORed by IC3a and its output is fed back to the data input of the first stage via coupling capacitor C5.

R7 and C5 prevent the possibility of the PRSG 'hanging up' permanently in the all-zero state. If this happens C5 will begin to charge through R7 until eventually a logic one is fed to the input of the first stage restarting the sequence.

A variable frequency oscillator, adjustable from 200Hz to 2kHz, is formed by EXOR gates IC3c and IC3d, C3,4 and RV1 connected in the well known CMOS oscillator configuration. Because IC1 is clocked on a negative edge and IC2 on a positive edge the clock to IC1 has to be inverted by IC3b.

The output from IC3a is a random sequence of high and low logic levels. These are fed to the gate of thyristor SCR1 via R3,4. In between 'on' flickers the lamp is kept glowing dimly by diode D4 which conducts during the negative cycle of the mains.

If during the positive cycle the gate of SCR1 receives a high level from the output of IC3a then SCR1 will conduct lighting the lamp brightly.

R2 and C2 form a snubber suppression circuit which controls the maximum rate of change of voltage and the peak voltage across SCR1.

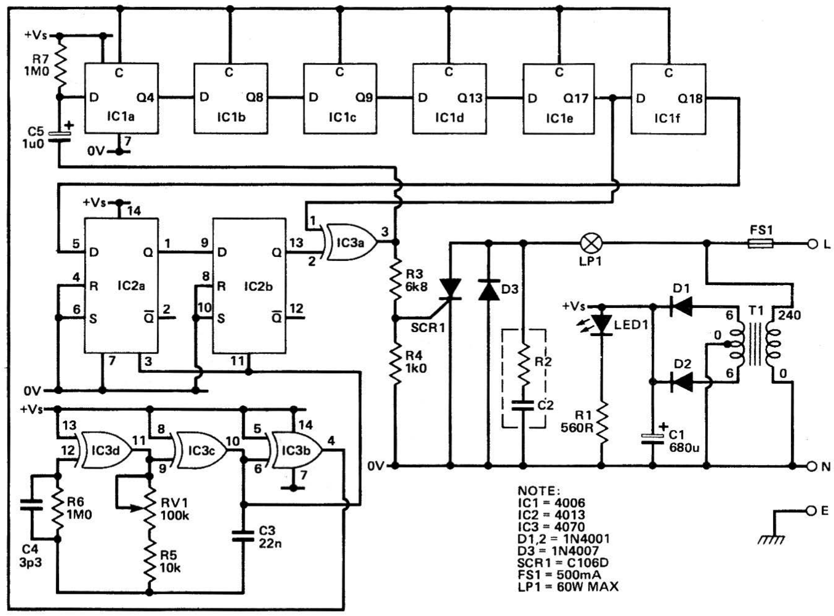


Fig. 2 The full circuit diagram of the flame simulator.

Construction

The component overlay is shown in Fig. 3. All the components except for the LED are mounted on the single PCB. This is divided by the transformer into two halves — one the mains voltage 240V section and the other the control circuit. However, the entire board is connected directly to the mains input and should not be handled when the unit is plugged in.

Begin by connecting the DIL sockets. Then mount the resistors, capacitors, diodes, the preset, the thyristor, suppressor, transformer and fuse clips. The ICs should be inserted last of all. As these are CMOS devices, normal anti-static precautions should be observed.

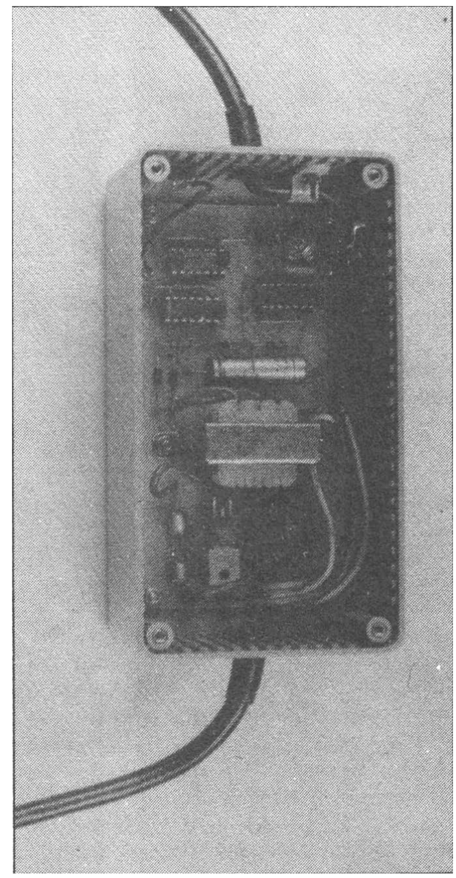
The prototype was mounted in a plastic case measuring 150 x 80 x 50mm. If a metal case is used it must be properly earthed. Care should also be taken to ensure the mains is connected the right way round.

Mains input is from an ordinary three-pin plug and the output is connected to a suitable holder for the lamp to be used. Cables in and out of the unit should pass through grommets.

Testing

Connect a lamp to the output and the unit to the mains and switch on. If all is well the LED should light and the lamp will begin to flicker.

If this does not happen switch off, unplug the unit from the mains and check for errors. The flicker rate should be adjustable by the preset RV1. This should be adjusted when the unit is unplugged or with an isolated tool (and with care!).



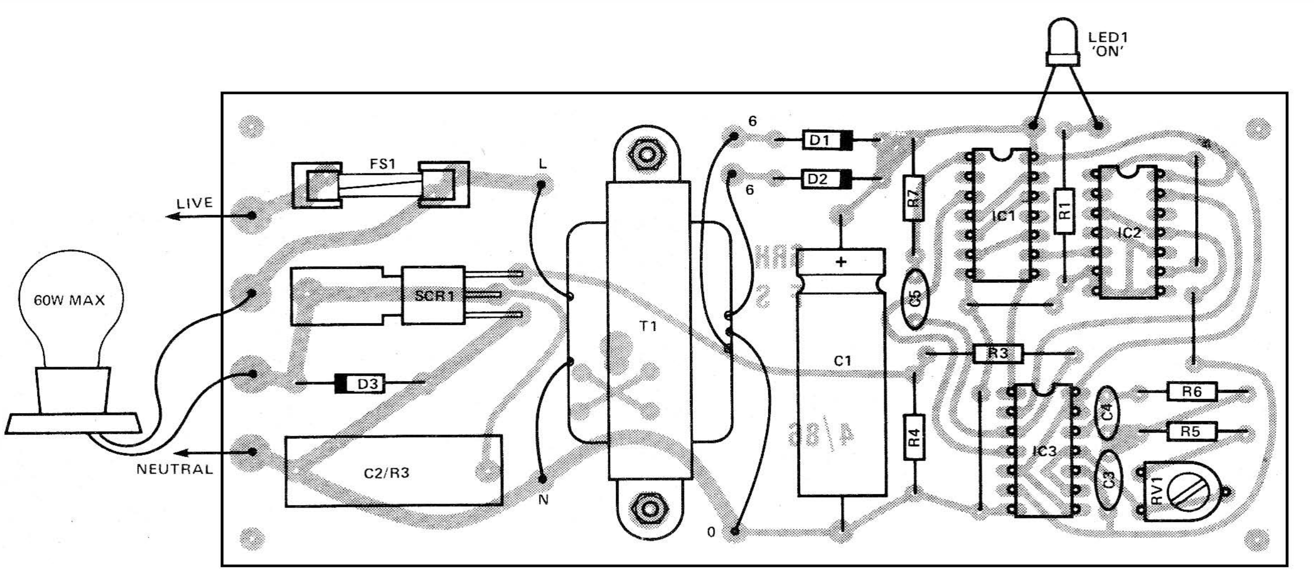


Fig. 3 The component overlay of the flame simulator.

PARTS LIST

RESISTORS all ¼W, 5%

R1	560R
R2	100R (see text)
R3	6k8
R4	1k0
R5	10k
R6,7	1M0
RV1	100k horizontal preset

CAPACITORS

C1	680u 16V electrolytic
C2	100n (see text)
C3	22n polyester
C4	3p3 ceramic
C5	1u0 16V tantalum

SEMICONDUCTORS

IC1	4006
IC2	4013
IC3	4070
SCR1	C106D thyristor
LED1	Red LED
D1,2	1N4001
D3	1N4007

MISCELLANEOUS

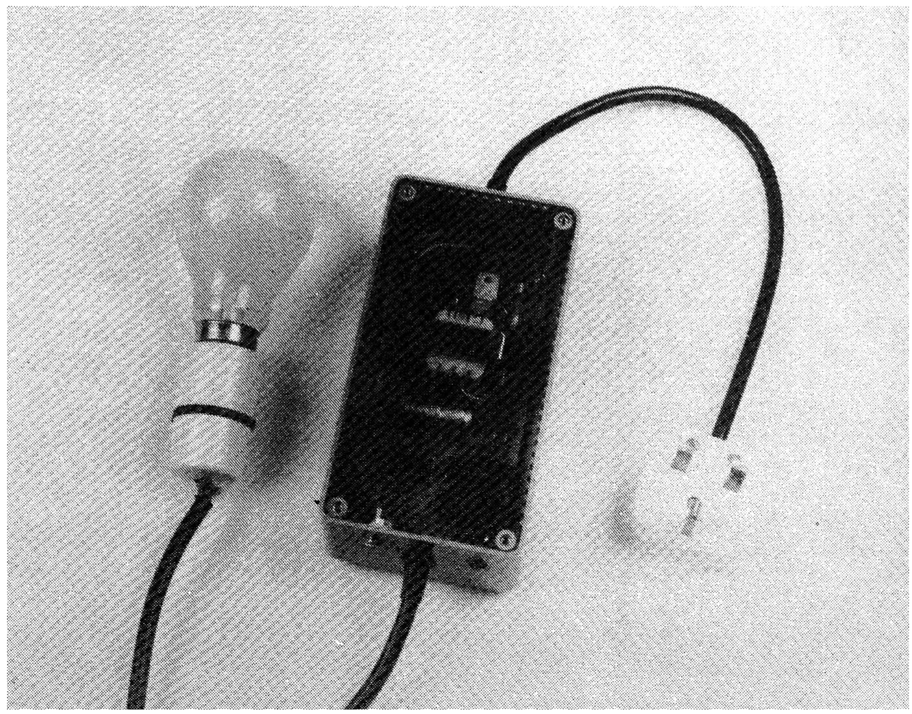
T1	6-0-6V mains transformer
C2,R3	contact suppressor

PCB; case; 500mA fuse and fuse clips; IC sockets; 3 amp mains cable; lamp socket.

BUYLINES

All the components are easily available from the usual suppliers. The case used is not critical and will depend on the application of the circuit.

The mains transformer is available from Maplin (type number WBOOA) as are R2 and C3 - the encapsulated snubber circuit (type number YR90X).



AFFORDABLE ACCURACY
Quality Multimeters from *Cirkit*

A comprehensive range of Analogue and (Pushbutton or Rotary Switched) Digital Models

ANALOGUE

HM-102BZ — 10ADC Range, 20kΩ/VDC, Buzzer, Battery Test Scale £12.50
19 measuring ranges
HM-102R — Low end voltage & current ranges, Jack for Audio o/p voltages ... £11.00
20 measuring ranges
HM-1015 — Rugged, Pocket sized meter, for general purpose use £7.50
16 measuring ranges

Battery, Test Leads and Manual included with each model.

Please add 15% for VAT and 70p for p&p

DIGITAL

HC-7030
0.1% Accuracy. Standard Model £39.50
HC-6010
0.25% Accuracy. Standard Model £33.50
HC-5010T
0.25% Accuracy. TR Test Facility £39.50
DM-105
0.5% Accuracy. Pocketable £21.50

All models have full functions and ranges and feature: 3½ digit 0.5" LCD display — low battery indication — auto zero & auto polarity — ABS plastic casing — DC AC 10amp range (not DM-105) — Overload protection on all ranges — battery, spare fuse, test leads and manual

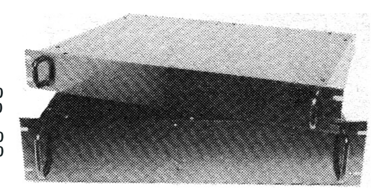
Full details and specification from:
Cirkit Distribution Ltd
Park Lane, Broxbourne, Herts, ENIO 7NQ Telephone (0992) 444111 Telex 22478
TRADE ENQUIRIES WELCOME

VISA

RACK STYLE CABINET

Suitable for instruments, high quality amplifiers and many other purposes· Black anodized aluminium front panel enhanced with two handles. Aluminium version, wholly made of black anodized aluminium sheets. Metal version, rear box is manufactured from steel painted in black with front panel. Rack mount or free standing. Customer who requires further details, please send SAE.

Panel Size W H (Inch)	Rear Box W H D	Price Steel	AL
19×2.5	17×2×10	22.50	27.50
19×3.5	17×3×10	24.50	29.50
19×5.25	17×5×10	26.50	
19×3.5	17×3×12	25.50	30.50
19×5.25	17×5×12	27.50	32.50
19×7.0	17×6.5×12	29.95	



Please add £3.00 P/P for the first item and £1.50 for each addftional item. Quantity discount available. A limited quantity of electronic kits at give away prices. SAE for details. Overseas orders welcome.
Mail order only. To order send cheque/postal order, please allow up to 7 days despatch for cheque clearance.

T J A DEVELOPMENTS
53 Hartington Road, London E17 SAS

MAKE YOUR INTERESTS PAY!

More than 8 million students throughout the world have found It worth their while! An ICS home-study course can help you get a better job, make more money and nave more from out of life! ICS has over90 years experience in home study courses and is the largest correspondence school in the world. You learn at your own pace, when and where you want under the guidance of expert personal tutors. Find out now we can help YOU. Post or phone today for your **FREE INFORMATION PACK** on the course of your choice. Tick one box onlv!

Electronics	☐	Radio, Audio and TV Servicing	☐
Basic Electronic Engineering (City & Guilds)	☐	Radio Amateur Licence Exam (City & Guilds)	☐
Electrical Engineering	☐	Car Mechanics	☐
Electrical Contracting/ Installation	☐	Computer Programming	☐
GCE over 40 'O' and 'A' level subjects			☐

ICS

Name
Address
P Code

International Correspondence Schools, 312/314 High ~St, Sutton, Surrey SM1 1PR, Tel: 01-643 9568 or 041-221 2926 (24hrs) Dept EBS67

HI-FI POWER METER

Paul Chappell builds the ultimate power meter that puts all others to shame and is the definitive upgrade for top-flight Hi-Fi.

Last month I described the three kinds of power associated with electronic circuits — apparent power, real power and reactive power. I also offered a few thoughts on deriving signals to drive the meter without disturbing the signal from the amplifier.

The method eventually chosen was to detect the magnetic flux around one of the speaker leads by means of a ferrite toroid wound with a suitable pickup coil. The result is this month's project — a power meter for top flight hi-fi equipment.

The Circuit

The final circuit of the power meter is shown in Fig. 1. I say final because it passed through a

HOW IT WORKS

The amplifier current is sensed by current transformer T1 and the voltage by C4 and C5. The sensing arrangement has a number of advantages. The primary concern is to not disturb the signal from amplifier to speaker in any way. The second is that the power meter should not be influenced by the DC voltage levels of the amplifier output — a failing of most other power meters. The use of a transformer and capacitors gives complete isolation.

The voltage is processed by an instrumentation amplifier consisting of IC3a,b and c. This arrangement gives the same input resistance on each lead, rejects voltages common to both and amplifies the difference. RV2 trims the circuit for best common mode rejection.

The multiplier, IC2, has been described in detail in the text. Its output currents are processed by IC4a to give a single ended voltage output centred on 0V. Power consumed by the load causes the mean voltage level at the output of IC4a to fall, drawing current from RV4 and R26.

This current is applied to the meter via R27, which allows the output of IC4b to operate at a higher voltage level than would be possible if the meter was connected directly across the IC.

In combination with D1, R27 also limits the maximum reverse current that can be applied to the meter under fault conditions.

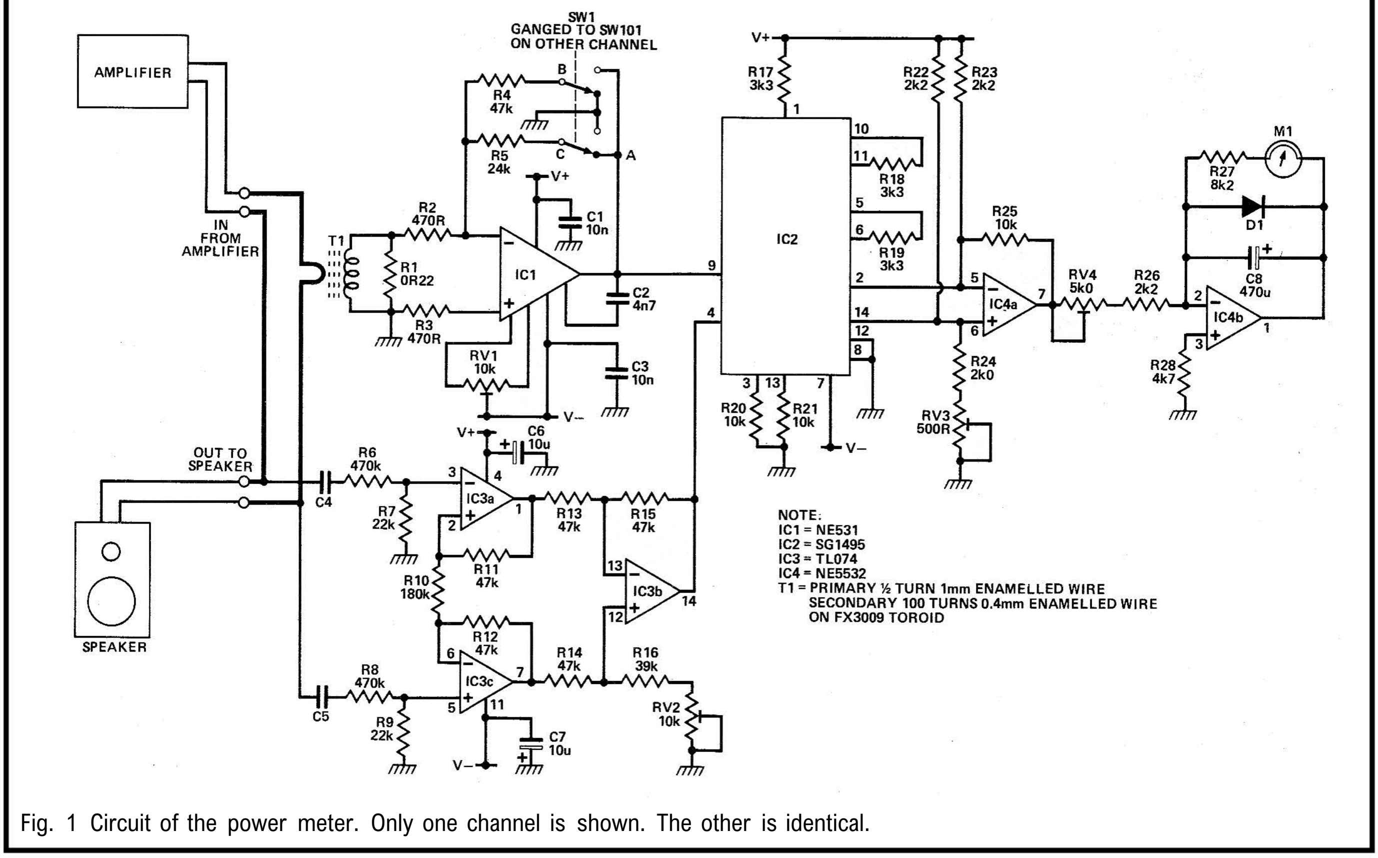


Fig. 1 Circuit of the power meter. Only one channel is shown. The other is identical.

number of stages of development before reaching its present form.

To derive a signal which is a true reflection of the amplifier's current output, the toroid coil must be terminated by an extremely small resistance. Experiment showed that a few ohms would introduce significant phase shift in the current signal. Since a 3° shift between the voltage and current signals will result in a multiplier error of 5%, the phase is quite critical. To meet the performance criteria I set myself for this project, the resistance had to be one ohm or less.

There is no reason why a physical resistor of small value shouldn't be connected across the coil. The current signal can then be detected as a voltage across the resistor and amplified to a usable level. This is the approach taken in the circuit of Fig. 1, and it gives excellent results.

It must be said, however, that this approach is not ideal. As far as the coil is conc rned, R1 should be as small as possible but to achieve a good clean signal with the minimum of noise, R1 should be fairly large. This conflict means that the choice of value for R1 is something of a compromise.

An attractive idea would be to feed the coil into some kind of electronic circuit which would maintain both ends of the secondary at the same voltage and sense the current directly. A great deal of effort was expended in trying to achieve this and anyone faced with a similar problem may be interested to know what not to try.

Currant Sauce

Having a requirement for a current amplifier, or a current to voltage converter, of fairly exacting specifications brings home the lack of ICs designed to process currents rather than voltages and the grossly inadequate performance of the few that do exist. It soon became clear that the matching would have to be achieved with the common or garden VCVS op-amps.

A current summing junction can be made without difficulty — Fig. 3a shows the general idea. The positive input of the op-amp is grounded, the negative input is held at 0V by the action of the feedback resistor. The secondary of the transformer 'sees' a short circuit and the output voltage is proportional to the current

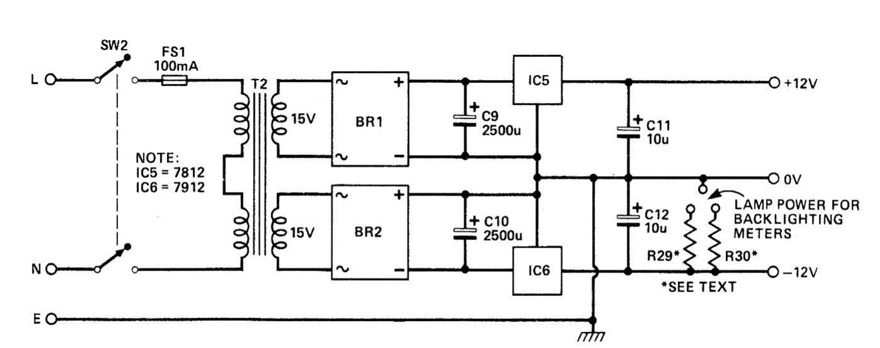


Fig. 2 Circuit diagram of the power supply.

through R and therefore to the current through the transformer. It seems perfect.

The killer here is the op-amp's offset voltage. In an attempt to maintain its inputs a few mV apart via the very small resistance of the coil, most of the amplifier's output current capability can easily be used up and a large voltage offset will be generated across R.

Offset trimming can reduce the problem to managable proportions but the DC stability would get very little help from the feedback loop and so offset drift with time and temperature would make the circuit totally unreliable. Introducing a capacitor in series with the transformer is out of the question because of the phase shift and resonance peak that would be introduced.

The underlying characteristics of the circuit are so close to ideal

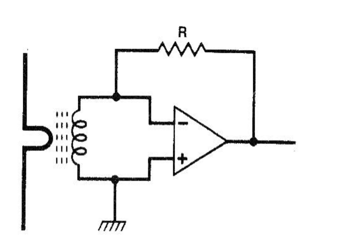


Fig. 3a A better circuit to match the transformer?

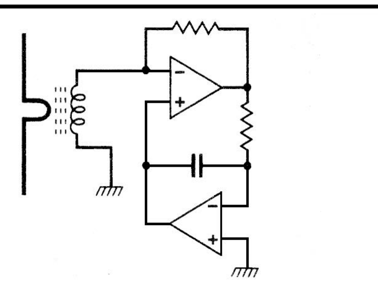


Fig. 3b Using a second op-amp to cancel the offset.

that it seemed to be well worth the effort of trying to get around the offset problem. The circuit of Fig. 3b gave quite encouraging results. In this the offset is cancelled by maintaining the mean level of the output at zero using a second op-amp. The compromise between settling time and low frequency phase shift was on the borderline of acceptability and it seems likely that replacing the integrator with a second order low pass filter would give a viable circuit. However, concern with phase, even below 20Hz or so, led to an alternative solution.

Although an op-amp will have difficulty in cancelling an offset of a few mV, it might more easily cope with a few uV. Op-amps with input voltage offsets of the order of a few uV do exist but you'll need a second mortgage to be able to afford one. However, there are some reasonably priced amplifiers which include an internal auto-zeroing circuit.

Such amplifiers vary in detail from device to device but the essence of their operation is that the signal is processed by one amplifier whilst a second amplifier alternately cancels its own offset and the offset of the main amplifier, switching at a rate of 1kHz or so.

Unlike the circuit of Fig. 3, the offset is sensed at the input rather than the output and some fiendishly clever circuitry prevents the input signal from being mistaken for an offset (at least it does in the Intersil ICL7650 but since the data book does not include the circuit of the IC, I can't be more specific about its operation).

A circuit based on the ICL7650 gave good results but was very sensitive to component values and lacked the solid and reliable 'feel' that a good circuit ought to have (or so John Bird tells me). On balance the circuit of Fig. 1 gave the best and most reliable results, and so was chosen for the final version.

Go Forth and Multiply

Togive a power reading, the voltage and current signals have to be multiplied together. There are several ways to achieve this. One possibility would be to use a pair of log-law amplifiers, sum the outputs, then apply the result to an anti-log circuit.

This would give single quadrant multiplication and with a bit of clever switching this could no doubt be extended to a full four quadrant multiplier. However, the thought of the half dozen or so critical adjustments is enough to make anyone shudder, let alone the complexity of the resulting circuit!

Most ETI readers will be aware that transconductance amplifier ICs will multiply after a fashion and they are commonly used for this purpose (see the power meter in ETI March 1984, for example). Better results can be achieved with the various special purpose multiplier ICs. The Intersil ICL8013, the Motorola MC1494/5 and 1594/5, the Analog Devices AD531/2/3/4 are some examples.

These devices are split into two main groups — most use techniques similar to the transconductance amplifiers, while a few are based on a translinear cell as shown in Fig. 4. If the transistors are perfectly matched, the relationship $I_1 \times I_3 = I_2 \times I_4$ holds between the collector currents of the four transistors, giving the basis for both multiplication and division. The matching requirement means that it is not practical to build an accurate multiplier from discrete components (unless you are prepared to sort and test a bag of 1000 transistors!) but in an IC linearity of 1% or better can be achieved without difficulty.

The multiplier chosen for this project was a Silicon General SG1495, which is a transconductance type. With careful choice of components it has very good linearity. It is also readily available and not too expensive. The main rival was the ICL8013, which is easier to use and requires fewer external components (IC4a and its associated resistors in Fig. 1 would not be needed, for instance), but the superior high frequency performance of the SG1495 tipped the balance in its favour.

Figure 5 shows a simplified version of the internal circuit of the SG1495. This circuit is the basis of almost all transconductance multipliers and

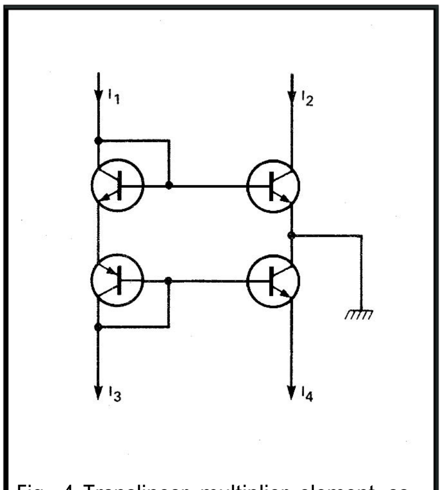


Fig. 4 Translinear multiplier element, as almost certainly used in the AD534 and similar devices.

provides an XxY output at pins 2 and 14.

Construction

Winding the toroidal transformers is the most time consuming part of the construction, but it's worth taking some time over it. Cut off about 8ft of 0.1mm enamelled wire and tack one end to the core with a little superglue, leaving a tail of two or three inches for connecting to the PCB.

The first 99 turns out of the 100 total are the worst. You'll have to feed the entire length of wire through the toroid, being careful not to get kinks in it, and not to wear away the enamel by scraping it on the core. Patience!

Wind as evenly as possible around the core with no lumps of wire in one spot and bald patches in another. Bring the coil to an end with another tail of two inches or so, about 5mm from the first. Hold it in place with another spot of Superglue.

Solder one end of the primary (0.4mm enamelled wire) to the PCB at point A. Thread it through the centre of the toroid and then through hole B, smoothing it down so that it forms a neat and fairly tight loop over the top of the secondary winding. Solder the ends to the PCB.

Thread the secondary connections through holes C and D and solder in place. The toroid should be held quite firmly in place by these connections. If not, another dob of Superglue will do the trick.

The preset pot positions on the PCB allow for either carbon skeleton presets or open cermets to be used in the outer holes, or enclosed cermets in the inner holes. I would recommend the enclosed cermets, but if the bank balance won't stretch that far, carbon types will do. (You can always 'upgrade' them later!).

The transformer is held in place on the PCB by its pins. For domestic use this should be all the support it needs, but if you intend to hump the meter around for use with PA or group gear, I would advise giving it extra anchoring with four N0.6 x ⅜" self-tapping screws, which fit into the corners of its case. You may also like to fix the smoothing capacitors firmly with some double sided adhesive pads.

Details of front panel arrangement are for you to choose. You can follow our layout

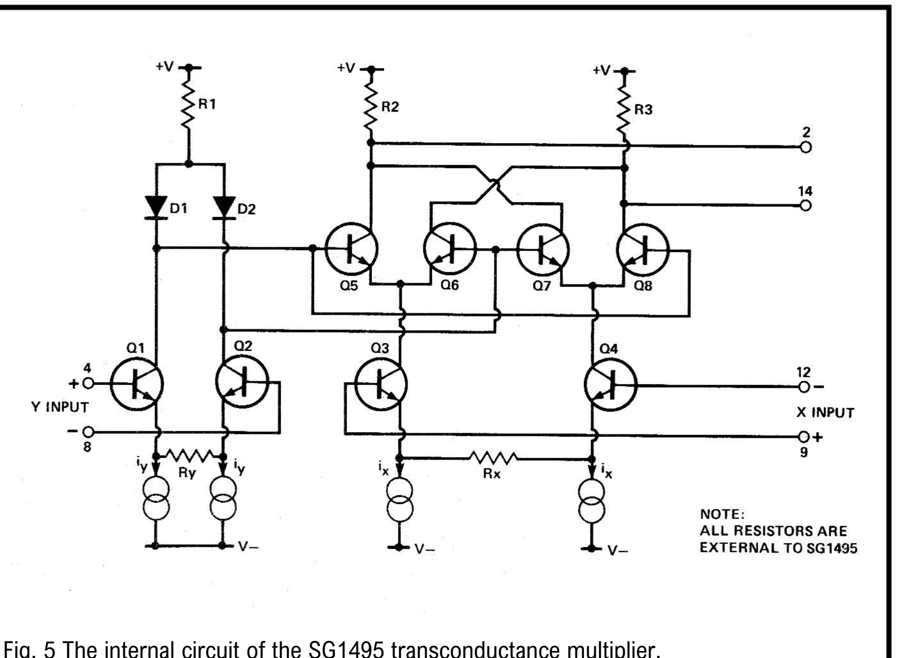


Fig. 5 The internal circuit of the SG1495 transconductance multiplier.

PARTS LIST

RESISTORS (all 1/4W 5% carbon film unless specified)

R1,101	0R22 metal film
R2,102	470R metal film
R3,103	470R
R4,104	47k 1% metal film
R5,105	24k 1% metal film
R6,8,106,108	470k
R7,9,107,109	22k
R10,110	180k
R11-15,111-115	47k
R16,116	39k
R17,18,19,117,118,119	3k3
R20,21,25,120,121,125	10k
R22,23,26,120,123,126	2k2
R24,124	2k0
R27,127	8k2
R28,128	4k7
R29,30	Choose to suit backlighting
RV1,2,101,102	10k horiz. preset
RV3,103	500R horiz. preset
RV4,104	5k horiz. preset

CAPACITORS

C1,3,101,103	10n ceramic
C2,102	4p7 ceramic
C4,5,104,105	470n 100V AC polycarbonate
C6,7,11,12,106,107	10u 16V tantalum
C8,108	470u 16V electrolytic
C9,10	2200u 25V electrolytic

SEMICONDUCTORS

IC1,101	NE531
IC2,102	SG1495
IC3,103	TL074
IC4,10,4	NE5532
IC5	7812
IC6	7912
D1	1N4148
BR2,1	DIL bridge rectifier

Miscellaneous

M1,101	1mA FSD meter movement
SW1/101	4 pole 2 way switch
T1,101	see text
T2	PCB mounting mains transformer 6VA 0-15,0-15

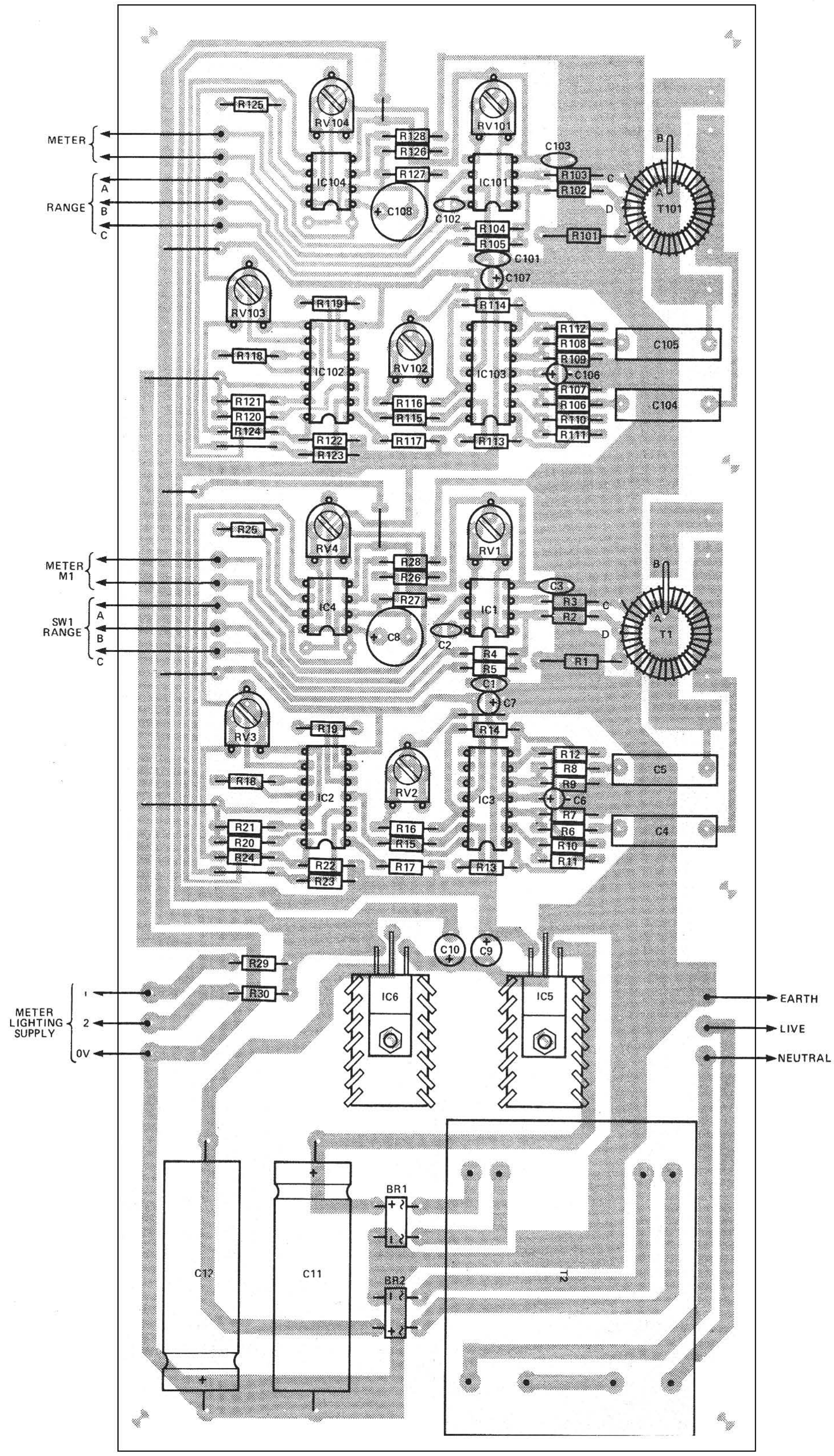


Fig. 6 Component overlay for the power meter.

from the photograph, or alter it to suit yourself. A suggested layout for the internal wiring is shown in Fig.7. If you don't follow it exactly, there are a few things to bear in mind.

Keep the mains wiring as far away as possible from the sensitive parts of the PCB (the toroids and IC1). Keep the range switch connections as short as possible. Don't foret to fit a fuse and a good earth connection to the case.

Use the best meters you can afford for the project — they are the main limiting factor in the accuracy. The ones we used were from Electromail, and with all the accessories they cost about £30 each.

There is no need to follow our example. Any 1mA meter movement will do but to use a £5 'budget' movement would be spoiling the ship for a ha'porth of tar.

If the meters you use have provision for back lighting, a supply for this purpose is available on the power supply section of the PCB. The resistor values you need will depend on

BUYLINES

The parts for this project are almost all obtainable from Electromail. The transformer is stock No. 208-282. The case we used was a Centurion instrument case, type DX5, from Cirkit. The toroid is the only part likely to cause problems. Cirkit should be able to help here. The PCB is available from the Ell PCB Service.

the choice of bulb, but I'm sure I don't have to tell ETI readers how to wire up a light!

Setting up

Before turning on the meter set RV1 (RV101) and RV2 (RV102) to mid position, RV3 (RV103) to minimum resistance and RV4 (RV104) to maximum. Disconnect both meters and turn on the power. With your multimeter on the 10mA range, check that both meter outputs are giving less than 1mA. If it won't go low enough, turn off the power and check the circuit thoroughly.

Adjust RV3 to give a zero current reading. Set your multimeter to the 1mA range, connect up your amplifier and loudspeaker and check the reading rises as you turn up the volume.

Disconnect the loudspeaker but leave your amplifier connected. Set your multimeter to a sensitive current range (100uA or less). Set RV3 to give a reading roughly in the centre of the meter scale. Turn up the volume control on your amplifier watch for any movement in the meter needle. RV1 must be set so that with no speaker connected, the output remains constant regardless of the volume setting on your amplifier.

With RV1 at one end of the scale the meter will move in one direction as the volume increases. At the other end of the scale the meter will move in the opposite direction. Somewhere in the middle, it won't move at all.

Each time you try a new setting for RV1, adjust RV3 to bring the meter needle back to centre scale and turn the amplifier volume up and down. When you find the position where the meter needle does not move, you've found the correct setting for RV1.

Having set RV1, adjust RV3 to give a meter reading of zero with your amplifier disconnected. Connect up the power meter's own meter movements. Connect a 10 ohm resistor across the output of the power meter. I would

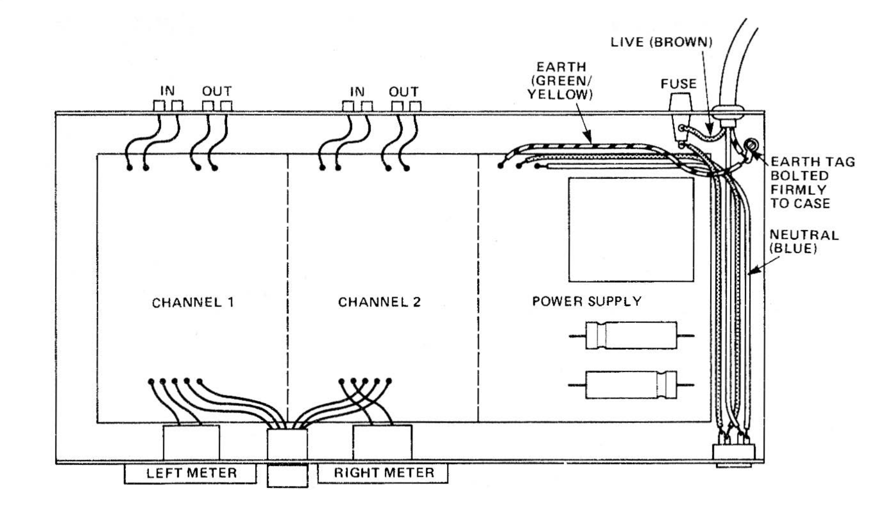


Fig. 7 Suggested internal wiring for the. power meter.

suggest using the 17 watt ceramic resistors available from Electromail — a pack of 5 costs around £1.50. Use a series/parallel arrangement of four 10R resistors to give a 10R resistor which can handle 68W.

Connect a sine wave oscillator or signal generator to the 'Aux' input of your amplifier. A suitable sine wave oscillator was given in last month's article. Connect your multimeter across the resistor on at least a 20V AC voltage range and turn up the amplifier's volume control until it reads 20V. At this point you can set the meter to read 40W on the 50W range by adjusting RV4.

If you are lucky enough to have a meter with an accurate AC current range, you can connect it in series with the 10 ohm resistor and, with the amplifier volume control in the same position, make a current reading (Don't burn your fingers on the resistors!). Multiplying the current you get by the 20V you set will give you a power reading independent of the accuracy of the resistor value. Set the power meter to the result of your calculation via RV4.

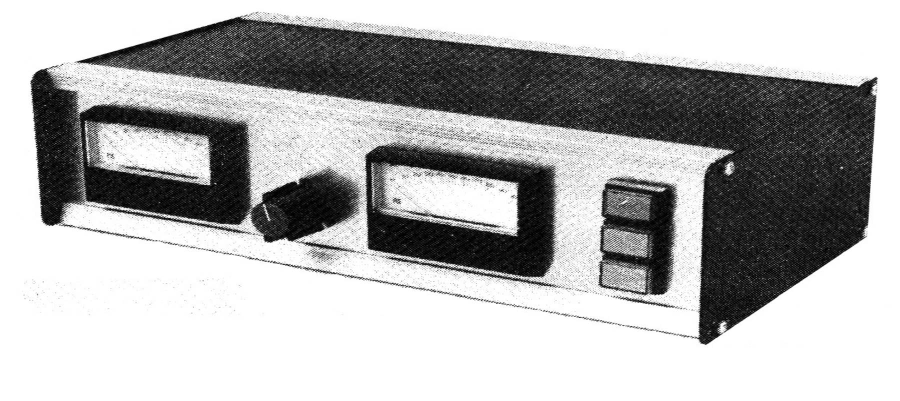
Only one calibration is necessary. The meter should now read correctly on both power settings.

If you are keen to check, you can make readings at other power levels and make sure that the power meter agrees. Either multiply the RMS voltage and current readings together, or square the voltage reading and divide by ten (for a ten ohm resistor).

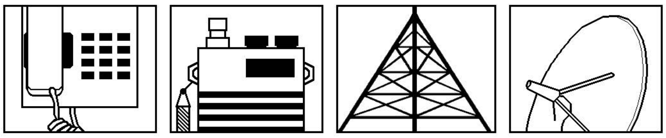
You'll notice I haven't said anything about setting RV2. This makes very little difference to the readings, and should be left at the centre of its travel. If you are a perfectionist and have a signal generator and oscilloscope, you can set it up (before making any of the other settings) like this.

Short together the speaker connections on one channel, then connect your signal generator between these connections and the PCB ground. Connect your oscilloscope to display the output from pin 14 of IC3 and adjust RV2 for the minimum output. Then do the same for the other channel.

If you would like to check that the meter does indeed reject the reactive component of the power, you can try running it with a capacitor across the output. A quick search around with your 'scope will show that voltage and current signals are present in the power meter circuit, but the meters move not a jot.



OPEN CHANNEL



Long ago the term was VANs (value added networks). These were communications-based networks connected to the existing public telephone network which could be accessed by individuals or organisations *and* which added value to the network. In other words, any network which a user can dial into through the PSTN — videoconferencing, teletex (*not teletext* that is), certain viewdata networks and electronic mail services, and so on.

Because the term didn't appear to be including data networks and maybe for a few other reasons, too, the Department of Trade and Industry have started to call such networks VADs — valued added and data services. The DTI policy since renaming these networks has also been to broaden the categories of services which are included under the banner, such that any bureau holding a database of any description which can be remotely accessed over the PSTN is now classed as a VAD.

Under the old VAN title, it was often taken that the network must be accessible with the user's own data equipment. But the VAD title no longer assumes this. In fact, even good old TIM, the speaking clock (a database by any other name?) is now a VAD.

A special programme, recently launched by the DTI to promote VADs is a good source of information for prospective users. Contact: DTI, Information Technology Division, 29 Bressenden Place, London SW1E 5DT.

The Number Game

At one stage, it was thought that users dialing into or out of Mercury Communications telephone network, which is rapidly being constructed to compete with BT's PSTN, would have to dial a prefixed number before the actual telephone terminal number.
If a Mercury user in London wanted to call a BT user also in London, the Mercury user would have to dial the London prefix (01), then the BT user's normal seven digit number. This has all changed.
Mercury has always fought against a prefix, on the grounds that a user's telephone number is the property of the user - not the service provider.
The fight has now paid off. A recent agreement between BT and Mercury gives Mercury users numbers of the same form as BT users. The other telephone network service providers, on the other hand (Vodofone and Cellnet) have no such agreement and their users are still lumbered with required prefixes (or is it prefices?).

All In the Exchange

Many moons ago, I reported on a new type of telephone exchange connection which could effectively decimate small to medium users' telecommunications bill. It was to be called Centrex.

Generally, exchange connections at present are through private automatic branch exchanges (PABXs). With a PABX, a company has an internal telephone network, with a number of extension terminals but only a restricted number of exchange lines. The number of extensions and the number of exchange lines depends directly on the PABX used. To dial another extension, a user simply dials the extension user. Dialling out onto the PSTN, however, is a matter of dialling a prefix number (typically, 9) to get 'an outside line', then dialling the required telephone number. Users can either buy or rent the PABX equipment.

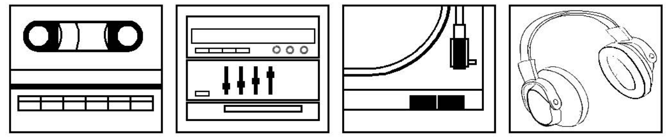
With Centrex, on the other hand, no PABX equipment is required. Instead, part of the local exchange becomes allocated to the user as a quasi-PABX. This means that all 'internal' calls as well as those dialled out are actually made through the local exchange. This, in turn, means that a greater number of exchange lines are required, but generally costs will be down.

Centrex also has the advantage of flexibility. Some services which cannot be included through a PABX (or which can only be included if the PABX is highly specialised) can easily be incorporated via Centrex. Furthermore, the addition of extra extensions or facilities (say, if the user's company is growing) can be incorporated without delay or the need to exchange obsolete equipment.

Although commonplace in (guess where!) North America, it's taken a bit of time to reach the UK. However, it's looks as though Centrex is on its way here at last. Users should be on the look out for Centrex services (probably launched in the City of London) by the start of next year.

Keith Brindley

PLAYBACK



The imminent arrival of DAT (digital audio tape) on the consumer market has record companies worried. They believe that DAT will encourage home copying on such a scale that record, cassette and CD sales will slump. There are reports of an effective 'spoiler' system, which protects copyright recordings with a signal in the audio band.

Such a signal could not be (illegally) filtered without damaging the audio quality but it is claimed not to affect the sound otherwise. An audio signal which can neither be heard nor filtered seems a remarkable thing.

This and DAT

DAT is a system for recording sound to 16-bit accuracy on a small format tape cassette, using a rotating, helically scanning head. Playing time could exceed two hours, as against 70 minutes on a Compact Disc. However, players are likely to cost around £800 and may not be available for one or two years yet.

The market penetration of CD is so far only around 5%. A representative of the British Phonographic Institute (BPI) tells me this is because most people will happily listen to poor quality sound — a factor which also allows bootleggers and home recording to flourish. But, she said later, DAT, with its CD-like quality, will encourage a boom in home taping.

Home taping, says the BPI, is far more of a problem than bootlegging (unlicensed copying of recordings for resale). The record industry believes that six times more music is copied in the home that is actually bought. 81 million blank cassettes were imported last year. Many of these are used for computing and for copying speech and non-copyright music but the record industry knows that people are taping records at home because they admit it. It would like them to stop.

The industry has an important point in its favour. Its expenses are vast. An enormous amount of money is needed to sponsor, develop, record, promote and market the artistes who bring in the capital. It the customers steal the product without paying for it, one day there will be no industry and no product. Everybody loses.

The record industry has pressed for a levy on blank tape to cover lost royalties. This has not happened yet but legislation is under consideration in the UK, the USA and in the European Parliament.

DAT worries them even more than this. They want to forbid the manufacture or import of DAT recorders unless these incorporate a circuit inside the main LSI chip which will search for a special signal in new copyright material, and switch off the recording.

DAT manufacturers say that they will use a different sampling rate from CD, so that direct digital recording will not be possible. The signal will have to be converted to analogue and back. In this case, any spoiler using signals outside the audio range can be thwarted by filtering out the signals.

The spoiler system invented by CBS works by cutting a notch out of the audio spectrum at a frequency above the top fundamental of most instruments. The notch is switched in and out in a pattern that the recorder recognises.

Already, there is a bizarre rumour that non-protected recordings will be made available, at a much higher price.

The record companies are also worried that even if DAT is 'spoilt' it will split the market away from their investment in CD. This is not a problem for the Japanese because CD has already peaked there. Their manufacturers need DAT as the next boom item.

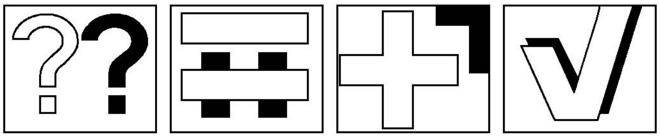
Myopia

Trying to raise market share by restricting access to new media strikes me as a short sighted view. I doubt that there is a one-to-one relationship between records casually copied and lost sales. Buyers have only so much money to spend and most would rather choose a properly packaged piece of vinyl for essential musical purchases, only making-do for non-essentials. If the going gets tight, they are likely to decide that they can do without.

The record companies have principle on their side but there does seem to be a place for allowing customers to copy their purchases for private use, if only to maintain a degree of goodwill towards the music business in general. If a consumer industry wages war on the consumer both sides are likely to lose. DAT will lead to MAD.

Andrew Armstrong

ALF'S PUZZLE



The news that Alf was leaving came as a shock to all of us. Things just won't be the same around the ETI offices without his coffee stains on our circuit diagrams and his half baked ideas to keep us all amused. 'Never mind, Alf,' we told him. 'One day next week we'll have a surprise party for you.'

That very afternoon, John Bird came across Alf looking utterly miserable. 'Cheer up, old chap,' said John. 'You can always change your mind, you know.'

'It's not the thought of leaving that's upset me,' moaned Alf. 'It's just that I've worked out that there won't be a party for me.'

'What makes you think that?' asked John. We've told you we're going to arrange one for next week but we can't tell you the day or it won't be a surprise.'

'That's just it,' said Alf. 'If it's got to be a surprise, I can't have a party at all. If you arrange it for Friday it won't be a surprise because on Thursday I'll know that it *must* be tomorrow. But if you arrange it for Thursday, it won't be a surprise because on Wednesday I'll know that it can't be on Friday, and so I'll be expecting it on Thursday. But since it won't be a surprise if it happens on Thursday or Friday, on Tuesday I'll know it's got to be on Wednesday, so that won't be a surprise either. The same applies to Tuesday, so I'm expecting the party on Monday. But then if it is on Monday that won't be a surprise either, so I can't have a surprise party at all.'

'I dare say you're right,' said John.

Alf's party was on Thursday, and since he wasn't expecting one at all, he was surprised!

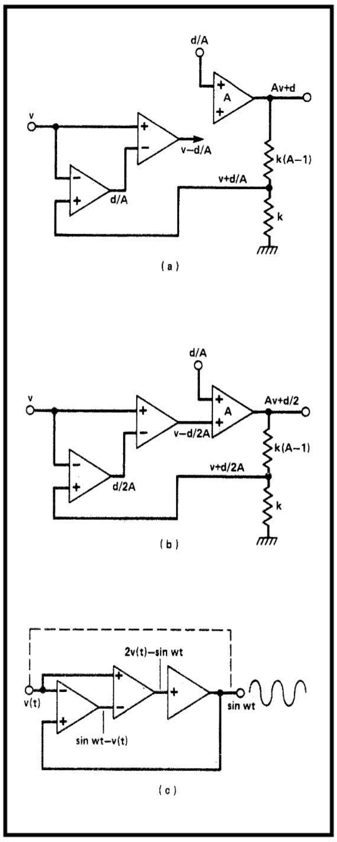
April's Puzzle

If you followed the reasoning behind the April issue puzzle, I'm sure you have had not the slightest difficulty in spotting the fallacy. If you complete the loop in Fig. 1a (reproduced from last month), the distortion is actually halved, not reduced to zero (Fig. 1b). It seems that we are still getting something for nothing — half the distortion without loss of gain. Is this an improvement on negative feedback or just another illusion? (The reduction in distortion is real enough, but is the apparent advantage over NFB genuine?) I'll leave you to work out that one for yourselves.

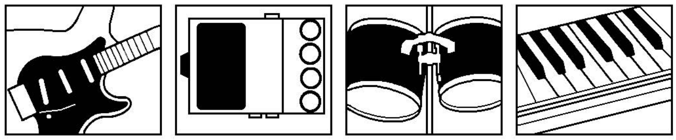
In case you think the bizarre conclusions are a result of Alf's 'muddling', here's a little sleight of hand without the controversial imaginary input. First of all, take Alf's circuit and decide what you'd like the output to be. Let's say a sine wave. We don't know what the input is at the moment, so we'll just call it v(t). Fig.1c shows that Alf's circuit will feed an input of 2v(t)—sin(wt) to the input of the amplifier (I've made it unity gain and got rid of the resistors for clarity — you can put them in if you like).

If we feed the output back to the input we now know what v(t) is: it's sin(wt). The input to the amplifier is now 2sin(wt) − sin(wt) = sin(wt), giving an output of sin(wt) which is fed back to give an input of sin(wt), which produces an output of sin(wt)...

OK, so there's nothing special about a sine wave generator, but I chose the sine wave completely at random. A lucky choice? Try it with a square wave, or anything else you choose — it will sustain any waveform whatsoever! The ETI universal function generator will *not* appear as a project, for reasons I'll leave you to work out for yourselves.



KEYNOTES



Frederick the Great, King of Prussia, was a busy man well known for his success in military defence strategy and international politics. Despite these obviously taxing commitments he was also a highly competent and active musician with a keen interest in any new music technology.

When a brand new synth known as the Piano-Forte came on the market, King Fred bought one immediately and was so enthralled by its sound synthesis capabilities that over the following years he purchased no less than 14 more in order to stay abreast of endless design updates.

Pianos soon became all the rage in Europe. Even J.S. Bach dropped in at the palace one evening to try them out. The rest, as they say, is history.

The piano has either two or three oscillators per note, a velocity-sensitive keyboard and a single (preset) output filter. Timbre is essentially fixed, envelope control limited, recalibration is required frequently, transportation is impractical and MIDI retrofits are unavailable.

It is therefore rather interesting to note that the machine is still widely acclaimed to be the best keyboard around and remains in production today, even in Japan.

It has to be said that there is more to the popularity of the piano than mere conservativism or nostalgia — beyond any shadow of a doubt its sound has a subtle and elusive quality that seems to defeat the best electronic instruments altogether.

Unnatural Practices

It is often argued that electronic instruments are unnatural. All musical instruments are contrived artifacts which at their time of development represented high technology.

It is normal for any new type of instrument to have its own characteristic sound and certainly this has always been true of synths. A synth sound is almost invariably recognisable as such and certainly not displeasing when used with creative imagination in an appropriate musical context.

The saxophone, electric guitar and synth have all been initially blamed of sounding unnatural, before being granted a grudging acceptance into the world of purists and stuck-in-the-muds. But the story does not quite finish there.

Over the course of time public familiarity with electronic music has led to the use of the word electronic as an appropriate adjective to describe any sound that is monotonous and lifeless or machine-like. This sentiment is very widespread and cannot be attributed entirely to unimaginative use of the instrument as has often been argued.

Good Character

Descriptions like *soul, character* and *expression* do no more than hint vaguely at the exact technical nature of the problem, even though their subjective meaning is intuitively quite clear. The best that we can do at the current time is to treat the output signal with chorus and reverberation effects in order to obscure its intrinsic deficiencies.

This state of affairs is indeed a poor show for a machine that originally held forward the promise of being able to synthesise any given sound.

Synthesis techniques are frequently pigeon-holed into three categories — subtractive, additive and contrived. Contrived techniques are pragmatically defined as those which do not fit in either of the other two groups and include methods such as FM, waveshaping and discrete summation formulae. However, there are not yet any popular techniques in any of the three categories which are capable of accurately modelling acoustic instruments in practice.

A possible exception is additive synthesis — the sledge hammer method of painstakingly building up a sound out of individual sine waves, each with its own intricate frequency and amplitude time envelopes. However, many acoustic instruments can only be satisfactorily imitated by specifying upwards of a hundred of such components, rendering additive synthesis as laborious to the musician as it is demanding of the hardware.

So what synthesis technique do acoustic instruments themselves use? Partial differential equations which 'acousticians' have not yet done enough work on.

Far from coming to maturity, music synthesis is merely leaving its infancy

Bruno Hewitt

ETI PCB SERVICE

Build your projects in style with a properly designed PCB.

Use the form below (or a photocopy) for your order. Please fill in all parts of the form.

The board reference number tells you when the PCB foil was published. The first two numbers are the year and the next two the month. The number after the dash indicates the particular project in that issue.

The terms are strictly cash with order. Make cheques payable to ASP Ltd. We cannot accept official orders but we can supply a pro-forma invoice if required. Such an order will not be processed until payment is received.

Orders can also be made by telephone on (0442) 211 882 for Access and Visa card holders.

Please allow 28 days for delivery.

Price Code	Price (inc VAT) £
C	1.80
D	2.50
E	3.23
F	4.00
G	4.75
H	5.50
J	6.62
K	7.20
L	8.80
M	10.60
N	13.10
O	15.80
P	17.90
Q	21.80
R	23.90
S	25.90
T	29.00
U	32.20
V	35.80
W	37.90
X	40.70

TO: ETI READERS SERVICES DEPARTMENT
Argus Specialist Publications Ltd,
9 Hall Road, Hemel Hempstead,
Herts HP2 7BH

Please supply:

No. required per type	Board reference number	Price letter	Price each £		Total for board type £	
	E		£	p	£	p
	E		£	p	£	p
	E		£	p	£	p
	E		£	p	£	p

POSTAGE & PACKING £ 0.75p

TOTAL ENCLOSED £ p

ORDER TO BE SENT TO: (BLOCK CAPS PLEASE)

Name ....

Address ....

....

....

Postcode ....

(Make cheques payable to ASP Ltd)
ACCESS and VISA credit card orders can be taken on (0442) 211 882 (office hours only).

E8107-1	System A Disc Input bd MC-MM	F
E8107-2	System A Preamplifier Main	K
E8108-1	System A Power Amp	L
E8109-2	System A PSU	F
E8201-2	Infant Guard	C
E8202-5	MM Stage Disc Preamp (Tilsbrook)	G
E8206-5	Logic Lock	F
E8208-1	Playmate Practice Amp 3bds SA1	K
E8212-1	ELCB	F
E8301-2	Analogue to digital conv (ZX81/Spectrum)	E
E8305-3	Dual Audio Power Supply, Linsley Hood	G
E8305-5	Balanced Input Preamplifier	F
E8307-2	Flash Trigger-sound or FR	F
E8308-1	Graphic Equaliser ⅓ Oct/Chnl	M
E8308-2	Servo Fail-safe	C
E8309-1	NICAD Charger/Regenerator	F
E8310-3	Typewriter Interface - EX42	F
E8311-1	Mini Drum Synth	F
E8311-8	Moving Coil Pre-Preamp	F
E8312-3	Light Chaser EPROM Controlled (2 Boards)	K
E8402-1	Speech Board	M
E8402-2	Modular Pre-amp Disc Input Mono	F
E8402-3	Modular Pre-amp Stereo Output	F
E8402-4	Modular Pre-amp Relay, PSU	F
E8402-5	Modular Pre-amp Tone Main Mono	F
E8402-6	Modular Pre-amp Tone Filter, Stereo	F
E8402-7	Modular Pre-amp Balanced Output	F
E8402-8	Modular Pre-amp Headphone Amp	F
E8404-2	Mains Remote control Receiver	F
E8405-1	Auto Light Switch	F
E8405-2	ZX81 EPROM Programmer	N
E8405-3	Mains Remote Control Transmitter	H
E8405-4	Centronics Interface	F
E8405-6	Drum Synth	F
E8406-1	Oric EPROM Board	O
E8406-2	Spectrum Joystick	E
E8406-3	Audio Design RIAA Stage	G
E8406-4	AD Buffer/Filter/Tone	H
E8406-5	AD Headphone Amp	F
E8406-6	AD Preamp PSU	K
E8406-7	AD Power Amp	H
E8406-8	AD Power Amp PSU	J
E8406-9	AD Stereo Power Meter	F
E8406-10	AD Input Clamp	C
E8407-1	Warlock Alarm	M
E8408-2	EPROM Emulator	N
E8408-3	Infrared Alarm Transmitter	E
E8408-4	Infrared Alarm Receiver	F
E8409-1	EX42 Keyboard Interface	F
E8409-2	Banshee Siren Unit	F
E8410-1	Echo Unit	F

E8410-2 Digital Cassette Deck .... N
E8410-3 Disco Party Strobe .... H
E8411-5 Video Vandal (3 boards) ..... N
E8411-6 Temperature Controller ..... D
E8411-7 Mains Failure Alarm .... D
E8411-8 Knite Light .... D
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
E8412-7 Active - 8 Equaliser .... F
E8501-3 Digital Delay (2 boards) ...... T
E8502-1 Digital Delay Expander ...... N
E8502-2 Data Logger .... J
E8503-1 Combo Preamplifier .... F
E8503-2 THD Meter mV & oscillator bds (2 boards) .... K
E8503-3 THD Meter Mains PSU .... F
E8504-1 Framestore Memory .... M
E8504-3 Framestore Control .... N
E8504-4 Buzby Meter .... E
E8504-5 CCD Delay .... F
E8505-5 Stereo Simulator .... F
E8506-1 Audio Mixer Main .... J
E8506-2 Audio Mixer PSU .... F
E8506-3 Audio Mixer RIAA .... D
E8506-4 Audio Mixer Tone Control ... D
E8506-5 EPROM Prog MKII .... O
E8508-1 RCL Bridge .... N
E8508-2 EX42/BBC Interface .... E
E8508-3 EPROM Emulator L
E8509-1 Spectrum .... F
E8509-2 Direct Injection Box .... E
E8510-9 Sunrise Light Brightener ...... K
E8511-1 MTE Waveform Generator ... H
E8511-2 Millifaradometer .... H
E8511-3 Cymbal Synth .... J
E8511-5 Chorus Effect .... H
E8511-7 Enlarger Exposure Meter ..... F
E8511-8 Switching Regulator .... E
E8511-9 Second Line of Defence ..... M
E8512-1 Specdrum connector .... F
E8512-2 MTE Pulse Generator .... H
E8511-3 Specdrum L
E8601-2 Walkmate L
E8601-3 MTE Counter-timer .... M
E8602-1 Digibaro .... O
E8603-2 Programmable Logic Evaluation Board .... H
E8603-3 Sound Sampler Analogue Board .... R
E8604-1 JLLH PA PSU .... H
E8604-2 Matchbox Amplifier C
E8604-3 Matchbox Amp Bridging Version C
E8604-4 MTE Analogue/Digital Probe .... M
E8605-1 Microlight Intercom .... E
E8605-2 Baud Rate Converter .... M
E8605-3 Baud Rate Converter PSU Board .... G
E8605-4 Portable PA .... H
E8606-1 Midi-CV Converter Board .... H
E8606-2 Midi-CV Converter PSU ..... D
E8606-3 Troglograph .... F
E8606-4 80m Receiver .... H
E8606-5 Sound Sampler .... R
E8607-1 Direction .... E
E8607-2 Upgradeable Amp, MC stage (Stereo) .... G
E8607-3 BBC Motor Controller .... F
E8608-1 Digital Panel Meter .... G
E8608-2 Upgradeable Amp, MM stage (mono) .... H
E8609-1 Mains Conditioner .... E
E8609-2 Experimental preamp .... F
E8609-3 Upgradeable amp, Tone board (mono) .... H
E8609-4 Upgradeable amp, Output board (mono) .... F
E8610-1 Audio Analyser Filter Board L
E8610-2 Audio Analyser Display Driver .... K
E8610-3 Audio Analyser Display .... H
E8610-4 Audio Analyser Power Supply .... F
E8611-1 Audio Switcher (2 bds) .... H
E8611-2 PLL Frequency meter (4 bds)...Q
E8611-3 Upgradeable Amp PSU .... J
E8611-4 Call meter, main bd .... O
E8611-5 Call meter, interface bd ...... N
E8612-1 Bongo Box .... J
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
E8701-6 Tacho-Dwell .... F
E8702-1 Ratemeter main board .... K
E8702-2 Ratemeter ranging board ..... F
E8702-3 Photo Process Controller (3bds) .... O
E8702-4 LEDline display board (2 off) .... K
E8702-5 LEDline PSU and controller (2 bds) .... G
E8703-1 Capacitometer .... F
E8703-2 Geiger Counter L
E8703-3 Credit Card Casino .... E
E8704-1 BBC micro MIDI interface L
E8704-2 ETIFaker patch box .... H
E8704-3 24Hr. Sundial .... E
E8705-3 MIDI Keyboard keyswitch bds (3 bds) .... W
E8705-4 Batlite C
E8705-5 Budget Power Meter ...... E
E8706-1 Hi-fi Power Meter .... N
E8706-2 MIDI Keyboard CPU .... U
E8706-3 MIDI Keyboard Front Panel ...... O
E8706-4 Flame Simulator .... G

OOPS!

Digital Audio Selector (November/December 1986 and January 1987)

In Fig. 5 (December 1986) the resistors shown as R14 and R114 should be R19 and R119. This error is continued in the discussion of gain setting in the January 1987 issue.

The DG507A IC used in the prototype came from Farnell Electronic Components of Leeds, Tel: (0532) 636 311 Farnell normally deals only with trade customers but private orders are sometimes handled at the company's discretion. Trilogic of 29 Holm Lane, Bradford BD4 OQA, Tel: (0274) 684 289 will obtain any Farnell component to order on payment of a 25% handling charge. The Farnell order code is simply the full device number DG507ACJ.

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. The byte at location BF should read ?F.

The Better Flanger January 1 1987)

In the circuit diagram (Fig. 2) D1 is not labeled. 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.

Photo Process Controller (February 1987)

In the circuit diagram (Fig.2) the cathodes of diodes D3,5 are shown connected to 0V. They should connect to the junction of R16,17,18. In the overlay diagrams (Figs. 3 and 5) the flying leads are numbered incorrectly. Leads 7, 8, 9 and 10 at the top of Fig. 3 should be numbered 16-19. In Fig. 5 leads 6 and 8 from the top of R13 should be numbered 16 and 17. Numbers 9 and 10 from Q1 and Q2should be 18 and 19. In addition the leads 11 and 'A' should be swapped.

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.

BBC Micro MIDI Interface (April 1987)

IC7 and IC8 (the 6N139 opto-isolator ICs) are missing from the parts list. In the Buylines section it is incorrectly said that these are available from Electromail as part 302-126. The isolator is available from Maplin as part number RA59P. Resistors R8,9 are missing from the overlay diagram (Fig. 4). These are located in the two pairs of pads below IC6. There should also be no 0V connection to the MIDI IN sockets, only to the OUT sockets (pin 2 so as to prevent earth loops.

Super alpha electronics

Dept ETI, P.O. Box 21,
Selsey, Chichester,
West Sussex PO20 0TH
Access 0243 607108 Barclaycard VISA

TRANSISTORS

BC107	15
BC107A	15
BC107B	15
BC108	15
BC108A	18
BC108B	15
BC108C	15
BC109	18
BC109B	18
BC109C	18
BC182	12
BC182B	12
BC183	12
BC183B	12
BC184	12
BC212	12
BC212B	12
BC213	12
BC213B	12
BC214	12
BC327	16
BC337	16
BC548	12
BCY70	22
BCY71	22
BD131	60
BD132	60
BD135	34
BD136	35
BF258	60
BFX85	40
BFX88	40
BFY50	37
BFY51	37
BFY52	39
TIP31	42
TIP31A	48
TIP31B	56
TIP31C	54
TIP32A	42
TIP32C	42
TIP33A	100
TIP41A	63
TIP42A	55
TIP3055	76
TIP2955	76
ZTX300	17
ZTX500	17
2N3053	60
2N3054	160
2N3707	12
2N3703	12
2N3705	12
2N3771	140
2N3904	15
2N3906	15

DIODES

IN4001	5
IN4002	5
IN4003	6
IN4004	6
IN4008	6

TRIACS

3 Amp 400V	75
8 Amp 400V	90

OPTO ISOLATORS

TILTIL111 transistor o/p	110
TIL 113 Darlington o/p	120
3021 Triac driver	150

LEDs

T1¾ 5mm

Red	18
Yellow	18
Green	18
Super bright t1¾ 5mm Red	35

ZENER DIODES

BZY88C 500m W	
4V7	10
10V	10
12V	10
BZX55C 500m W	
24V	10
BZX85C 1.3 Watt	
4V7	20
10V	20
12V	20
24V	20

VOLTAGE REGULATORS

LM317T +1.2V to 37V	150
LM341P +5V	60
LM7905 -5V	70

BRIDGE RECTIFIERS

W004 1.5A	50
6005 6A	90

CAPACITORS

Electrolytic

47uF	25V	10
100uF	25V	12
470uF	25V	28
1000uF	25V	36

Tantalum

.1uF	35V	10
.22uF	35V	10
.47uF	35V	10
1uF	35V	10
2.2uF	35V	15
4.7uF	35V	20

Ceramic

220pF	500V	6
470pF	500V	6
1000pF	100V	6
2200pF	100V	6
4700pF	100V	6

RESISTORS

Metal Film 5%
⅓ Watt

100R 680R 1K 1K2 2K2 4K7 5K6 6K8 10K 12K 15K 22K 27K 33K 39K 47K 56K 68K 82K 100K 120K 150K 180K 220K 270K 330K 390K 470K 560K 680K 820K 1M **2p**

SKELETON PRESETS

Horizontal	19
Vertical	19

LINEAR ICs

741	18	NE5532	120	LM308	70
555	30	NE5534	80	TL081	50
556	65	ZN414	90		
LM301	28	ZN416	160		

B.T. APPROVED TELEPHONES

B.T. Statesman with last number redial	Stone	31.26
	Brown	31.26
	Maroon	31.26
	Grey	31.26
B.T. Viscount with last number redial	Beige	26.04
	Ice Grey	26.04
	Red	26.04
	White	26.04

B.T. cordless Freeway 700ft range security coded, last number redial with base paging,
Ivory **85.00**

Carriage on telephones and telephone accessories **£1.50**
Add 15% VAT to total. Allow ten days for delivery.

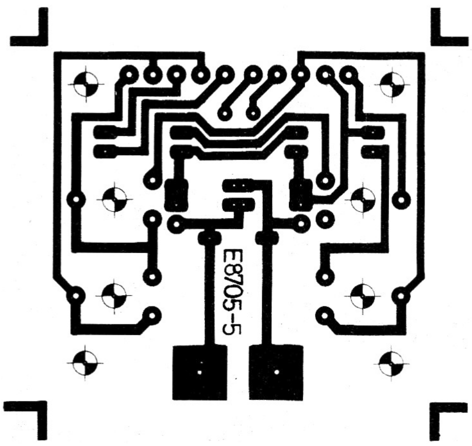
Super Alpha Guarantee

All components brand new and by top manufacturers to full specification.

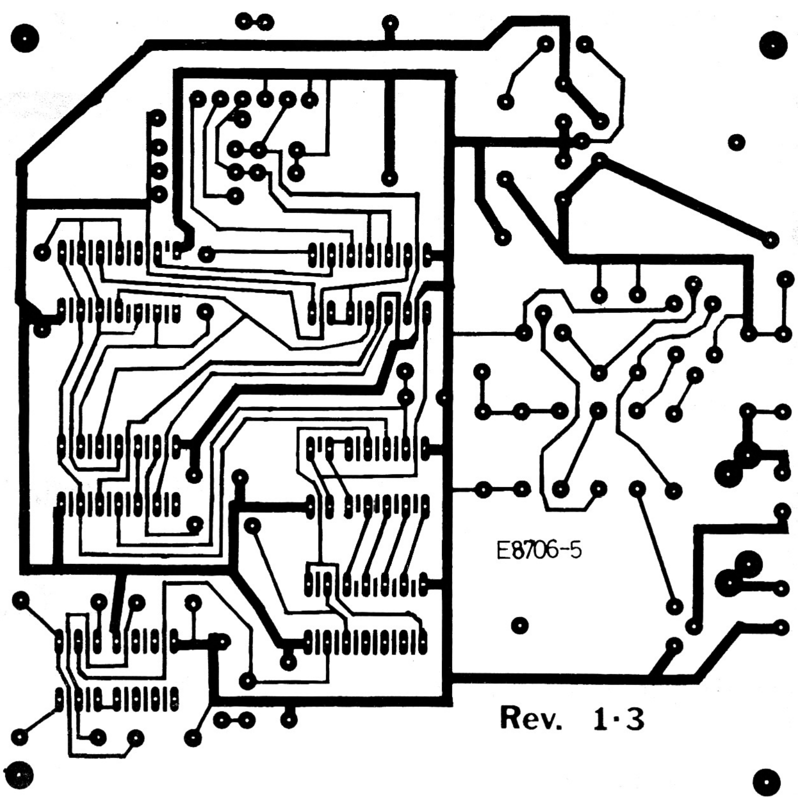
ORDERING: Cash, Postal-Order, Access or Visa, orders despatched same day by first class post. Add **50p** p&p to order then add 15% VAT. Telephone orders welcome with Access or Visa, orders accepted by answer service outside office hours. Overseas orders add **£2.00** no VAT. Prices subject to alteration.

PCB FOIL PATTERNS

Due to lack of space the foil for the front panel board from the MIDI Master Keyboard has been held over until next month.

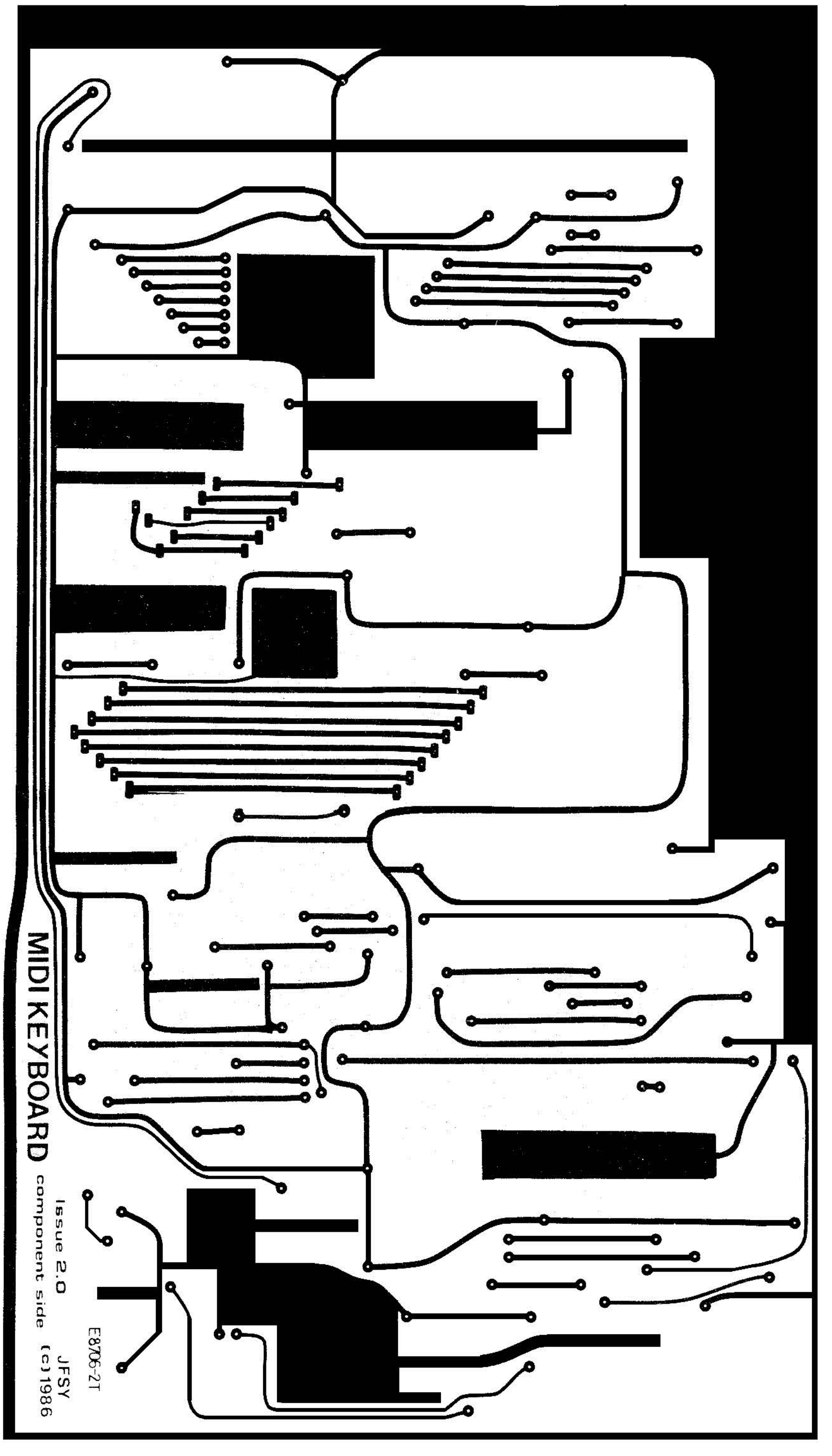


The foil for the budget power meter which was incorrectly given half full size last month.



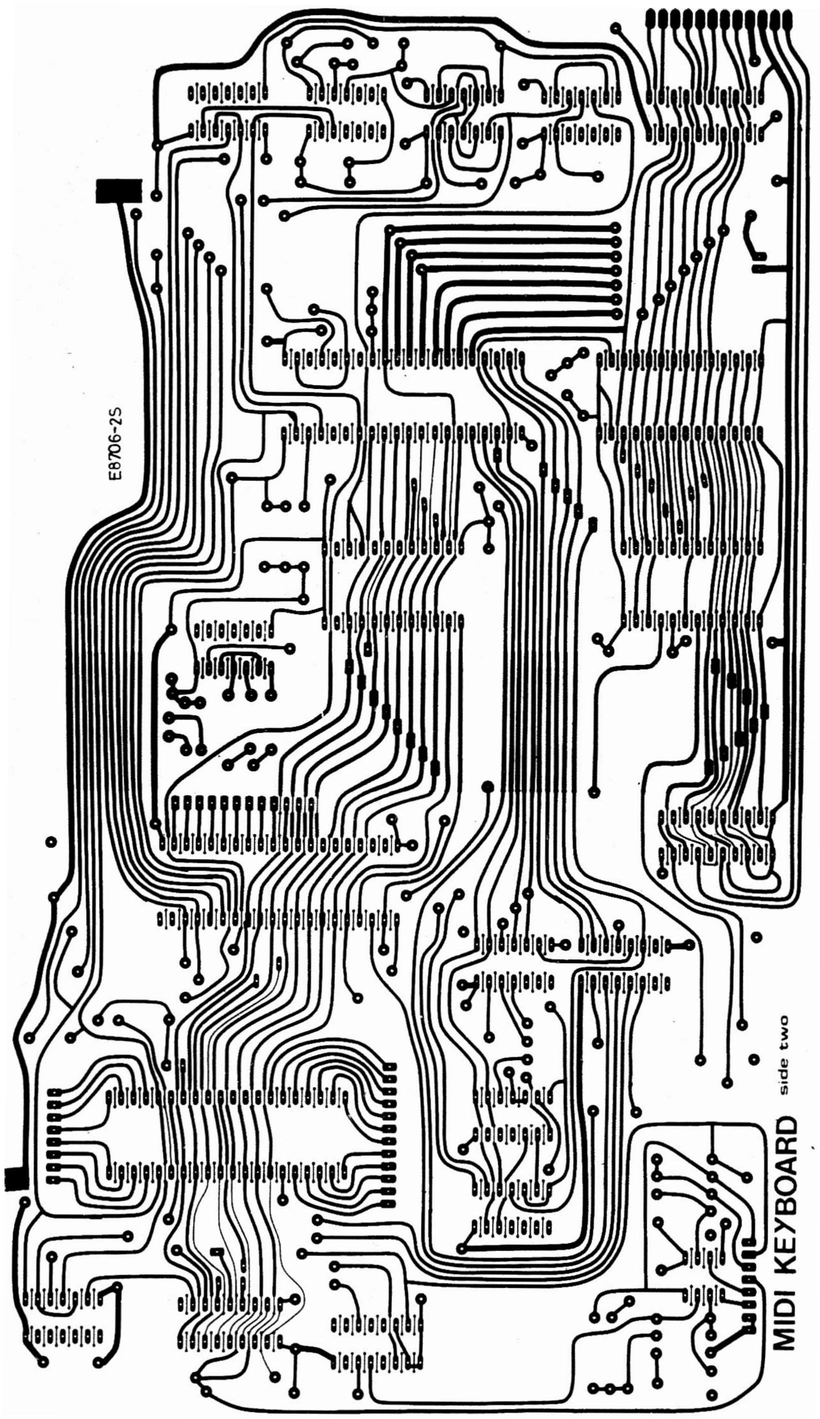
The Flat Alarm foil pattern.

PCB FOIL PATTERNS



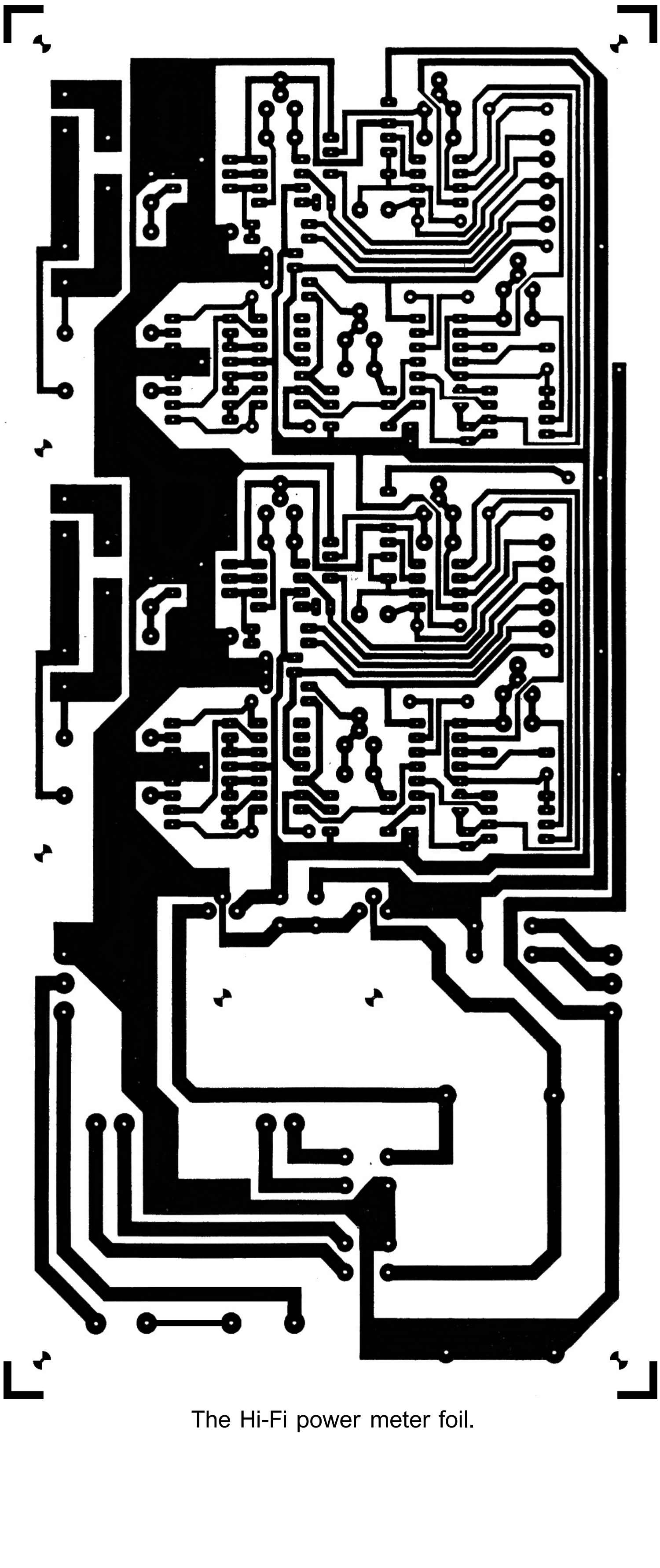
The topside foil for the MIDI Master Keyboard CPU board.

PCB FOIL PATTERNS



The solder side foil for the MIDI Master Keyboard CPU board.

PCB FOIL PATTERNS



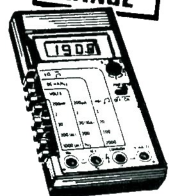
The Hi-Fi power meter foil.

INSTRUMENTS FROM STOCK

UK's LARGEST IN-STOCK RANGE

DIGITAL MULTIMETERS

105 14 Range 2A OC. 2 Mohm	£24.75
528 14 Range 0.2A OC. 2 Mohm Hfe text	£29.95
615 19 Range 10A OC. 20 Mohm Hfe West	£34.95
6010 28 Ranga 10A AC/OC 20 Mohm (0.2MAAC/OC)	£38.53
578 20 Range 10A AC/OC 2M. Buzzer Display Hold Auto Ranga Memory (20MAAC/OC)	£39.68
5010 28 Range 10A AC/OC 20 Mohm (20mAAC/OC)	£41.98
5010EC 34 Ranga 10A AC/OC 20 Mohm Hfe test Capacitance test. Conductance	£59.95
ME540 Auto/manual 10A AC/OC 20M	£48.30
6013 Digital Capacitance meter B ranges 200pf-2000 MFO	£63.25



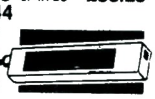
ANALOGUE MULTIMETERS

101515 Range Pocket 10K/V	£8.63
1035 19 Ranga Pocket 20K/V 10A OC 10 Mohm	£11.95
103BZ 19 Range 20K/V 10A OC Hfe Buzz 10 Mohm	£14.50
201 19 Range 20K/V 12A AC/OC 10 Mohm	£17.95
2010 20 Ranga 30K/V 10A OC 20 Mohm	£21.95
3010BZ 24 Range 30K/V 10A OC Buzz Mohm	£23.95
830A 26 Range 30K/V 10A AC/OC 10 Mohm	£28.95
5050E 41 Range 20MEG FET 12A AC/OC 1000 MEG	£32.95

POWER SUPPLIES

001c 13.8v 3A DC £14.95
243 0/24v 0/3A DC £49.75
0.30V 1.5A DC £34.44
154 5/15v 0/4A DC £38.25

LOGIC PROBE



07 20MHZ Logic Probe TTL cmos etc £10.95

LCR METER

TC200 Digital LCD Handheld Tester £97.75

STOCKISTS FOR Frequency Counters • Generators • Power Supplies • Tools • Computer Equipment • TV/Video Accessories • Nicads • Communications and Security Equipment • Public Address & Audio • (See catalogue)

OSCILLOSCOPES

UK FREE DELIVERY

HAMEG Dual trace with component testers 8 x 10cm screen:-

203/6 Dual 20MHZ with probes	£361.10
204 with a sweep delay	£480.70
CROTECH with component tester single trace:	
3031 5¼ x 6½cm Display	£228.85
3036 8 x 10cm Display	£253.00
HUNG CHANG	
620 Dual 20MHZ + component test	£339.25
635 Dual 30MHZ Sweep delay	£458.85
615 Dual 15MHZ bat/Mains	£458.85

ALL PRICES INCLUDE VAT

ORDER BY POST OR PHONE. OPEN 6 DAYS A WEEK FOR CALLERS

FREE CATALOGUE Ref TG/E Send s.a.e. (min 12" x 9") with £1 stamp UK Callers/ex. port £1.00

HENRY'S electronics
301 Edgware Road. London W21BN. 01-724 3564
404 Edgware Road. London W2 1BN. 01-724 0323
EDUCATION/TRAINING & EXPORT SUPPLIED

OSCILLOSCOPES

TELEQUIPMENT D75 Dual Trace 50MHz Delay Sweep £325
COSSOR CDU150. Dual Trace 35MHz Solid State Portable 8×10cm display. With Manual £200
S.E. LABS SM111. Dual Trace 18MHz Solid State Portable AC or External DC operation 8×10cm display. With Manua £165
TELEQUIPMENT D61 Dual Trace 10MHz. With Manual £150
TELEQUIPMENT D43. Dual Trace 15MHz. With Manual £100
SOLARTRON CD1400 Dual Trace 15MHz. With Manual £100
TELEQUIPMENT S54A. Single Trace 10MHz. Solid State. With Manual £110
PHILLIPS PM3200 Single Trace 10MHZ £80

MULTIMETERS

AVO 9 Mk 4 (Identical to AVO 8 Mk 4 but scaled differently) Complete with Batteries & Leads... £55
AVO 8 Mk 2 Complete with Batteries & Leads £45
Above Items in GOOD WORKING ORDER - appearance not A1 hence the price
AVO TEST SET No 1 (Military version of AVO 8) Complete with batteries, leads & Carrying Case £65
AVO Model 7x. Complete with batteries. leads & carrying case £40
AVD Model 72 Pocket Multimeter (Analogue) 30 ranges. With Batteries & Leads £10
ANALOGUE POCKET MULTIMETERS. Philips/Taylor etc. With Batteries & Leads .... from £10

ADVANCE/GOULD DVM5
Auto ranging; max reading 20.000 AC/DC volts res stance only £50 p&p £5

AVO TRANSISTOR TESTER TT169
Handled. GO/NO GO for in-situ Testing. With batteries. leads & instructions.(p&p £3) **NOW ONLY £12**

ISOLATING TRANSFORMERS
240V INPUT - 240V OUTPUT
500 VA £15ea P&P £5 100 VA £6ea P&P £2
240V Input 24V500VA output £6 p&p £5
240V Input 24V200VA output £4 p&p£4

DISK DRIVE PSU.240V IN: 5V 1.6A & 12V 1.5A out. Size: W125mm. H75mm. D180mm. Cased. Un-used. Only £10.00 each (P&P £2)
Qwerty keyboard (as in Lynx Micro). Push to make. Cased .... £5 each (P&P £2)

Various 5¼" Floppy Disk Drives and Stepping Motors Available

COMMUNICATION RECEIVERS
Racal RA17L 500kHz-30MHz ... **ONLY £140 each** with manual
Eddystone 730/4 480KHz-30MHz only £110 each with manual.

SPECIAL OFFERS
B + K Precision CRT Restorer/Analyser Model 467. Supplied with 2 bases and Manual. (P&P £7) **ONLY** .... £125 each
LABGEAR Colour Bar Generator KG1. 8 Test Patterns. (P&P £4) .... **ONLY £40 each**

STEPPING MOTORS

Type 1	200 Steps per rev. 4 Phase (5 wire) 12 24V Torque 25oz inch will run on 5V with reduced torque .... £15 ea
Type 2	6/12 Steps per rev 3 Phase 12/24V (will work on 5V) £2 ea 5 off £7.50
Type 3	NORTH AMERICAN PHILIPS 24 Steps per rev. 4 wire 5V 3.3Amps 0 250rpm 0 200 PPs .... £6 ea
Type 4	200 steps per rev. 120V (3 wire) Torque 25oz inch .... £4 ea
Type 7	WARNER 24 Steps per rev. 3 Phase (6 wire) .... £5 ea

ADVANCE AM SIGNAL GENERATOR Type 62. 150KHz-220MHz £30
RACAL 32MHz UNIVERSAL COUNTER TIMER Type 836 .... £50
MARCONI TF2604 (Later version of TF 1041 VTVM) 20Hz-1500MHz; AC/DC/Ohms AC 300mV-300V FSO £60
PHILIPS COLOURBAR GENERATOR typr 5508 Video out. Many Functions £125

NEW EQUIPMENT

HAMEG OSCILLOSCOPE 605 Dual Trace 60MHz Delay Sweep Component Tester £583
HAMEG OSCILLOSCOPE 203 6 Dual Trace 20MHz. Component Tester with 2 Probes £314
All Other Models Available

BLACK STAR FREQUENCY COUNTERS P&P £4
Meteor 100 - 100MHz £99
Meteor 600 - 600MHz £126
Meteor 100 - 1GHz £175
BLACK STAR JUPITOR 500 FUNCTION GENERATOR Sine/Square/Triangle 0 1Hz - 500KHz P&P £4 £110

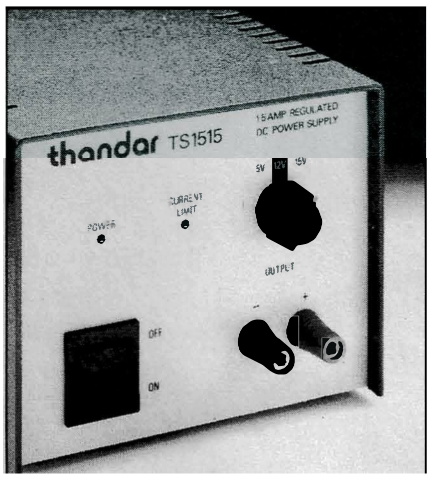
HUNG CHANG DMM 7030. 3½ digit. Hand held 28 ranges including 10 Amp AC/DC 0.1%. Complete with Battery and Leads P&P £4 .... £39.50
As above DMM6010 0 25 % £33.50

OSCILLOSCOPES PROBES Switched x1; x10 P&P £2 .... £11

Used equipment - with 30 days guarantee. Manuals supplied if possible.
This is a VERY SMALL SAMPLE OF STOCK. SAE or Telephone for Lists. Please check availability before ordering. CARRIAGE all units £16. VAT to be added to Total of Goods & Carriage.

STEWART OF READING
110 WYKEHAM ROAD, READING, BERKS RG6 1PL
Telephone: 0734 68041 Callers welcome 9 am - 5.30 pm Mon.-Fri. (until 8 pm Thurs.)

POWER SUPPLIES



TS1515 **£75 + VAT**

Output switchable to 5V, 12V or 15V.
1.5A max; protected output.
Line and load regulation <0.5%.

TS3021 **£150 + VAT**

0–30V by coarse and fine controls.
0–2A by log control.
Dual 3.5 digit LCD readout of V and I.
Constant V or constant I Modes; protected output.
Line and load regulation <0.01%.
Ripple and noise <1mV; low radiated and conducted interference.

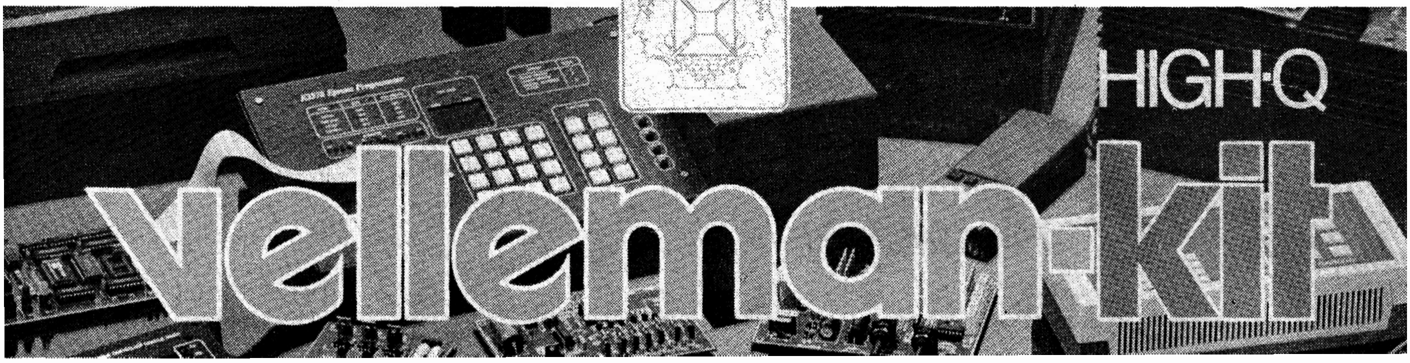
TS3022 **£280 + VAT**

Two identical 0–30V/0–2A supplies in the same case.

thandar
ELECTRONICS LIMITED

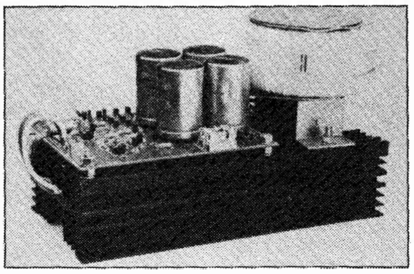
Thandar Electronics Limited.
London Road. St. Ives, Huntingdon.
Cambridgeshire PE17 4HJ, England.
Telephone (0480) 64646 Telex 32250 Test.

THE LOGICAL CHOICE



NOW AVAILABLE FROM ETI READERS SERVICES, 9 HALL ROAD MAYLANDS WOOD ESTATE, HEMEL HEMPSTEAD. HP2 78H

POWER CRAZY



240W HIFI AUDIO POWER AMPLIFIER KIT NR. K2587

The introduction of MOSFET transistors in power amplifiers opened a new area in this field.
Wide power bandwidth, low driving power, high output power and an almost ideal transient response are only a few of the advantages.
This kit is based on this technology. Apart from the power-amplifier, it also includes the power supply, heatsink and transformer. Once assembled, its ready for use and can easily be housed. Only 2 final adjustments are required and only needs a multimeter.

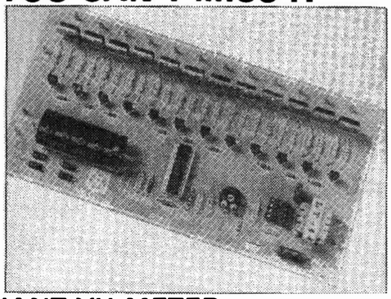
Some applications: Discobars and discotheques - Orchestra or theatre - DC coupled power controls.
- Power supply (including transformer) 2x45 VDC/5A
- 240w music power at 4 Ohm.
- Distortion (1kHz): 0.05%
- Intermodulation distortion: 0.07%
- Input impedance: 33K.

Price £184.80 + p&p

AUDIO LABORATORY D I Y TEST GEAR COMPUTERS TOP QUALITY KITS FOR HOME CONSTRUCTION

velleman-kit

YOU CAN'T MISS IT



GIANT VU METER KIT NR. K2620

Several circuits providing different light effects, from the simple lightorgan to real 'lightcomputers', have already appeared on the market.
This kit is something new... a giant VU meter with 240V bulbs. The 12 bulbs are mounted as a lightcolumn which varies according to the sound level.
The input is galvanically separated and the sensitivity is adjustable, so there is no danger when connected to a pre-amplifier or to a power amplifier.
- 12 triac outputs: 400W each (non-cooled).
- Input impedance: ca. 20 Kohm.
- Input sensitivity: adjustable from ca. 100mV to 3V at full scale.
- Power supply: 9 VAC/0.5A.

Price £36.85 + p&p

K610	VU-LED MONO (UAA 180) USING LED'S	13.74
K611	7W LF AMPLIFIER	7.13
K612	DIMMER 1000 WATTS	7.93
K613	DIMMER DEPARASITE 9 (NOISE SUPPRESSED)	12.60
K1771	FM OSCILLATOR	7.48
K1803	PRE-AMPLIFIER INIVERSAL MONO	5.22
K1804	60 WATT LF AMPLIFIER	23.84
K1823	1 AMP POWER SUPPLY WITH LM317 IC	9.18
K1861	POWER SUPPLY FOR 60 WATT STEREO (K1804)	24.67
K1874	RUNNING LIGHT (4 CHANNEL)	23.70
K2032	LOW COST DIGITAL PANEL METER	26.82
K2532	ADAPTOR SOCKET FOR TMS2532 TO	39.45
K2543	ELECTRONIC TRANSISTOR IGNITION	13.13
K2545	UNIVERSAL CRYSTAL 50HZ TIMEBASE	18.65

VELLEMAN KIT PACKS FOR SCHOOLS

5 quality-components packs and (undrilled) printed circuit boards in one package. Includes Construction manual, data sheet and special instruction for educational experiments. **Incl. VAT**

K 1823 1A POWER SUPPLY or **35.90**
K 2637 2.5 AUDIO AMPLIFIER or **30.60**
K 2644 FROST INDICATOR **41.05**

NEW PRODUCTS

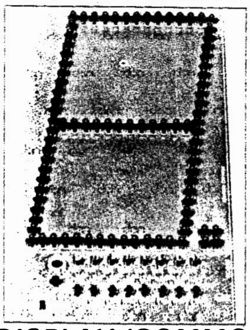
K 2649 THERMOSTAT WITH LCD DISPLAY 53.95
K 2650 TELEPHONE CALL CONTROLLED SWITCH 26.25
K 2651 DIGITAL VOLTAGE METER LCD DISPLAY 31.95
K 2652 TOUCH CONTROLLED DIMMER 14.50

K2549	INFRA-RED DETECTOR TRANSMITTER (ALARM)	17.88
K2550	INFRA-RED DETECTOR RECEIVER (ALARM)	21.37
K2551	CENTRAL ALARM UNIT	25.26
K2553	STEREO DECODER WITH 19KC FILTER	16.26
K2554	HIGH QUALITY FM TUNER	30.30

K2557	DIGITAL PRECISION THERMOMETER	37.68
K2568	20 CM DISPLAY (CATHODE)	31.93
K2569	3 TONE CHIME (DOOR CHIME)	11.23
K2570	POWER SUPPLY 5-14 DC 1AMP	9.18
K2572	STEREO PRE-AMPLIFIER	9.13
K2573	STEREO RIAA CORRECTION AMPLIFIER	10.33
K2574	UNIVERSAL 4 DIGIT UP & DOWN COUNTER WITH COMPARATOR	65.50
K2575	MICRO PROCESSOR DOORBELL (25 TUNES PLUS 1 CHIME)	23.12
K2576	40WATT AUDIO AMPLIFIER	17.10
K2578	MICRO PROCESSOR CONTROLLED EPROM PROGRAMMER	316.81
K2579	UNIVERSAL START & STOP TIMER	10.93
K2580	POWER SWITCH$DIMMER (600 WATT UNCOOLED)	13.69
K2581	DC COMTROLLED STEREO TONE CONTROL	21.00
K2582	STEREO AUDIO INPUT SELECTOR	16.50
K2588	3 CHANNEL SOUND TO LIGHT WITH PRE-AMPLIFIER	29.70
K2590	LIGHTCOMPUTER WITH EPROM	31.30
K2592	20 WATT LF AMPLIFIER KIT	13.45
K2594	ZERO CROSS PROGRAMMABLE TIMER	15.25
K2598	CAR BOOSTER 15-30 WATT	18.15
K2578M	EPROM PROGRAMMER (BUILT AND TESTED)	374.23
K2600	2A DIMMER	10.12
K2601	STROBOSCOPE	14.78
K2602	4 CHANNEL RUNNING LIGHT WITH MODULATOR	32.25
K2603	MICROPROCESSOR YEAR TIMER	152.15
K2604	KOJAK POLICE SIREN	9.90
K2606	LED AUDIO POWER METER	16.75
K2607	THERMOMETER ADAPTOR	16.00
K2622	AM & FM AERIAL AMPLIFIER	10.40
K2623	LAB POWER SUPPLY 0-24V 3 AMP	38.41
K2625	DIGITAL RPM METER	31.00
K2626	27640/27128 ADAPTOR KIT FOR K 2578	38.30
K2632	HARDWARE EXTENSION KIT FOR K 2603	22.08
K2636	AC MOTOR CONTROL	20.30
K2637	2.5 WATT AUDIO AMPLIFIER	8.23
K2638	CAR ALARM	19.32
K2639	LIQUID LEVEL CONTROL	21.50
K2644	FROST INDICATOR	11.15
K2646	MEDICAL-PILL TIMER	18.86
K2645	GEIGER MUELLER COUNTER	71.53

A FULLY ILLUSTRATED CATALOGUE IS AVAILABLE WHICH GIVES COMPLETE DETAILS OF KITS.

LIGHT UP THE SKY



20CM DISPLAY 'COMMON ANODE' KIT NR. K2567

This kit contains a 7-segment display consisting of 12 leds per segment and 4 leds for the decimal point. With the aid of a supplementary power supply, it is possible to connect this kit to any existing circuit equipped with common anode displays of any brand and any dimension.
If the digit and segment drivers of the circuit can supply sufficient current, it will be possible to connect in parallel two or more displays, or even, leave the small display of the circuit in place and connect the 20cm display in parallel. This latter will not effect the brightness of the 20cm display due to the specila concept of the driver circuit.
- Common anode.
- Power supply: 22 to 26VDC non-stabilized.
- Minimum anode input voltage (on): 2V.
- Maximum anode input voltage (off): 1.2V.
- Segments input impedance: 10K.
- Segment current: static (R6=00):+40mA multiplex (R6=220hm): +75mA.
- Total current consumption in static mode: maximum 400mA.
- Maximum power (U=22V): 8.8Watt.

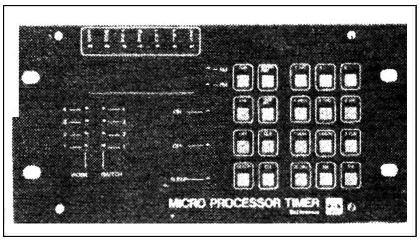
Price £30.26 + p&p

20CM DISPLAY 'COMMON CATHODE' KIT NR. K2568

This kit is in terms of appearance and application identical to K2567 'COMMON ANODE'.
As far as specifications are concerned; read cathode for anode.

Price £31.93 + p&p

MICROPROCESSOR UNIVERSAL TIMER KIT NR. K1682

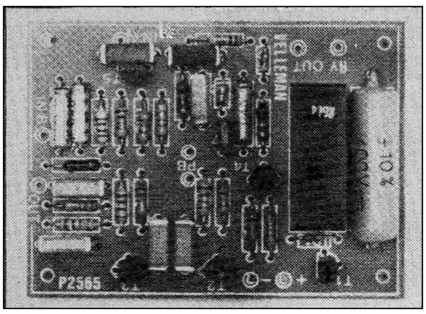


This unique timer is in principle a 24-hour clock provided with 4 relay-switched outputs and a programmation period of 1 week. 20 switching programs can be memorized and via the membrane keyboard be programmed. Outputs or timing periods can be selected at random.
All program steps are indicated be leds.
A printed alu frontplate is included in the kit, making building-in of this timer a simple affair.
This microprocessor timer was primarily designed for industrial and labo purposes, but the amateur can use it in dozens of applications as well.

- 20 daily- or weekly programmable timerfunctions.
- Memory display of programmed timer functions per output or per day.
- 4 independent relay outputs (1 relay included).
- Display of: day of week - AM/PM - output - clock.
- ON/OFF - sleep.
- The timer is based on the TMS 1122 microprocessor.
- Transformer 12VAC/1A (not included).

Price £75.85 + p&p

TAPE/SLIDE SYNCHRONIZER KIT NR. K2565

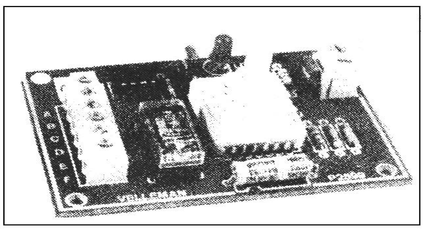


Actually, a lot of tape/slide synchronizers are available on the market. The price of these devices varies from expensive to very expensive.
Those owning a tape- or cassette recorder can with this simple and inexpensive device, record synchronizing pulses and use these pulses to control automatic slide projectors.
The circuit is small in size and can easily be housed.

- Power supply: 9 to 13VDC.
- Current consumption: 40mA.
- Output frequency (tone):+1.5KHz.
- Output amplitude:+250mV.
- Input sensitivity A: minimum 1.5V peak to peak.
- Input sensitivity B: minimum 100mV.
- Oscillator: AMV type.
- Input impedance (B): 1 KOhm.
- Output impedance: 15 KOhm.

Price £12.75 + p&p

SCREEN WIPER ROBOT KIT NR. 2599



Three different time intervals may be selected by using a multipole rotary switch. With small component changes. the intervals may be varied. Some applications: windscreen wiper delay, diaprojector control, hazard warning via the braking lights of the car. In the manual you will find a complete description how to build this kit in a car, with wiring instructions to connect it to the existing wiper installation.

- Power supply: 12-15V DC.
- Intervals: 5-10-15-seconds.
- Relay output: 240V/2x3A.
- Relay output with two change-over contacts.
- Current consumption:
- Output 'OFF': 25mA.
- Output 'ON': 100mA.
- Dimensions:82×56×41mm.

Price £14.84 + p&p

VELLEMAN INTERFACE SYSTEM

NEW DIMENSIONS IN COMPUTER INTERFACES

The Velleman Interface System starts your computer to measure, convert and control signals. This universal interface links your computer with everyday devices such as light and heat sources, audio amps, pumps, waterheaters, etc...

AUTOMATION, CONTROLLING, MASTERING ROBOTICS

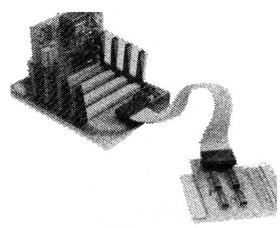
Even the smalles computer can afford powerful applications you wouldn't dare to imagine. Today we have 10 function cards in our system but tomorrow there might be more. And while using this system you keep all communication means originally provided on your computer.

VELLEMAN INTERFACE SYSTEM - KITS

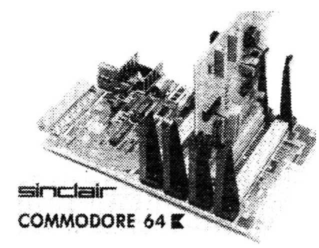
K2609	OC OUTPUT BOARD INTERFACE FOR HOME COMPUTER	22.60
K2610	A/D CONVERTER INTERFACE FOR HOME COMPUTER	35.55
K2611	OPTO INPUT BOARD INTERFACE FOR HOME COMPUTER	26.30
K2613	BREADBOARD INTERFACE	32.43
K2614	ZX 81 SPECTRUM CENTRONICS INTERFACE	39.56
K2615	INTERFACE MOTHERBOARD (SPECTRUM)	40.02
K261B	D/A CONVERTER INTERFACE FOR HOME COMPUTER	32.80
K262B	INTERFACE MOTHERBOARD (COMMODORE)	51.65
K2629	REAL TIME CLOCK INTERFACE FOR HOME COMPUTER	41.35
K2631	EXTENSION BOARD FOR K2640 OR K2641	21.22
K2633	RELAY CARD	15.25
K2634	QUAD TRIAC SWITCH CARD	16.33
K2635	8 TO 1 ANALOG MULTIPLEXER INTERFACE	27.60
K2640	INTERFACE MOTHERBOARD FOR AMSTRAD	48.70
K2641	INTERFACE MOTHER-BOARD KIT FOR MSX STANDARD	48.70
K2642	MOTHERBOARD KIT FOR B.B.C. AND MASTER COMPUTERS	53.13
K2643	MOTHERBOARD KIT FOR AMSTRAD CPC6128 COMPUTERS	55.32
K2612	RS232 MOTHERBOARD (I.B.M. COMPATIBLE)	123.34

VELLEMAN INTERFACE SYSTEM - BUILT AND TESTED

M2615	INTERFACE MOTHERBOARD SOECTRUM	63.85
M2616	INTERFACE MOTHERBOARD ZX 81	63.60
M2628	INTERFACE MOTHERBOARD COMMODORE 64	80.40
M2609	OC OUTPUT BOARD FOR HOME COMPUTERS	29.96
M2610	A/D CONVERTER INTERFACE FOR HOME COMPUTER	41.92
M2611	OPTO INPUT INTERFACE FOR HOME COMPUTER	40.13
M2614	ZX 81 SPECTRUM CENTRONICS INTERFACE	45.60
M2618	D/A CONVERTER INTERFACE FOR HOME COMPUTER	36.86
M2629S	REAL TIME CLOCK INTERFACE (SPECTRUM)	58.60
M2629U	REAL TIME CLOCK INTERFACE (UNIVERSAL)	58.48
M2633	RELAY CARD	22.31
M2634	QUAD TRIAC SWITCH CARD	22.21
M2635	8 TO 1 ANALOG MULTIPLEXER INTERFACE	38.64



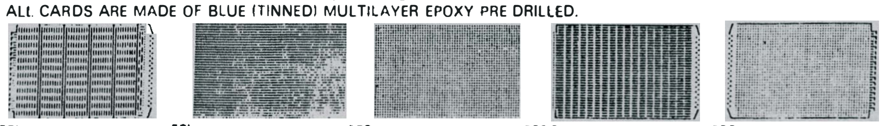
Schneider



EURO CARDS

ECL	160×100 MM	**4.07**
ECS	160×100 MM	**4.07**
ECI	160×100 MM	**4.07**
ECS3	160×100 MM	**4.07**
ECL½	80×100 MM	**2.24**
ECS½	80×100 MM	**2.24**

ECI. ECS3 AND ECC CARDS ARE COMPATIBLE WITH EURODIN CONNECTORS DIN 41617 AND DIN 41612
ALL CARDS ARE MADE OF BLUE (TINNED) MULTILAYER EPOXY PRE DRILLED.



ECI ECL ECS ECS 3 ECC

TOROIDAL TRANSFORMER - KITS

TR2623	TOROIDAL TRANSFORMER KIT (2×16V/2×7-5V-130VA) FOR K2623	**44.39**
TR2603	TRANSFORMER FOR K2603	**9.66**

MEMBRANE KEYBOARDS

KN12	MEMBRANE KEYBOARD 12 KEYS WITHOUT SYMBOLS	**11.48**
KB12S	MEMBRANE KAYBOARD 12 KEYS WITH SYMBOLS	**11.48**
KB16	MEMBRANE KEYBOARD 16 KEYS WITHOUT SYMBOLS	**11.48**
KB16S	MEMBRANE KEYBOARD 16 KEYS WITH SYMBOLS	**11.48**
DF1R	DISPLAY FILTER	**1.61**

ELECTRONICS TODAY INTERNATIONAL CLASSIFIED

Lineage:
48p (VAT Incl) per word (minimum 15 words)
Semi Display: (minimum 2 cms)
£11.60 per single column centimeter

Ring for information on series bookings/discounts
All advertisements in this section must be prepaid.
Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request)

01-437 0699 Ext 292
Send your requirements to:
Nicola Baty
ETI Class. Dept.,
ASP Ltd.,
1 Golden Square,
London W1.

COURSES

Start training now for the following courses. Send for our brochure — without obligation or Telephone us on 06267 79398

REF: ETI/6

NAME ________________

☐ **City & Guilds Exam**
☐ **Radio Amateur Licence**
☐ **Micro-processor**
☐ **Introduction to Television**

Radio & Telecommunication Correspondence School, 12, Moor View Drive; Teignmouth, Devon. TQ14 9UN

ELECTRONICS TECHNICIANS
Updating Courses
London Electronics College, (Dept ETI), 20 Penywern Road, London SW5 9SU. 01-373 8721.

MISCELLANEOUS

HEATHKIT U.K. Spares and service centre. Cedar Electronics, Unit 12, Station Drive, Bredon, Tewkesbury, Glos. Tel. 0684 73127

ALARMS

ALARMS ADE
FREE BOOKLET
on
BURGLAR ALARMS
with
LOWEST U.K. DIY PUBLISHED PRICES
PHONE OR WRITE FOR YOUR COPY
051-523 8440
AD ELECTRONICS
217 WARBRECK MOOR
AINTREE LIVERPOOL L9 OHU

FIRE. Hundreds of deaths are caused by fire each year. Protect yourself and your family with this easy to fit pre-built Fire Alarm Kit. We supply Control Unit, 4 Sensors and Wire for only £68 inclusive of VAT etc. Extra Sensors £6. Cheques/P.O./Cash to: Rainbow Computer and Electronic Products, Dept ETI1, 98 Nelson Road, Ipswich IP4 4DU.

SUPPLIES

QUALITY WALKIE TALKIES 49 MHz, long range satisfaction or refund. £24.99/pair (normally £31.49), 48 hrs delivery, Xenon (dept ET 19) 24 Wharncliffe Street, Barnsley, Yorkshire.

AUDIO

CLASS A Hi-Fi
POWER AMPLIFIERS
Made in Gt. Britain

The worlds most advanced active Class A MOSFET power amplifiers, designed for listening to, whilst engineered to break all performance limits.

THE 'SUPERMOS' *50*–150W O/P, 4–16ohms, one unique module

Integral heatsink, no external components needed. Simply mounts onto a flat panel.

There's no other amplifier modules that can offer ANY of these advanced features:—

- ★ Active class A MOSFET O/P (cool running)
- ★ Distortion @ 0.0002% (2ppm)
- ★ Slew rate greater than 250V/us
- ★ High current capability 50amps p-p
- ★ Very low feedback for true Hi-Fi sound
- ★ Unique input stage giving exceptional power supply ripple rejection for clear bass.

PSU requirements +30 to +45V DC, full details with each amplifier.

Build the ultimate in CLASS A sound quality at a fraction of the cost of commercial units. *SUPERMOS* modules £59.95 each, *SUPERAMP* (Bipolar version) **£47.50** total inc, *SEE ETI MAY 87 FOR INDEPENDENT REVIEW.*
UPGRADE YOUR UPGRADEABLE PREAMP with the SAGE Super-regulator a dual PSU module with 1000 times lower output & ripple than 78/79 regulators, **£20.** P&P £1.
SAE for details of these and all our other products.

SAGE AUDIO
Construction House, Whitley St, Bingley, Yorks BD16 4JH (0274) 568647

KITS AND READY BUILT

FM TRANSMITTERS Same day despatch **MINIATURE MODEL** frequency 60-145 Mhz, range 1 mile. Glass fibre P.C.B. All components. Full instructions 9-12V operation, broadcast reception. Super sensitive microphone. Pick up on **FM/VHF** radio. £6.95 inc or ready built £8.95. Size 57 × 19 × 12mm. **HIGH POWER MODEL**. 3 watts 80-108 MHz. Professional broadcast performance. Low drift varicap controlled. Range up to 7 miles. 12V operation. Any input audio/microphone. All components P.C.B. diagrams and instructions. Size 103 × 39 × 29mm. Kit 13.99 inc or ready built £18.99 inc. Send S.A.E. for our DataPack on other products. **ZENITH ELECTRONICS**. 14 Cortlandt Business Centre, Hailsham, East Sussex BN27 1AE. **Tel: 0323 847973**.

ETI KITS assembled and tested* by electronic trainees under supervision within a purpose built electronic workshop for as little as £10* (* depending on type of kit and complexity). Contact:- A.J. Smith, Dept K.A. Electronics Workshop, Lincoln I.T.E.C. Dean Road, Lincoln LN2 4JZ. Tel. 0522 43532.

LINSLEY HOOD Designs. Send S.A.E. for details to Teleradio Electronics. 325 Fore Street, London N9 OPE.

COMMUNICATIONS

Learn morse the Easy way with a Zx morse Tutor.
This unit comes complete with a morse key, Interface and Software to Connect up to a Zx Spectrum computer. Unit can be used on its own!
Price only **£14.95**

P. GOODRUM
9 Ryston Close, Downham Market, Norfolk PE38 9 BD
Tel: 0366 388615

SWITCHES

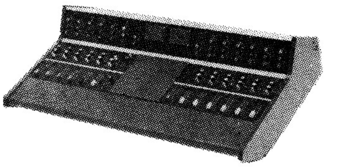
VOICE/SOUND ACTIVATED SWITCHES easy to follow diagrams and uses only £1.00. Components and P.C.B's available: **Herrington, 63 Home Farm Rd, Hanwell, London W7 1NL.**

BOOKS

PARAPHYSICS Journal (Russian Translation); Psychotronics; Kirlianography, Heliphonic Music, Telekinetics. Computer Software. S.A.E. 4 × 9", Paralab, Downton, Wiltshire.

EQUIPMENT

WOULD YOU BUY A CAR WITHOUT A TEST DRIVE? THEN WHY BUY A MIXER WITHOUT A TEST DRIVE?



Thinking about a new project — from a small Mixer to a large studio complex — come and talk over ideas with the people who offer manufacturing and user experience at our new premises:

Unit D, 318 High Road, Benfleet, Essex SS7 5HB

TO TAKE THAT TEST DRIVE — PHONE 0268-793381

(Weekend Committee visits welcome by prior arrangement)

PARTRIDGE ELECTRONICS

Head Office, 56 Fleet Road, Benfleet, Essex SS7 5JN
Telephone 0268-793256

Ring Nicola Baty on 01-437 0699 for details of our series discounts

COMPLETE GEIGER counter (with Tube) for radiation measurement - Under £50. Send for details: Radiation Detectors 46/47 Pall Mall, London SW1Y 5JG. Tel (01) 839 3143.

SCOPES

COMET TEST EQUIPMENT OSCILLOSCOPES

Dual Trace in fine condition.

TEK 585A 85 MHz Delay Sweep from **£235**
TEK 547 50 MHz Delay Sweep from **£185**

TEK 561B 875 MHz Sampling **£195**
TEK Eight-Trace from **£185**
Hameg 70 MHz Delay Sweep **£415**

MANUALS, SPARES, ACCESSORIES

Tel: 01-868 4221

SPECIAL OFFERS

FREE MEMBERSHIP to a new NATIONAL ELECTRONICS CLUB.
For details and a free gift of components worth over **£10** send only **£1.00** p&p to **Woodside, Dowsett Lane, Ramsden Heath, Essex CM11 1JL**

K.I.A. AMAZING GIVEAWAYS!! ....8 Cunliffe Road, Ilkley LS29 9DZ ....Poweramps 60 watt/£5 ---- 100 watt/£8....Powersupplies 40V/STAB/£5 **----•40 FREE ASTD CAPACITORS----RETURN AD + 50p (p&p)!!**

PLANS & DESIGNS

ELECTRONIC PLANS, laser designs, solar and wind generators, high voltage teslas, surveillance devices, pyrotechnics and computer graphics tablet. 150 projects. For catalogue, SAE to Plancentre Publications, String Works, Bye St., Ledbury HR8 2AA.

SERVICES

DESIGN SERVICES, microprocessor, special interfaces, analogue, digital, signalling, alarm systems, PCB design and artwork. Prototype and small batch production. **ALAB ELECTRONICS.** Grantham (0476) 860089.

COMPONENTS

PROMs - EPROMs - PALs
ANY PROGRAMMABLE IC SUPPLIED OR BLOWN
PRICES (Including Programming)

2716	**£3.45**	2732	**£3.60**
2764	**£2.85**	27128	**£3.20** etc.

BIPOLAR PROMs from £1.35
e.g. 82S123, 18S030, 74S288
PALs, PLDs etc. from £3.26
e.g. 82S153, 16L8, EP300
Full design and prototyping service
Any quantity programmed - SAE or phone for details
P.L.S., 16 Wordsworth Drive, Cheam, Surrey, SM3 8HF
Phone 01-644 8095

3" CF2 disks	**£2.40**
3.5" unbranded DS disks	**£1.14**
5.25" unbranded disks, DS 96tpi	**£0.46**
Resistors .25W 5% E12 values	**£0.01**
25 way D plug, socket or shell	**£0.74**
Cent. printer cable, PC1512/IBM	**£9.95**
BBC printer cable	**£5.80**
DIN plugs & skt's 5, 6, 7 pin	**£0.20**
LED's 5mm red, grn, amber	**£0.10**

All prices inc P&P, please add VAT at 15%
T—systems Ltd
The Signal Cabin, 61 High Street, Orpington, Kent BR6 0JF
Tel: 0689 22196

MANUFACTURERS STOCK CLEARANCE
Thousands of brand new components at ROCK BOTTOM PRICES
OP-AMPS, TTL, CMOS, Regulators, capacitors, switches, displays, etc.
DON'T MISS THIS GREAT OPPORTUNITY
Send S.A.E. for details, or ring:
(0384) 74540
COPE ELECTRONICS LTD.
UNIT 1
Oak Street Trading Estate, Quarry Bank, Brierley Hill, West Midlands DY5 2JQ.

I.G.S. COMPONENTS, NO 18 QUEENSWAY, SHELLEY, ONGAR, ESSEX. CM5 0BN.

Resistors ¼W 5% carbon film E12 1+2p, 25+1.5p, 100+1p 4R7 to 10M anymix, 10off each above=770 resistors £4.40. 5mm LEDs red 1+8p, 25+6p, 100+5p, green or yellow 1+11p, 25+9p, 100+8p. IDC Ribbon Cable Grey 0.05in pitch, 10way 12p/ft,16way 18p/ft,20way 23p/ft,26way 30p/ft,34way 34p/ft,40way 46p/ft. IDC connectors also available full list free on request. All prices inc VAT. Orders under £10.00 50p extra.

WANTED

We purchase for cash or immediate settlement surplus stocks of I.C's, Memories, Transistors, etc. Please contact by:
Telephone or Telex No: 825616 or 0767 317388.

Turn your surplus transistors, IC's etc., into cash. Immediate settlement. We also welcome the opportunity to quote for complete factory clearance.
Contact:
Coles Harding & Co.
103 South Brink
Wisbech, Cambs.
ESTABLISHED OVER 10 YRS
Tel: 0945 584188

WANTED
Test equipment, receivers, valves, transmitters, components, cable and electronic scrap and quantity. Prompt service and cash.
M & B RADIO
86 Bishopsgate Street
Leeds LS1 4BB
0532 435649

PLANS & DESIGNS

Design and build your own electronic dashboard.
Plans, instructions, circuits, parts lists £4.95 inc p&p
BURLINGTON MOTOR CO. LTD., (G5) ARCH 39M, BATH PLACE, LEAMINGTON SPA. CY3 3AQ.

ELECTROMART

EDINBURGH

OMNI ELECTRONICS
stock a wide range of electronic components at
174 Dalkeith Road
Edinburgh EH16 5DX
Tel: 031 667 2611
situated midway between Commonwealth Pool and Cameron Toll

GLOUCESTER

R.S.P. ELECTRONICS
109 EASTGATE STREET
GLOUCESTER GL1 1PY
TEL: 0452 23034
ELECTRONIC COMPONENTS SPECIALISTS IN P.A. SYSTEMS and INTERCOM SYSTEMS.
* We Also Buy Surplus Stock *
Open Mon-Fri. 9-5.30pm

LIVERPOOL

PROGRESSIVE RADIO
87/93 Dale Street Tel: 051 236 0154
47 Whitechapel. Tel: 051 236 5489
Liverpool 2
'THE ELECTRONICS SPECIALISTS'
Open: Tues-Sat 9.30-5.30

YORKSHIRE

COMPUTERCARE
Electronic Components ★
Computer Supplies ★
Repairs
12 COMMERCIAL ROAD, LEEDS, LS5 3AQ.
(Across from Kirkstall leisure centre)
Open: Monday-Friday 9-5.30
(Saturday please phone first)
Phone LEEDS 743356 for stock list

TYNE AND WEAR

ELECTRONIC COMPONENTS AND KITS
STATION ROAD, CULLERGOATS, NORTH SHIELDS, TYNE & WEAR NE30 4PQ. 091 251 4363.
MON-SAT 9.30 to 5.30
CLOSED THURS.

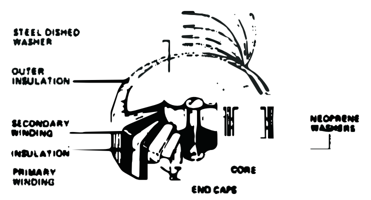
ELECTROMART

ILP TRANSFORMERS FROM JAYTEE

ILP Toroidal Transformers are now available through Jaytee. The UK Distributor with the availability and service to match the quality of the toroidals.

FOR FREE DATA PACK PLEASE WRITE TO OUR SALES DEPT.

Jaytee Electronic Services
Dept 20, **143 Reculver Road, Beltinge, Herne Bay, Kent CT6 6PL**
Telephone: (0227) 375254



TYPE	SERIES NO.	SEC. VOLTS	R.M.S. CURRENT
15VA	03010	6 · 6	1 25
Regulation 19%	03011	9 · 9	0 83
62 x 34 (See diagram)	03012	12 · 12	0 63
0 35 Kgs	03013	15 · 15	0 50
Mounting bolt M4 x 12	03014	18 · 18	0 42
	03015	22 · 22	0 34
	03016	25 · 25	0 30
	03017	30 · 30	0 25
30Va	13010	6 · 6	2 50
Regulation 18%	13011	9 · 9	1 66
Size	13012	12 · 12	1 25
A B C	13013	15 · 15	1 00
70 35 37	13014	18 · 18	0 83
0 45 Kgs	13015	22 · 22	0 68
Mounting bolt M5 x 50	13016	25 · 25	0 60
	13017	30 · 30	0 50
50Va	23010	6 · 6	4 16
Regulation 13%	23011	9 · 9	2 77
Size	23012	12 · 12	2 08
A B C	23013	15 · 15	1 66
80 40 43	23014	18 · 18	1 38
0 9 Kgs	23015	22 · 22	1 13
Mounting bolt M5 x 50	23016	25 · 25	1 00
	23017	30 · 30	0 83
	23028	110	0 45
	23029	220	0 22
	23030	240	0 20
80Va	33010	6 · 6	6 66
Regulation 12%	33011	9 · 9	4 44
Size	33012	12 · 12	3 33
A B C	33013	15 · 15	2 66
95 40 43	33014	18 · 18	2 22
1 0 Kgs	33015	22 · 22	1 81
Mounting bolt M5 x 50	33016	25 · 25	1 60
	33017	30 · 30	1 33
	33028	110	0 72
	33029	220	0 36
	33030	240	0 33
120VA	43010	6 · 6	10 00
Regulation 11%	43011	9 · 9	6 66
Size	43012	12 · 12	5 00
A B C	43013	15 · 15	4 00
95 45 50	43014	18 · 18	3 33
12 Kgs	43015	22 · 22	2 72
Mounting bolt M5 x 50	43016	25 · 25	2 40
	43017	30 · 30	2 00
	43018	35 · 35	1 71
	43028	110	1 09
	43029	220	0 54
	43030	240	0 50

TYPE	SERIES NO.	SEC. VOLTS	R.M.S. CURRENT
160VA	53011	9 · 9	8 89
Regulation 8%	53012	12 · 12	6.66
Size	53013	15 · 15	5.33
A 3 C	53014	18 · 18	4.44
110 45 50	53015	22 · 22	3.63
1 8 Kgs	53016	25 · 25	3.20
Mounting bolt M5 x 50	53017	30 · 30	2.66
	53018	35 · 35	2 28
	53026	40 · 40	2 00
	53028	110	1 45
	53029	220	0.72
	53030	240	0 66
225VA	63012	12 · 12	9.38
Regulation 7%	63013	15 · 15	7 50
Size	63014	18 · 18	6.25
A B C	63015	22 · 22	5 11
110 50 55	63016	25 · 25	4 50
2 2 Kgs	63017	30 · 30	3 75
Mounting bolt M5 x 60	63018	35 · 35	3 21
	63026	40 · 40	2 81
	63025	45 · 45	2.50
	63033	50 · 50	2 25
	63028	110	2.04
	63029	220	1 02
	83030	240	0 93
300VA	73013	15 · 15	10 00
Regulation 6%	73014	18 · 18	8 33
Size	73015	22 · 22	6 82
A B C	73016	25 · 25	6.00
110 57 62	73017	30 · 30	5.00
2 6 Kgs	73018	35 · 35	4 28
Mounting bolt M5 x 60	73026	40 · 40	3 75
	73025	45 · 45	3 33
	73033	50 · 50	3 00
	73028	110	2 72
	73029	220	1 36
	73030	240	1 25
500VA	83016	25 · 25	10.00
Regulation 5%	83017	30 · 30	8 33
Size	83018	35 · 35	7.14
A B C	83026	40 · 40	6 25
135 60 65	83025	45 · 45	5 55
4 0 Kgs	83033	50 · 50	5 00
Mounting bolt M8 x 70	83042	55 · 55	4.54
	83028	110	4 54
	83029	220	2 27
	83030	240	2 08

TYPE	SERIES NO.	SEC. VOLTS	R.M.S. CURRENT
625VA	93017	30 · 30	10 41
Regulation 4%	93018	35 · 35	8.92
Size	93026	40 · 40	7 81
A B C	93025	45 · 45	6.94
140 70 75	93033	50 · 50	6 25
5.0 Kgs	93042	55 · 55	5.68
Mounting bolt M8 x 90	93028	110	5.68
	93029	220	2.84
	93030	240	2.60

ILP TRANSFORMERS ARE NOW SUPPLIED WITH DUAL PRIMARIES PERMITTING 110V OR 220V/240V OPERATION

THE TOROIDAL POWER TRANSFORMER

Offers the following advantages:-
SMALLER SIZE AND WEIGHT TO MEET MODERN 'SLIMLINE' REQUIREMENTS.
LOW ELECTRICALLY INDUCED NOISE DEMANDED BY COMPACT EQUIPMENT.
HIGH EFFICIENCY ENABLING CONSERVATIVE RATING WHILST MAINTAINING SIZE ADVANTAGES.
LOWER OPERATING TEMPERATURE.

PRICES

VA	SERIES NO.	£
15	0	8.90
30	1	10.07
50	2	11.21
80	3	12.50
120	4	13.28

VA	SERIES NO.	£
160	5	15.64
225	6	17.09
300	7	18.66
500	8	24.63
625	9	27.15

ALL ABOVE PRICES INCLUDE VAT AND CARRIAGE. QUANTITY DISCOUNTS AVAILABLE FOR 6 OR MORE OF ANY ONE TYPE

SIZES

ADVERTISERS INDEX

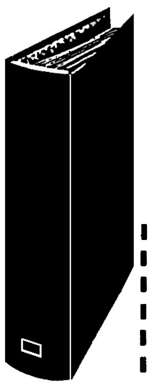
PCB lay-out, design on BBC, store on disc, plot an EPSON HI-80, 4-pen, A-4 plotter **£20**

VIEW FOIL lay-out on screen, store on disc, mix design from disc, plot on EPSON HI-80 **£20**

COMPLEX NUMBER CALCULATOR, enter and display in Cartesian (X + jY) or polar (Z ∠θ) format **£10**

VINDEREN Associates, PO BOX 130 BELFAST BT9 6NB, TEL 0232 667885

BINDERS



FOR YOUR VALUABLE COLLECTION OF ELECTRONICS TODAY INTERNATIONAL MAGAZINES
• SMART • EASY TO USE • TOP QUALITY
To ASP Readers Services, PO Box 35, Wolsey House, Wolsey Road, Hemel Hempstead, Herts HP2 4SS (0442-41221)

£5.20 inc P&P

Please supply..................Electronics Today Interntional Binders @ £5.20 inc. P&P

Total £....... (Please make cheques payable to ASP Ltd.)

Years Required — 198........198........198........198........

Name..
Address..

Please allow 21 days for delivery

COMPUTER WAREHOUSE

1000's OF BARGAINS FOR CALLERS

THE "ALLADINS' CAVE OF COMPUTER AND ELECTRONIC EQUIPMENT

HOT LINE DATA BASE

DISTEL©

The **ORIGINAL FREE OF CHARGE** dial up data base. Buy, browse or place **YOUR OWN AD** for goods or services to sell. 1000's of stock items, spares and one off bargains. Updated daily. **ON LINE NOW.** CCITT, 8 bit word, no parity. For **300** baud modems call 01-679 1888 For **1200**-75 baud modems call 01-679 6183

DON'T MISS THE CPM Deal OF the CENTURY

The FABULOUS CPM TATUNG PC2000 Professional Business System

A cancelled export order and months of negotiation enables us to offer this professional **PC, CPM** system, recently on sale at **OVER £1400**, at a **SCOOP** price just over the cost of the two internal disk drives!! Or less than the price of a dumb terminal!!

Not a toy, the **BIG BROTHER** of the **EINSTIEN** computer, the **DUAL PROCESSOR PC2000** comprises a modern stylish three piece system with ALL the necessities for the **SMALL BUSINESS, INDUSTRIAL, EDUCATIONAL** or **HOBBYIST USER**. Used with the THOUSANDS of proven, tested and available CPM software packages such as **WORDSTAR, FAST, DBASE2** etc, the **PC2000** specification, at our prices, **CANNOT BE BEATEN**!!

The central processor plinth contains the **64K, Z80A** processor, **DUAL TEAC 55 F 5¼"** Double sided **40/80** track disk drives (1Mb per drive), **PSU, 4K** of memory mapped screen RAM, disk controller, **RS232, CENTRONICS** and system expansion ports, and if that's not enough a ready to plug into **STANDARD 8" DRIVE** port for up to **FOUR 8"** disk drives, either in double density or **IBM** format. The ultra slim **92** key, detachable keyboard features 32 user definable keys, numeric keypad and text editing keys, even its own integral microprocessor which allows the main **Z80A** to devote **ALL** its time to **USER** programs, eliminating "lost character" problems found on other machines. The attractive, detachable 12" monitor combines a green, anti-glare etched screen, with full swivel and tilt movement for maximum user comfort. Supplied **BRAND NEW** with **CPM 2.2**, user manuals and full 90 day guarantee. Full data sheet and info on request.

PC2000 System with CPM Etc. COST OVER £1400 **NOW only £399**

PC2000 Business System with CPM and 'Ready to Run' FAST Sales and Purchase ledger, supports up to 9000 Accounts, VAT etc. COST OVER £1700 **NOW only £499**

Carriage & Insurance £12.00

PC2000 Wordprocessor System with CPM and TEC FP25 daisywheel printer **NOW only £799**

FREE

Your monitor from its computer!! For **only £24.95** it becomes a **SUPERB HIGH QUALITY * COLOUR * TV SET**

The fabulous **TELEBOX**, an **INVALUABLE MUST** for the owner of **ANY** video monitor with a composite input, colour or monochrome. Made by a major UK Co. as a **TOP QUALITY**, stand alone **UHF** tuner and costing **OVER** £75 to manufacture, this opportunity to give your monitor a **DUAL FUNCTION** must not be missed!! The **TELEBOX** consists of a compact, stylish two tone charcoal moulded case, containing ALL electronics tuner, power supply etc to simply plug in and convert your previously dedicated computer monitor into a **HIGH QUALITY COLOUR* TV SET**, giving a real benefit to ALL the family!! Don't worry if your monitor doesn't have sound – **THE TELEBOX** even has an integral 4 watt audio amplifier for driving an external speaker, **PLUS** an auxiliary output for superb quality television sound via your headphones or **HI FI** system etc. Other features include: Compact dimensions of only 15.75" w x 7.5" d x 3.5" h, latest technology, **BRITISH** manufacture, fully tuneable 7 channel push button tuner, Auto **AGC** circuit, **SAW** filter, LED status indicator, fully isolated 240v AC power supply for total safety, Mains ON-OFF switch etc. Many other uses.

LIMITED QUANTITY – DON'T MISS THIS OFFER!!!

ONLY £24.95 OR £19.95 if purchased with **ANY** of our video monitors. Supplied **BRAND NEW** with full instructions and 2 YEAR warranty. Post and packing £3.50 *When used with colour crt.

COLOUR & MONOCHROME MONITOR SPECIALS

'SYSTEM ALPHA' 14" COLOUR MULTI INPUT MONITOR
Made by the famous **REDIFFUSION Co.** for their own professional computer system this monitor has all the features to suit your immediate and future requirements. Two video inputs: **RGB** and **PAL** Composite Video, allow direct connection to **BBC/IBM** and most other makes of micro computers or **VCR's**, including our very own **TELEBOX**. An internal speaker and audio amp may be connected to computer or **VCR** for superior sound quality. Many other features: PIL tube, Matching **BBC** case colour, Major controls on front panel, Separate Contrast and Brightness – even in **RGB** mode. Separate Colour and audio controls for Composite Video input. **BNC** plug for composite input, 15 way 'D' plug for **RGB** input, modular construction etc. etc.

This Must Be ONE OF THE YEAR'S BEST BUYS. PC USER

Supplied **BRAND NEW** and **BOXED**, complete with DATA and 90 day guarantee. **ONLY £149.00** as above **OR IBM PC** Version **£185.00**
15 Day 'D' skt **£1.00**. **BNC** skt **75p BBC** interface cable **£5.50**

DECCA 80 16" COLOUR monitor. RGB Input.
Little or hardly used manufacturer's surplus enables us to offer this special converted **DECCA RGB** Colour Video TV Monitor at a super low price of **only £99.00**, a price for a colour monitor as yet unheard of!! Our own interface, safety modification and special 16" high definition PIL tube, coupled with the **DECCA 80** series TV chassis give 80 column definition and quality found only on monitors costing **3 TIMES OUR PRICE**. The quality for the price has to be seen to be believed!! Supplied complete and ready to plug direct to a **BBC MICRO computer** or any other system with a **TTL RGB** output. Other features are: internal speaker, modular construction, auto degaussing circuit, attractive TEAK CASE, compact dimensions only 52cm W x 34 H x 24 D, 90 day guarantee. Although used, units are supplied in **EXCELLENT condition. ONLY £99.00** + Carriage.

DECCA 80, 16" COLOUR monitor. Composite video Input. Same as above model but fitted with Composite Video input and audio amp for **COMPUTER, VCR** or **AUDIO VISUAL** use. **ONLY £99.00** + Carr

REDIFFUSION MARK 3, 20" COLOUR monitor. Fitted with standard 75 ohm composite video input and sound amp. This large screen colour display is ideal for SCHOOLS, SHOPDS, DISCO'S, CLUBS and other AUDIO VISUAL applications. Supplied in **AS NEW** or little used condition **ONLY £145.00** + Carr

BUDGET RANGE EX EQUIPMENT MONOCHROME video monitors.
All units are fully cased and set for 240v standard working with composite video inputs. Units are pre tested and set up for up to 80 column use. Even when MINOR screen burns exist – normal data displays are unaffected. 30 day guarantee.
12" KGM 320-1 B/W bandwidth input, will display up to 132 x 25 lines. **£32.95**
12" GREEN SCREEN version of KGM 320-1. Only **£39.95**
9" KGM 324 GREEN SCREEN fully cased very compact unit. Only **£49.00**

Carriage and insurance on all monitors £10.00

DC POWER SUPPLY SPECIALS

GOULD OF443 enclosed, compact switch mode supply with DC regulated outputs of +5v @ 5.5a, +12v @ 0.5a, −12v @ 0.1a and −23v @ 0.02a. Dim 18 x 11 x 6 cm. 110 or 240v input. **BRAND NEW** only **£18.95**
GOULD G6-40A 5v 40 amp switch mode supply **NEW £130.00**
AC-DC Linear PSU for **DISK** drive and **SYSTEM** applications. Constructed on a rugged ALLOY chassis to continuously supply fully regulated DC outputs of +5v @ 3 amps, −5v @ 0.6 amps and +24v @ 5 amps. Short circuit and overvoltage protected. 100 or 240v AC input. Dim 28 x 12.5 x 7 cm **NEW £49.94**

Carriage on all PSU's £3.00

KEYBOARDS

Manufacturer's BRAND NEW surplus.
DEC LA34 Uncoded keyboard with 67 quality gold plated switches on X-Y matrix – ideal micro conversions etc. **£24.95**
AMKEY MPNK-114 Superb word processor chassis keyboard on single PCB with 116 keys. Many features such as On board Micro, Single 5v rail, full ASCII coded character set with 31 function keys, numeric keypad, cursor pad and 9600 baud SERIAL TTL ASCII OUTPUT!! Less than half price **Only £89.00** with data. Carriage on Keyboards £3.50

SURPLUS SPECIALS ON PRESTEL – VIEWDATA – TELEX

PLESSEY VUTEL, ultra compact unit, slightly larger than a telephone features **A STANDARD DTMF TELEPHONE** (tone dial) with 5" CRT monitor and integral modem etc. for direct connection to **PRESTEL, VIEWDATA** etc. Designed to sell to the EXECUTIVE at over £600!! Our price **BRAND NEW AND BOXED** at only **£99.00**
DECCAFAX VP1 complete Professional **PRESTEL** system in slimline desk top unit containing Modem, Numeric keypad, CPU, PSU etc. Connects direct to standard RGB colour monitor. Many other features include: Printer output, Full keyboard input, Cassette port etc. **BRAND NEW** with DATA. A **FRACTION OF COST** only **£55.00**
ALPHATANTEL. Very compact unit with integral **FULL ALPHA NUMERIC** keyboard. Just add a domestic TV receiver and you have a superb PRESTEL system and via **PRESTEL** the cheapest **TELEX** service to be found!! Many features: **CENTRONICS** Printer output, Memory dialling etc. Supplied complete with data and **DIY** mod for **RGB** or Composite video outputs **AS NEW** only **£125.00**

Post and packing on all PRESTEL units £8.50

EX-STOCK INTEGRATED CIRCUITS

4164 200 ns D RAMS 9 for £11 4116 ns £1.50 **2112** £10.00 **2114** £2.50 **2102** £2.00 **6116** £2.50 **EPROMS 2716** £4.50 **2732** £3.00 **2764** £4.95 **27128** £5.50 **8800** £2.50 **6821** £1 **68A09** £8 **68B09** £10 **8085A** £5.50 **8086** £15 **8088** £8 **NEC765** £8 **WD2793** £28 **8202A** £22 **8251** £7 **8748** £15 **Z80A** DART £6.50 **Z80A** CPU £2.00. Thousands of IC's **EX STOCK** send SAE for list.

DISK DRIVES

Japanese 5¼" half height, 80 track double sided disk drives by **TEAC CANON, TOSHIBA** etc.
Sold as **NEW** with **90 day** guarantee **ONLY £85.00**
TEC FB-503 Double sided HH 40 TRK **NEW £75.00**
SUGART SA400 SS FH 35 TRK **£55.00**
SIEMENS FDD100 SS FH 40 TRK **£65.00**
carriage on 5¼" drives £5.50
Brand NEW metal 5¼" **DISK CASES** with internal **PSU**.
DSKC1 for 2 HH or 1 FH drive **£29.95** +pp £4.00
DSKC 2 for 1 HH drive **£22.95** +pp £3.50
DKSC 3 As DSK1 LESS PSU **£12.95** +pp £2.50
DSKC 4 As DSK2 LESS PSU **£10.95** +pp £2.00
8" IBM format **TESTED EX EQUIPMENT.**
SHUGART 800/801 SS **£175.00** +pp £8.50
SHUGART 851 DS **£250.00** +pp £8.50
TWIN **SHUGART 851's** 2 Mb total capacity in smart case, complete with PSU etc. **£595.00**
MITSUBISHI M2894-63 8" DS 1 Mb equiv. to **SHUGART SA850R. BRAND NEW** at **£275.00** +pp £8.50
DYSAN 8" Alignment disk **£29.00** + pp £1.00
Various disk drive PSU's **Ex Stock SEE PSU section.**
HARD DISK DRIVES
DRE/DIABLO Series 30 2.5 Mb front load **£525.00**
Exchangeable version **£295.00. ME3029** PSU **£95.00**
DIABLO 44/DRE4000A, B 5+5 Mb from **£750.00**
CDC HAWK 5+5 Mb £795.00. CDC 9782 80 Mb RMO3 etc. **£2500.00.**
PERTEC D3422 5+5 Mb **£495.00**
RODIME 5¼" Winchesters ex-stock from **£150** CALL
Clearance Items – Sold as seen – No guarantee.
ICL 2314 BRAND NEW 14" Mb Removable pack hard disk drive, cost **over £2000** with data **ONLY £99.00**
BASF 6172 8" 23Mb Winchesters **£199.00**
Unless stated all drives are refurbished with 90 day guarantee. Many other drives and spares in stock – call sales office for details.

MODEMS

Join the communications revolution with our super range of DATA MODEMS, prices and specifications to suit all applications and budgets.....
BRAND NEW State of the art products.
DACOM DSL2123 Multi standard 300-300, 1200-75 Auto answer etc. **£268.00**
DACOM DSL2123AQ Auto dial, smart modem with multi standard AUTO SPEED detect, and data buffer with flow control etc. **£365.00**
DACOM DSL2123GT The CREAM of the intelligent modems, auto dial, auto call, index, buffer etc. etc. **£498.00**
Steebeck SB1212 V22 1200 baud FULL DUPLEX, sync or async, optional auto dial **£465.00**
TRANSDATA 307A Acoustic coupler 300 baud full duplex, originate only, RS232 interface **£49.00**

Ex **BRITISH TELECOM** full spec, CCITT, ruggedised, bargain offers. Sold TESTED with data. Will work on any MICRO or system with RS232 interface.
MODEM 13A 300 baud unit, only 2" high fits under phone. CALL mode only **£45.00**
MODEM 20-1. 75-1200 baud. Compact unit for use as subscriber end to **PRESTEL, TELECOM GOLD, MICRONET** etc. **£39.95** +pp £6.50
MODEM 20-2 1200-75 baud. Same as 20-1 but for computer end **£85.00** +pp £6.50
DATEL 2412. Made by SE Labs for BT this two part unit is for synchronous data links at 1200 or 2400 baud using **2780/3780** protocol etc. Many features include 2 or 4 wire working, self test, auto answer etc. **COST OVER £800.** Our price **ONLY £199** +pp £8.00
DATEL 4800, RACAL MPS4800 baud modem, EX BT good working order, **ONLY £295.00** +pp £8.00

SPECIAL OFFER
MODEM TG2393. Ex BT, up to 1200 baud, full duplex 4 wire or half duplex over 2 wire line. **ONLY £85.00 PER PAIR** +pp £10.00

For more information **contact our Sales Office.**

MATRIX PRINTERS

SPECIAL BULK PURCHASE of these compact, high speed matrix printers. Built in Japan for the Hazeltine Corporation this unit features quality construction giving 100cps bidirectional, full pin addressable graphics, 6 type fonts, up to 9.5" single sheet or tractor paper handling, RS232 and CENTRONICS parallel interface. Many other features. **BRAND NEW** and **BOXED**. COST £420. **Our price Only £199.00**

RECHARGEABLE BATTERIES

Dry Fit MAINTENANCE FREE by Sonnenschein & Yuasa.
A300 07191315 12v 3Ah NEW **£13.95**
A300 07191312 6v 3Ah NEW **£9.95**
A300 07191202 6-0-6v 1.8Ah TESTED Ex Equip **£5.99**

VDU TERMINALS

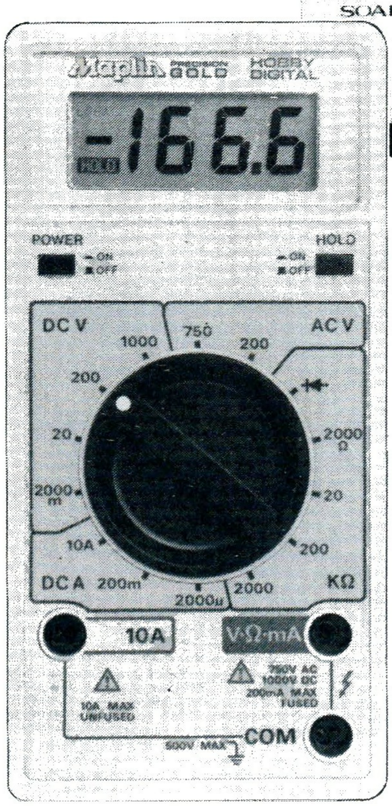
Standard VDU data entry terminals at give away prices!!
QUME QVT108. Current product, state of the art terminal with detachable keyboard, 12" Green screen, 2 page **RAM, TVI 925**, Hazeltine, **ADMSA** emulations, software setup, 25 x 80, Clock, Swivel and tilt base, Printer port, Function keys etc. **BRAND NEW** and **BOXED AT ALMOST HALF PRICE** Only **£425.00**
AJ510 – EX RENTAL, Z80 controlled, 15" green screen 24 x 80 display, graphics, cursor addressing, printer port etc. Very good condition **TESTED** complete with manual only **£225.00**
ADDS 520 – Dumb terminal, used, 12" b/w screen RS232 interface and printer port. **TESTED. ONLY £125.00.** Carriage on terminals £10.00
100's of other terminals in stock, CALL for more details.

DISPLAY -ELECTRONICS-

All prices quoted are for U.K. Mainland, paid cash with order in Pounds Sterling PLUS VAT. Minimum order value ***£2.00***. Minimum Credit Card order ***£10.00***. Minimum BONA FIDE account orders from Government Depts., Schools, Universities and established companies ***£20.00***. Where post and packing not indicated please ADD £1.00 + VAT. Warehouse open Mon-Fri 9.30-5.30. Sat 10.30-5.30. We reserve the right to change prices and specifications without notice. Trade, Bulk and Export

32 Biggin Way, Upper Norwood, London SE19 3XF
Telephone 01-679 4414 Telex 894502 Data 01-679 1888

IN METERS .... WE'RE MILES AHEAD



Pocket Digital Multimeter

A calculator size autoranging DMM which reads 1mV-400V DC, 1mV-400V AC, 0.1Ω-2MΩ and has a continuity buzzer.
Overall size only 120 x 75 x 15mm.
Order Code YN78K **Price £24.95**

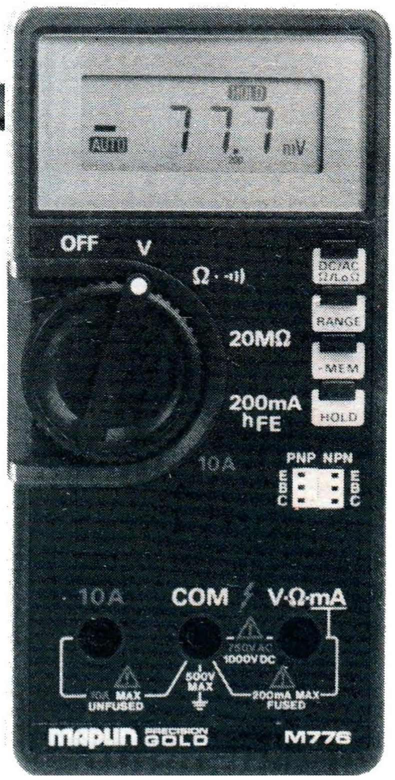
Hobby Digital Multimeter

A very high quality multimeter at a very low price! 14 selectable ranges covering AC and DC volts, DC current and resistance. Also has a diode junction test range.
Order Code YM63T **Price £28.95**

Auto Ranging Digital Multimeter with Transistor Tester

A 6 position rotary switch selects off, volts, ohms/continuity, 20MΩ, 200mA/h_{FE} or 10A. Features include display hold, NPN and PNP transistor tester, autorange override and low battery indication.
Order Code YM64U **Price £45.95**

All prices include VAT. Please add 50p towards postage. Prices firm until 15th August 1987. Subject to availability.



Maplin ELECTRONIC SUPPLIES LTD.

Mail Order: P.O. Box 3, Rayleigh, Essex SS6 8LR. Tel: Southend (0702) Sales: 554161, Enquiries: 552911; Trade sales: 554171, Trade enquiries: 552961.

Shops
Birmingham: Lynton Square, Perry Barr. Telephone: 021 356 7292.
London: 159-161 King Street, Hammersmith W6. Telephone: 01 748 0926.
Manchester: 8 Oxford Road. Telephone: 061 236 0281.
Southampton: 46-48 Bevois Valley Road. Telephone: 0703 225831.
Southend-on-Sea: 282-284 London Road, Westcliff-on-Sea, Essex. Tel: 0702 554000.
All shops except Manchester closed all day Monday.

Pick up a copy of our 1987 catalogue from any branch of W.H. Smith for just £1.50. Or to receive your copy by post just send £1.50 + 40p p & p to Mail Order address. If you live outside the U.K. please send £2.50 or 11 International Reply Coupons.