AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

APRIL 1986 £1.20

ALMOST AN AUDIO SPECIAL

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PLUS:

MATCHBOX AMP

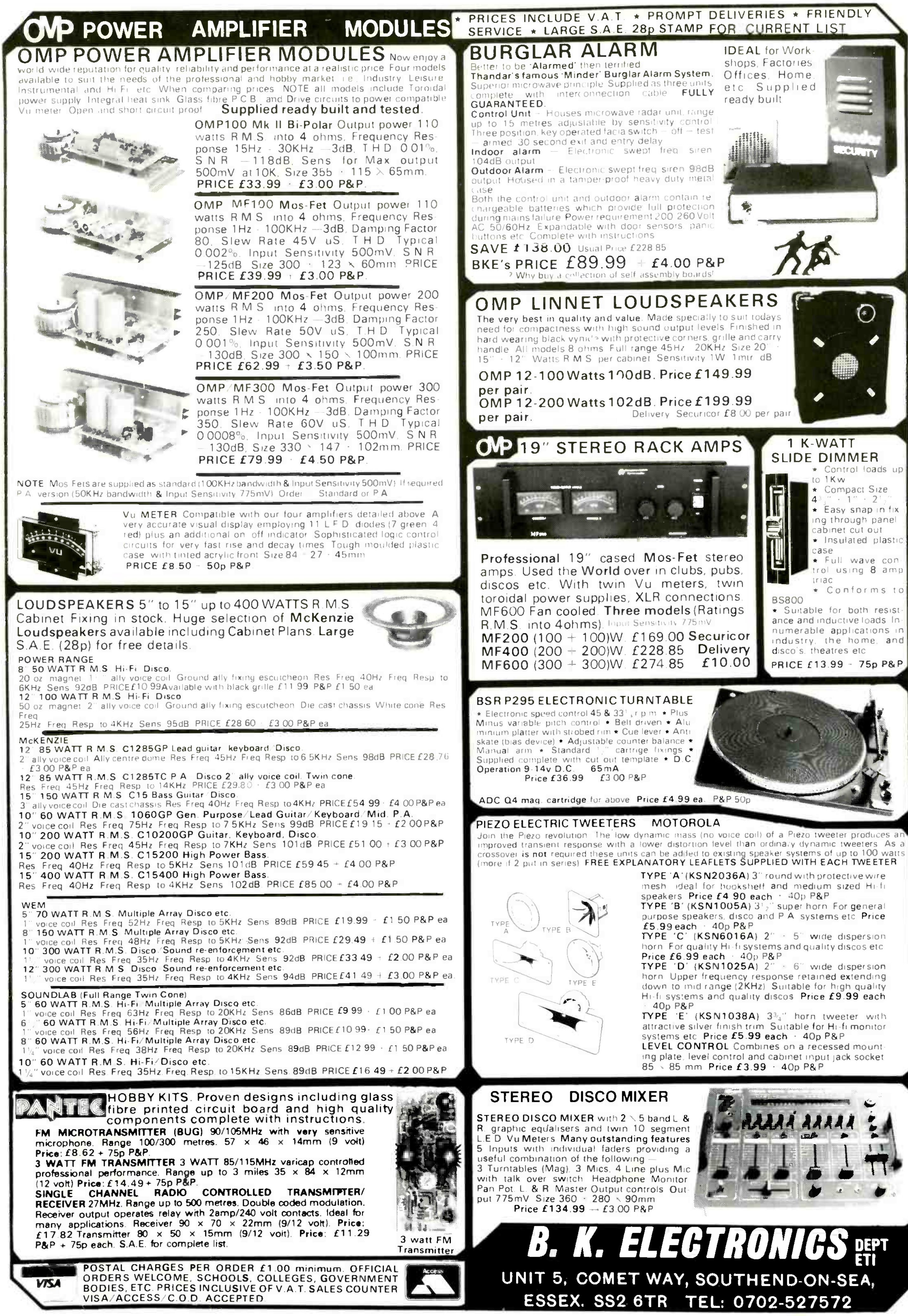
MTE TEST PROBE

DIY DATA ENCRYPTION

DIGITAL ADVERT FILTER

MORE FREE PCB PROJECTS INSIDE PLUS AMAZING OFFER ON DIGITAL PANEL METERS

AUDIO.... COMPUTING.... MUSIC.... RA OTICS..



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 £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 £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 £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' than 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.
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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.
SAVE £138.00 Usual Price £228.85
BK E's PRICE £89.99 + £4.00 P&P
? Why buy a collection of self assembly boards!
IDEAL for Workshops, Factories, Offices, Home etc. Supplied ready built.
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. £274.85 £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 £28.76 + £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 £29.80 + £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 £54.99 + £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 £19.15 + £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 £51.00 + £3.00 P&P
15" 200 WATT R.M.S. C15200 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 5KHz. Sens. 101dB. PRICE £59.45 + £4.00 P&P
15" 400 WATT R.M.S. C15400 High Power Bass.
Res. Freq. 40Hz. Freq. Resp. to 4KHz. Sens. 102dB. PRICE £85.00 + £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 £19.99 + £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 £29.49 + £1.50 P&P ea.
10" 300 WATT R.M.S. Disco/Sound re-enforcement etc.
1½" voice coil. Res. Freq. 35Hz. Freq. Resp. to 4KHz. Sens. 92dB. PRICE £33.49 + £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 £41.49 + £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) 3¾" 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
TYPE A
TYPE B
TYPE C
TYPE E
TYPE D
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
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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
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FEATURES

PROJECTS

Due to illness, a number of items scheduled for this month's ETI have had to be held over. We especially regret not being able to run the constructional details for the digital sound sampler digital board which should now appear next month. Our apologies to our readers.

ETCETERA

INFORMATION

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SWITCHES

TOGGLE 2A 250V
SPST 35p DPDP 48p

SUB-MIN TOGGLE

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

SLIDE 250V:

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

PUSHBUTTON 6A with 10mm Button

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

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIGITAST Switch Assorted Colours 75p each

DIP SWITCHES

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

ROTARY SWITCHES

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

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

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

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

ROCKER SWITCHES

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

THUMBWHEEL Mini front mounting switches

Decade Switch Module	275p
B.C.D. Switch Module	298p
Mounting Cheeks (per pair)	75p

ULTRASONIC TRANSDUCERS

40 Khz 475p

GAS/SMOKE DETECTORS

TGS812 or TGS813
£6 each
Holders for above 40p

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	185p	240p	380p
Double ended DIP (Header Plug) Jumper				
12 inches	198p	215p	315p	480p
24 inches	210p	235p	345p	540p
3ft	290p	370p	480p	525p

IDC Female Header Socket Jumper Leads 36

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

VEROBOARD 0.1in

2½ x 3¼	95p
2½ x 5	110p
3¾ x 3¾	110p
3¾ x 5	125p
3¾ x 17	420p
4¾ x 17	590p
VQ Board	195p
DIP Board	395p
Vero Strip	95p

VERO PINS per 100

Single ended	55p
Double ended	60p
Wire wrape S/E	155p
Wire wrape D/E	255p

PEN

Pen + Spool	380p
Spare spool	75p
Combs	8p

PROTO DECs

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

VERO TOOLS

Spot face Cutters	150p
Pin Insertion	165p

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

DALO ETCH RESIST PEN
Plus spare tip 100p

COPPER CLAD BOARDS

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

DIL SOCKETS

	Low Prof	Wire Wrap
8 pin	8p	20p
14 pin	10p	28p
16 pin	10p	40p
18 pin	16p	40p
20 pin	20p	58p
22 pin	22p	60p
24 pin	25p	68p
28 pin	28p	78p
40 pin	30p	89p

EDGE CONNECTORS

	.1"	.156"
2x6 way	—	75p
2x12 way	—	160p
2x15 way	—	165p
2x18 way	175p	160p
2x22 way	200p	170p
2x23 way	150p	—
2x25 way	250p	245p
2x28 way	180p	—
2x30 way	280p	—
2x36 way	300p	—
2x40 way	320p	—
2x43 way	400p	—
2x75 way	600p	—

SIL SOCKET 0.1" Pitch 20 way 65p

ANTEX SOLDERING IRONS

C15W	600p;	CS17W	620p
C18W	620p;	XS25W	650p
Spare Bits	85p;	Elements	230p
Iron Stand	175p;	Heat Shunt	30p

IDC CONNECTORS

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

EURO CONNECTORS

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

DIL PLUG (Header)

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

ZIF TEXTOOL DIL SOCKETS

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

RIBBON CABLE price per foot

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

'D' CONNECTORS

	9 way	15 way	25 way	37 way
Male				
Solder lugs	55p	80p	120p	150p
Angle pins	110p	175p	225p	300p
PCB pins	100p	100p	180p	250p
Female				
Solder lugs	90p	125p	180p	275p
Angle pins	150p	200p	260p	390p
PCB pins	100p	125p	195p	355p
Covers	75p	70p	70p	85p

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

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

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

AMPHENOL CONNECTORS

	IDC	SOLDER
24 way IEEE plug	465p	460p
24 way IEEE skt	485p	480p
36 way Centronics plug	375p	390p
36 way Centronics skt	480p	450p

PANEL METERS

FSD 60 x 46 x 35mm
0–50μA
0–100μA
0–500μA
0–1mA
0–5mA
0–10mA
0–50mA
0–100mA
0–500mA
0–1A
0–2A
0–25V
0–50V
0–300V AC
520p

CRYSTALS

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

RELAYS

Miniature, enclosed, PCB mount.

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

DOUBLE POLE Changeover, 6A 30V DC or 250V AC
RL-113 53R Coil, 6V DC (5V4 to 9V9) 190p
RL6-111 205R Coil, 12V DC (10V7 to 19V5) 195p
RL6-114 740R Coil, 24V DC (22V to 37V) 200p

ASTEC UHF MODULATORS

Standard 6MHz	375p
Wideband 8MHz	550p

BUZZERS

miniature, solid-state 6V; 9V & 12V 70p
PIEZO TRANSDUCERS FB2720 70p

LOUDSPEAKERS

Miniature, 0.3W 8 2in, 3¼in, 2½in, 3in	80p
2½in 40Ω, 64Ω or 80Ω	80p
6" x 4" 8Ω	200p
7" x 5" 8Ω	225p
8" x 5" 8Ω	250p

VIDEO MONITORS

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

Carriage £7 Securicor

BT TELEPHONE CONNECTOR

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

TRANSFORMERS

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

PCB mounting. Miniature. Split bobbin
3VA: 2x6V/0.25A, 2x9V/0.15A, 2x12V/0.12A; 2x15V/0.2A 235p
6VA: 2x6V/0.5A, 2x9V/0.3A, 2x12V/0.25A, 2x15V/0.2A 280p

Standard Split Bobbin type
6VA: 2x6V/0.5A, 2x9V/0.4A, 2x12V/0.3A, 2x15V/0.25A 250p
12VA: 2x4.5V/1A3, 2x5-1A, 2x9V/06A, 2x12V/0.5A, 2x15V-0.4A, 2x20V/0.3A 345p (35p p&p)
24VA: 2x6V/1.5A, 2x9V/1.2A, 2x12V/1A, 2x15V/0.8A, 2x20V/0.6A 385p (60p p&p)
50VA: 2x6V/4A, 2x9V/2.5A, 2x12V/2A, 2x15V/1.5A, 2x20V/1.2A, 2x25V/1A, 2x30V/0.8A 520p (60p p&p)
50VA: Outputs +5V/5A, +12V, +25V, −5V, −12V at 1A 620p (60p p&p)
100VA: 2x12V/4A, 2x15V/3A, 2x20V/2.5A, 2x25V/2A, 2x30V/1.5A, 2x50V/1A 955p (75p)
P&P charge to be added over and above our normal postal charge

VOLTAGE REGULATORS

1A TO220 Plastic Casing

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

100mA TO92 Plastic package

5V	78L05	30p	79L05	45p
6V	78L06	30p	—	—
8V	78L08	30p	—	—
12V	78L12	30p	79L12	45p
15V	78L15	50p	79L15	45p

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

SOLDERCON PINS
Ideal for making SIL or DIL Sockets
100 pins 35p
500 pins 100p

ALUM BOXES

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

CMOS

4000	20	4075	25	4543	65
4001	20	4076	60	4548	40
4002	20	4077	25	4549	390
4006	70	4078	25	4553	210
4007	25	4081	20	4554	180
4008	60	4082	20	4555	50
4009	40	4085	60	4556	50
4010	40	4086	60	4557	250
4011	20	4089	120	4558	120
4012	20	4093	25	4559	340
4013	30	4094	70	4560	110
4014	50	4095	70	4561	104
4015	40	4096	100	4562	350
4016	25	4097	260	4566	160
4017	45	4098	70	4568	250
4018	55	4099	110	4569	175
4019	35	4160	95	4572	45
4020	50	4161	96	4580	255
4021	55	4162	96	4581	125
4022	60	4163	96	4582	99
4023	20	4174	96	4583	100
4024	35	4175	105	4584	40
4025	20	4194	105	4585	65
4026	90	4408	850	4597	330
4027	30	4409	850	4599	155
4028	40	4410	725	40085	90
4029	45	4411	750	40097	45
4030	20	4412	805	40098	42
4031	125	4415	590	40100	215
4032	65	4419	280	40101	130
4033	130	4422	770	40102	140
4034	145	4435	850	40103	412
4035	70	4440	900	40104	120
4036	250	4450	380	40105	220
4037	115	4451	350	40106	40
4038	75	4490	450	40107	55
4039	270	4500	395	40108	325
4040	45	4501	40	40109	100
4041	55	4502	90	40110	235
4042	45	4503	45	40114	240
4043	45	4504	100	40161	194
4044	50	4505	350	40163	75
4045	110	4506	100	40173	100
4046	60	4507	45	40174	75
4047	50	4508	130	40175	75
4048	50	4510	55	40181	220
4049	25	4511	55	40182	80
4050	25	4512	55	40192	75
4051	50	4513	150	40193	90
4052	50	4514	115	40194	70
4053	60	4515	115	40195	75
4054	70	4516	50	40244	196
4055	70	4517	275	40245	196
4056	85	4518	50	40257	196
4057	1000	4519	35	40373	220
4059	400	4520	50	40374	220
4060	70	4521	110	45106	586
4061	500	4522	125	**OPTO**	
4062	986	4526	70	OCP71	120
4063	80	4527	60	ORP12	85
4066	25	4528	45	ORP61	86
4067	230	4529	80	BPX25	250
4068	20	4530	90	BPW21	320
4069	20	4531	120	TIL139	225
4070	25	4532	65		
4071	20	4534	385		
4072	20	4536	250		
4073	20	4538	70		
		4539	80		
		4541	95		

OPTO ELECTRONICS

LEDs with clips

TIL209	10
TIL211 GRN	14
TIL212 Yel	14
TIL220 2 Red	12
2" Green, Yellow or Amber	14
0.2 Bi colour Red/Green	100p
Green/Yellow	115p
0.2 Tri colour Red/Green/Yellow	85
Hi-Brightness Red	58
High-Bri Green or Yel	68
Flashing red 0.2 red	55
Square LEDs, Red, Green, Yellow	30
Rectangle Stackable LEDs Red, Green or Yellow	18
Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	48
SFH205 Detector	118
TIL32 Infra Red	52
TIL78 Detector	55
TIL38	50
TIL100	75
BARGRAPH Red 10 segments	275

ISOLATORS

IL74	75
ILD74	145
ILQ74	275
TIL111/2/4	70
ILCT6 Darlington	135
TIL117	125
4N33 Photo Darlington	138

7 Segment Displays

TIL312 .3" CA	120
TIL313 .3" CC	120
TIL321 .5" CA	140
TIL322 .5" CC	140
TIL729/730	140
DL704 .3" CC	125
DL707 .3" CA	125
FND357 Red	120
FND500	130
3" Green CA	150
6" Green CA	215
3" ± 1 Red CA	150
3" ± 1 Green CA	150
LCD 3½ Digits	496
LCD 4 Digits	530
LCD 6 Digits	625
Reflective Switch	225
SLOTTED Optical Switch similar to RS Comp's	295

TURNED PIN Low Profile

Professional DIL SOCKETS

8 pin	18p
14 pin	23p
16 pin	28p
18 pin	33p
20 pin	37p
22 pin	39p
24 pin	42p
28 pin	52p
40 pin	72p

SPECIAL OFFER

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

SPDOS

The only professional Disc Interface for the Spectrum Micro.

SPECIAL OFFER THIS MONTH for ONLY £75

COMPUTER CORNER

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

Cable for above printers to interface with BBC Micro £7

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

(Securicor Carriage charge on printers is £7)

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

5¼" DRIVES for the BBC Micro

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

- **CS200** — Epson Single 200K, 40 track Double sided £89
- **CS400S** — Mitsubishi Single 400K, Double sided 40/80 track switchable £103
- **CD400** — Epson dual 400K, 40 track, Double sided £140
- **CD800S** — Mitsubishi dual 800K, Double sided 40/80 track switchable £186
- **TWIN Disc drive case** with Power supply and Cables to house your own drives £35
- All Single Drives with Power supply are supplied in a twin case for later inclusion of a second drive.

(Securicor Carriage on Drives £7)

- **DISC INTERFACE KIT** complete £59
- **DFS Manual** (comprehensive) (NO VAT) £7

BBC MICRO WORDPROCESSING EXAMPLE PACKAGE

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

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

Only: £999

BBC & MICROCOMPUTER & ACCESSORIES

BBC Model B PLUS £365

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

Rapid Electronics

Fast component distribution

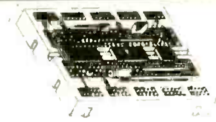
**Unit 1,
Hill Farm Industrial Estate
Boxted, Colchester
Essex CO4 5RD**

**Telephone orders: 0206 36412
Telex: 987756**

LINEAR

		ICM7555	55	LM386	85	ML924	290	SL486	240	TL084	90
		LF347	90	LM387	90	ML925	290	SL490	280	TL170	50
555 CMOS	55	LF351	40	LM393	45	ML926	275	SN76477	380	TL170	50
556 CMOS	150	LF353	70	LM710	48	ML927	275	SPO256AL2	425	ULN20003	80
709	35	LF356	90	LM711	48	ML928	275	Data on above	50	ULN2004	80
741	16	LM301A	30	LM725	270	ML929	275	TBA800	70	ULN2803	130
748	35	LM311	45	LM741	18	NE531	135	TBA810	85	XR2206	395
AY-3-8910	390	LM318	110	LM747	60	NE555	20	TBA820M	60	ZN414	75
AY-3-8912	430	LM324	40	LM1458	35	NE556	45	TCA940	65	ZN423	100
CA3043	60	LM334Z	85	LM2917	170	NE565	95	TDA1022	270	ZN424	70
CA3080E	65	LM335Z	130	LM3909	85	NE566	95	TL061	40	ZN425E	340
CA3130E	75	LM339	40	LM3914	190	NE567	100	TL062	65	ZN426E	200
CA3140E	38	LM348	60	LM3915	190	NE570	230	TL064	95	ZN427E	580
CA3240E	100	LM358	45	LM13600	100	NE571	195	TL071	32	ZN428E	435
ICL7106	680	LM377	210	MC3302	75	NE5532	160	TL072	55	ZN435E	360
ICL7611	100	LM380	80	MC3340	130	NE5534	105	TL074	105	ZN448E	525
ICL8038	395	LM381	130	MF10CN	330	RC4136	65	TL081	28	ZN459	190
ICL8211A	200	LM382	130	ML922	415	RC4558	45	TL082	45	ZN1034E	190

BREADBOARDS



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

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

CAPACITORS

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

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

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

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

TRANSISTORS

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

MICRO

		27128-250	320	6800	200	6522	330
		27256-250	480	6802	280	6532	520
		6116LP3	150	6809	600	6551	540
2716	310	6264LP15	320	6810	140	8085A	320
2532	380	4164-15	160	6821	140	8156	380
2732 one time programmable	280	41256-15	320	6840	360	8251	350
		Z80A CPU	270	6850	165	8253	370
		Z80A PIO	270	6852	240	8255	320
2732	280	Z80A CTC	270	6875	500	8259	400
2764-250	240	Z80A SIO	700	6880	100	MC1488	60
2764-BBC	240	Z80A DMA	700	6502	370	MC1489	60

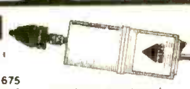
IDC CONNECTORS

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

HARDWARE

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

PCB EQUIPMENT



We offer a comprehensive range of equipment

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

Photo-etch PCB (Professional quality)

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

Plain fibre glass board

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

Etch resist pen 70p

Full range of PCB transfers also available — see catalogue

RESISTORS

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

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

COMPONENT KITS

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

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

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

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

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

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

BRIDGE RECTIFIERS

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

TOOLS

Low cost side cutters 180	
Low cost pliers 180	
Both the above represent exceptional value. We have seen similar tools advertised at £5!!!	
Bib wire stripper	180
Automatic wire stripper	590
Light duty cutters	380

VERO

Veroboard. Size 0.1in matrix

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

Veropins per 100
single sided 55 double sided 65

Spot face cutter 150

RIBBON CABLE

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

CABLES

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

REGULATORS

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

RELAYS

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

SOCKETS

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

NEW CATALOGUE

Our new fully illustrated 84 page catalogue is now available. Contains over 3400 stock lines at the most competitive prices in the market. We now sell more components that all the other mail order companies put together! When you have our new catalogue it's easy to see why! Price just £1 including postage (includes £1 discount voucher) or free with orders over £20 in value. Send for your copy now!

AVAILABLE NOW

OPTO

3 or 5mm red	8		
3 or 5mm green	11		
3 or 5mm yellow	11		
3 or 5mm clips	3		
5mm superbright	30	TIL32	40
5mm tricolour	30	TIL38	35
ILD74	95	TIL78	40
ILQ74	185	TIL100	75
MOC3020	180	ORP12	85

Seven segment displays

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

DIODES

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

AUDIO CONNECTORS

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

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

LS00

		LS13	25	LS47	60	LS95	50	LS157	35	LS193	55	LS273	55
		LS14	35	LS48	65	LS96	75	LS158	35	LS195	55	LS279	50
		LS15	20	LS73	33	LS122	45	LS161	55	LS221	70	LS283	60
LS00	18	LS20	20	LS74	25	LS123	48	LS163	55	LS240	65	LS365	40
LS01	20	LS21	20	LS75	30	LS125	35	LS164	55	LS241	60	LS366	40
LS02	20	LS26	20	LS76	30	LS126	38	LS166	85	LS242	60	LS367	40
LS04	18	LS27	20	LS78	28	LS132	45	LS170	100	LS244	55	LS373	60
LS05	20	LS30	20	LS83	45	LS138	38	LS173	45	LS245	55	LS374	60
LS08	20	LS32	20	LS85	50	LS139	38	LS174	45	LS247	60	LS375	40
LS09	20	LS37	20	LS86	22	LS148	100	LS175	45	LS251	45	LS390	55
LS10	20	LS38	20	LS90	25	LS151	35	LS190	60	LS257	45	LS393	55
LS11	20	LS40	20	LS92	35	LS154	120	LS191	55	LS259	70	LS541	95
LS12	20	LS42	35	LS93	30	LS155	45	LS192	55	LS266	32	LS670	110

D CONNECTORS

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

BOXES

Black ABS with lid and screws

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

CMOS

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

DIN 41612

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

CRYSTALS

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

SWITCHES

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

Submin toggle switches
SPST 55 SPDT 60 DPDT 65

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

Standard toggle
SPST 35 DPDT 48

Miniature push to make 15
Miniature push to break 25

Slide switches DPDT
Miniature 14 Standard 16

CONNECTORS

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

SOLDERING IRONS

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

TTL

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

POTENTIOMETERS

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

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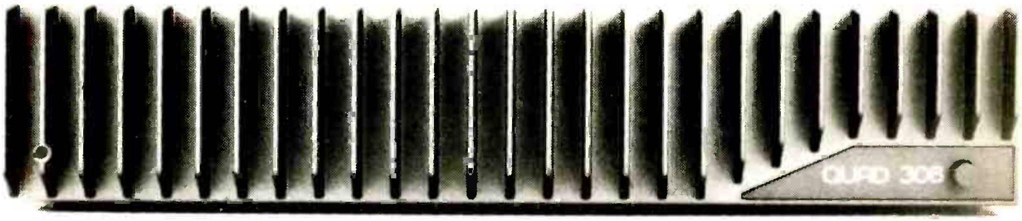
DIGEST

Quad Celebrate With New Amplifier



The Acoustical Manufacturing Company, now known as Quad Electracoustics Ltd, was founded in 1936.

To kick off thier fiftieth anniversary year in accustomed style, they have launched a new stereo power amplifier, the Quad 306.

Designed for use in high quality domestic systems, the 306 has an output of 70 watts into eight ohms and uses a refined version of the 'current dumping' system which was pioneered in the highly-acclaimed Quad 405 amplifier. Separate power supplies are used for each channel, fed from separate windings on a common toroidal, transformer, and the amplifier has a signal-to-noise ratio of 110dB. Fuses, relays and the like have been carefully excluded from the signal path without sacrificing the standard of protection.

The Quad 306 should be available from dealers by the time you read this and will cost £229.00 including VAT.

Quad Electroacoustics Ltd, Huntingdon, Cambridgeshire PE18 7DB, tel 0480-52561.

Free PCB

We would like to remind readers that the multi-purpose PCB (given away free with the last issue of ETI) is available from our Readers' Services Department at the special price of £1 each (plus a stamped addressed envelope). This offer will last only as long as we have stocks of the mass-produced board — after they run out, the board will be available through the PCB service at the normal full price of £2.87 (plus 50p P&P). So if you want to save money, get your order off now!

System A Transistors

Universal Semiconductor Devices Ltd, tell us that they can supply all of the transistors required for the System A amplifier. They offer a kit of semiconductors for the System A power amplifier for £75.00 inclusive and are happy to quote for individual semiconductors for the rest of the system. Their address is 17, Granville Court Road, Hornsey, London N4 4EP, tel 01-348 9420.

Four-In-One Plug

Duraplug have introduced a 13 amp plug which enables up to four appliances to be connected to a single socket outlet without the need for additional plugs and adaptors.

The MultiLine plug is simple to wire and features a mains-on indicator light. It is available in black or white, is fused at 5 amps and constructed in a tough thermoplastic which is highly resistant to impact.

The plug has been especially designed for use with lighting, hi-fi units, video and television, etc. It will cost about £5.00 from most leading electrical and hardware stores.

Ah, So Old

Events at the Hitachi factory in Aberdare have angered Gwent MP Anne Clwyd. In January she told the House of Commons she wants to introduce a Bill to fight age discrimination at work. She informed MPs:

"A year ago the management invited workers aged 35 or more to take so called voluntary redundancy." This, she said, told them they were over the hill at 35. She described how the company had sent a letter to all employees saying that older workers cause problems through sickness, slower reactions, poor eyesight and resistance to change.

The letter did not mention that these problems are almost certainly the direct result of working in electronics factories.

As a recent report on electronics workers in Malaysia* points out:

"Well before they are thirty years of age women electronics workers begin to lose their value. Their productivity begins to diminish as a result of boredom, accumulated fatigue or failing eyesight caused by years of peering through a microscope at hair-breadth wire."

The report also comments:

"It costs less to hire new workers at base starting rates than to keep old workers on at their enhanced rates and fresh workers can achieve high marginal productivity within three or four months of starting a job."

In Malaysia, natural wastage runs at a staggering 6% turnover per month, substituting young workers for older ones. In Britain where the figure is nearer 6% per year, the replacement process has to be forced, but replacing older women with young workers is precisely what Hitachi is doing. The firm announced 500 redundancies when it took over the Aberdare plant from GEC two years ago. Unions at the factory, which makes televisions and videos, insisted on a 'last in first out' policy for the sackings. This left a workforce of 800, mainly older workers, 60% of them women.

Since then the EETPU has won sole negotiating rights and has made a 'no strike agreement'. The union also approved the management proposal for redundancy for older workers. Clearly many older workers felt this left them with no options. They left. Ninety-two workers took voluntary redundancy, 78 of them women. Management refused to consider younger workers for redundancy, but their motivation was hardly philanthropic.

"Redundancy for anyone under 35 is nonsense," company spokesman Tony Pegg told ETI. "Young workers can adjust to change. Older workers can't."

As an example of the intractability of older workers he points out that among the older workers: "Heavy smokers can't cope with the no smoking rule in the production area."

It is difficult to believe that such matters really form company labour policy, but Tony Pegg probably doesn't care whether we believe it or not. His firm has successfully, as he puts it, 'shed' older workers and has found suitable replacements. The company has taken on 77 school leavers.

Hitachi is not the only electroncis company which pursues an apparently ageist employment policy. Another Japanese company, The Nippon Electric Company, has made it a policy to recruit school leavers for its factory in Livingstone, Scotland. The average age of the workforce is reported to be 21.

*Electronics Development: Scotland and Malaysia in the International Electronics Industry. Published by Scottish Educational Action for Development.

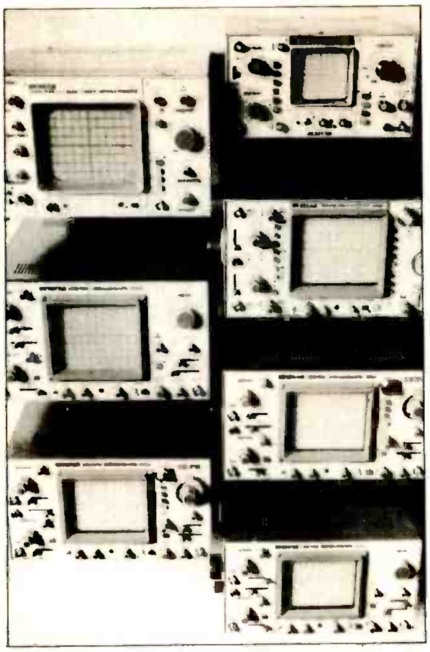
LEADER OSCILLOSCOPES

The Leader range of high performance oscilloscopes are designed to suit most requirements, offering comprehensive specification and long term reliability, yet remaining low cost.

The LBO series includes a battery portable with 20MHz bandwidth, two lost cost 15MHz and 20MHz models and 35MHz, 50MHz and 100MHz laboratory performance models with or without delayed sweep:

LBO-514A is a dual trace, 15MHz bandwidth, 1mV sensitivity, low cost general purpose oscilloscope.

LBO-522 is a dual trace, 20MHz bandwidth, 500uV sensitivity oscilloscope, featuring X-Y, variable hold off plus full TV triggering.



LBO-523 is a dual trace 35MHz oscilloscope offering similiar features to the LBO-522 plus internal graticule dome-mesh tube with 7kV acceleration (pda).

LBO-524 is a 35MHz dual trace oscilloscope similar to the LBO-523 plus the added facility of delayed sweep timebase.

LBO-525L is a 50MHz dual trace oscilloscope offering comprehensive triggering and timebase facilities.

LBO-518 is a 100MHz quad channel oscilloscope with eight trace capabilities, offering comprehensive triggering and timebase options.

LBO-308S is a battery/mains dual trace 20MHz small compact oscilloscope offering all the features normally found in a bench scope.

For further information contact:-

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SATELLITE TV ROUND-UP

Slow But Sure?

Britain's Independent Broadcasting Authority, the IBA, has adopted the slogan 'Evolution Not Revolution' in its attempt to win the broadcast industry over to its C-MAC television transmission system.

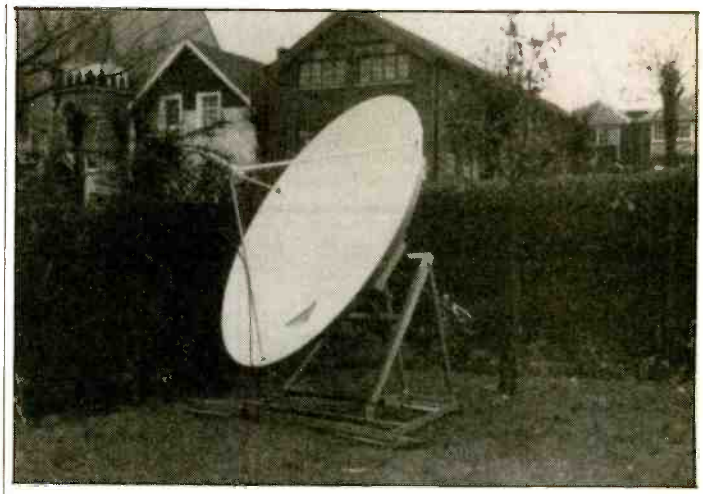
Designed for satellite-based systems in advance of the arrival of genuine DBS (direct broadcast by satellite), C-MAC is a step-up from the 625-line, 50Hz PAL system which dominates world TV broadcasting.

As a first step towards higher definition TV, C-MAC offers a 5:3 aspect ratio (like CinemaScope) and double the normal frame scanning rate. The result is a notably superior picture without too great a departure from current practice but capable of further improvement within a compatible system.

C-MAC has been accepted as the DBS standard by the European Broadcasting Union, is supported by Philips and other European manufacturers and is actually in use in Norway, but it faces strong competition from the 1125-line high definition TV system (HDTV) developed by Sony and NHK, the Japanese broadcasting authority.

Sony have recently demonstrated their system to plaudits from even their greatest opponents. The trouble is not that HDTV is technologically inferior. Far from it. The problem is that the system is not compatible with any existing broadcasting standard. Apart from that, it is expensive, requires tremendous bandwith and utilises a 60Hz field rate (alleged to prevent flicker). Even if the world adopts a 1125-line standard, 75% of all broadcast systems will still use a 50Hz field rate. Converters are inordinately expensive and cannot cope with the interference produced when 60Hz video equipment is used with 50Hz lights.

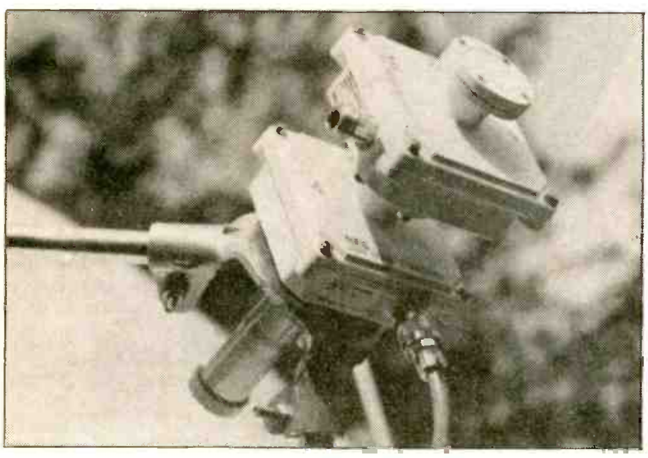
The Sony-NHK system may yet prove victorious — especially since the USA is one of the minority of countries operating on a 60Hz standard. Typically, we may expect Sony (with the aid of American friends) to try to batter us into submission, using a combination of seductive PR and crafty price manipulation. There is a real possiblity that the Japanese HDTV system may become a de facto international standard against the trend of the majority of TV users simply because those who might support the IBA and the EBU in Britain and elsewhere are too busy looking westwards for scraps from Ronald Regan's table to care what happens to European industry and innovation.



Good Connexions

A North London company claim to be the first to supply a full-band low-cost satellite TV receiving system aimed at the UK consumer. Connexions Satellite Systems, part of the SMC Supplies group, have three systems available comprising a 1.2 or 1.6 metre dish antenna, Low Noise Block converter and satellite receiver. The 1.2m system, designed to pick up 'Music Box' from the Eutelsat F1 satellite, costs £995 including VAT, but exclusive of delivery and installation. £1,045 will buy you a similar system with a fixed 1.6m antenna and for £1,295 you can get a system including a motor-driven 1.6m dish which can be readily adjusted to point at either of the two satellites currently broadcasting to Europe and the UK on the 12GHz band, Eutelsat F1 and Intelsat V. The component parts of the system can be bought separately and Connexions say they have 14 distributors throughout the UK. The company are mounting an advertising campaign in March, and they can be contacted at 125 East Barnet Road, New Barnet, Herts. EN4 8RF (tel: 01-441 1282).

X and Y



NEC Busines Systems (Europe) are claiming a first for their NESAT Satellite TV Receiver System. The system features a 1.8m antenna and a small-size Low Noise Converter mounted at the focus. apart from being particularly unobstuctive, the LNCs can be stacked at right angles and their IF outputs combined. In this way, the system is readily utilised for the reception of X,Y and mixed polarisation signals. NEC say that a complete system including antenna, one LNC and tuner with PAL UHF output will cost around £1,500.

Contact: NEC Business Systems (Europe) Ltd, 35 Oval Road, London NW1 7EA (tel: 01-267 7000).

TV Times

● A total of 18 channels are now available for satellite TV viewers in Europe, with two more channels from the Telecom 1 satellite planned for early this year. The channels are: Premiere (movies), Mirrorvision (entertainment), ScreenSport, The Children's Channel and Cable News Network from Intelsat; and Music Box, Sky Channel (entertainment, requires a decoder), TV5 (French language, general), RA1 (Italian language, general), Teleclub (German language movies), Filmnet (Dutch movie channel), Europa TV (general European programming), World Public News and Worldnet (US government news), SAT1 (publishers' channel), New World (religious broadcasts), 3SAT (German language, general) and RTL-Plus (entertainment) from Eutelsat. Only 14 of these, at most, are available at the same time, since Intelsat has only four and Eutelsat ten spare transponders.

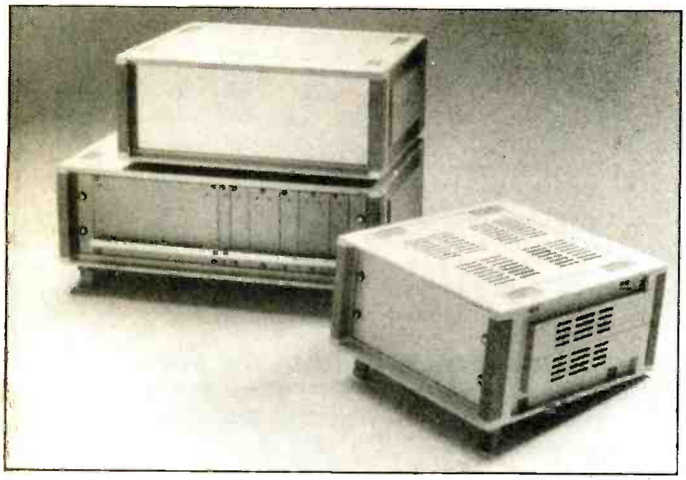
DB Prepared

A French subsidiary of Philips, Portenseigne SA, has announced production of a complete range of receiving equipment satellite TV aimed at every potential user from the large-scale cable and SMATV operator down to individual households. Portenseigne stress that they will be marketing an indoor adaptor for the reception of C-MAC broadcasts when higher-powered DB satellites come into use early in 1987.

PS

eti

A Mr. Gale informs us that he has bound volumes of ETI for disposal. The volumes in question cover the years 1972 to 1977. Mr. Gale can be contacted on 91-205 0221.



Moulded 19"Cases

New from West Hyde Developments is a lightweight, moulded enclosure designed to house 19" racking units.

The Internorm range is available in half, three-quarter and full width versions in heights from 3U (5¼") to 6U. They incorporate fold-away tilt legs which are released by buttons at the sides and an integral handle recess at either end, and West Hyde say they are strong enough to support a man's weight. Wall-mounting and panel mounting versions are availabel as well as free-standing types and other options include ventilation slots and dust/water protection to IP54.

3U high cases are available now ex-stock and larger cases will be supplied to order as they become available. West Hyde Developments Ltd, 9-10 Park Street Industrial Estate, Aylesbury, Buckinghamshire HP20 1ET, tel 0296-20441.

● The latest publication from BICC-Vero is a sixteen page, full colour catalogue which describes their range of plastic instrument cases. The range includes small held-held types, flip-top cases in various sizes, free-standing instrument cases with moulded or aluminium front and back panels, sloping-front cases and tilt-up cases which have a carry-handle cum stand. Accessories such as battery compartments and battery connectors are also listed. For a free copy contact BICC-Vero Electronics Ltd, Unit 5, Industrial Estate, Flanders Road, Hedge End, Southampton SO3 3LG, tel 04892-5824.

● **The Institution of Electrical Engineers have issued further amendments to the 15th Edition of the Wiring Regulations which take effect as from the first January 1986. The principal change is the addition of regulations to cover the use of low voltage control circuits in shower units and other bathroom equipment, but there are also some changes to existing regultions and a number of points have been clarified. Copies of the amendments can be obtained from IEE, PO Box 26, Hitchin, Hertfordshire SG5 1RS for £1.00 including postage. Copies will also be on sale to callers at the IEE, Savoy Place, London WC2.**

● *Dage have released a catalogue of international standard connectors manufacturered by Positronic Industries. Thirteen connector families are described in its 108 pages with photographs, detailed drawings and full dimensions. Also included are cross-reference guides to equivalent products from other manufacturers and to military parts numbers. Contact Terry Reeve, Dage (GB) Ltd, Eurosem Division, Rabans Lane, Aylesbury, Buckinghamshire HP19 3RG, tel 09296-33200.*

● Two people who work for Maplin Electronic Supplies at Southend have raised £420.00 in a sponsored parachute jump for charity. Technical Artist Lesley Foster and Deputy Sales Manager Paul Ridler undertook the jump with four friends in aid of the Child Care Unit at Rochford Hospital. None of them had ever jumped from a plane before. They plan to repeat the jump next year with other Maplin staff and hope to double their sponsorship target.

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PLEASE NOTE

From January 1st 1986 we will be closed Saturdays. Opening times:– Monday to Friday 9am – 5.30pm with late night Thursdays until 8pm.

PROFESSIONAL 9" GREEN SCREEN MONITORS made by KGM for REUTERS. Gives quality 80 x 24 line display' Composite Video In. Cased. Good Condition .... **only £40 each**

5¼" FLOPPY DISK DRIVES

TANDON ½ Height. Brand New
Single Sided Double Density **£45**
Double Sided Double Density **£100**
MPI Double sided, Double Density 80 Track unused **£100**

DISK DRIVE PSU. 240V 1N; 5V 1.6A & 12V 1.5A out. Size: W125mm, H75mm, D180mm. Cased. Un-used. Only £10.00 p&p £2

QWERTY KEYBOARD (as in LYNX micro). Push to make. Cased ...**Only £5 each p&p £2**

AVO TRANSISTOR TESTER TT169 Handheld. GO/NOGO for In-situ Testing. Complete with Batteries, leads & instructions (P&P £3) .... **NOW ONLY £12**

NEW EQUIPMENT

HAMEG OSCILLOSCOPES 605. Dual Trace 60MHZ Delay Sweep. Component Tester **£515**
HAMEG OSCILLOSCOPE 203.5 Dual Trace 20MHZ Compontent Tester **£270**
All Other Models Available.

BLACK STAR COUNTER TIMERS .... **2(p&p £5)**
APOLLO 10 – 100MHz. Ratio/Period/Time Interval etc **£219**
APOLLO 100 – 100MHz. (As above – with more functions) **£285**

BLACK STAR FREQUENCY COUNTERS. P&P £4
Meteor 100-100MHZ **£99**
Meteor 600-600MHZ **£126**
Meteor 1000-1GHZ **£175**
BLACK STAR JUPITOR 500 FUNCTION GENERATOR Sine/Square/Triangle 0.1Hz — 500KHz P&P £4 .... **£110**

HUNG CHANG DMM 6010. 3½ digit. Hand held 28 ranges including 10 Amp AC/DC. Complete with batteries & leads. p&p £4 .... **£33.50**

OSCILLOSCOPES PROBES. Switched x1; x10 P&P£2 .... **£11**

This is a VERY SMALL SAMPLE OF STOCK. SAE or Telephone for Lists.
Please check availability before ordering. CARRIAGE all units £12.
VAT to be added to Total of Goods & Carriage. Please allow 21 days for delivery.

STEWART OF READING
110 WYKEHAM ROAD, READING, BERKS RG6 1PL
Telephone: 0734 68041
Callers welcome 9am-5.30pm Mon-Fri (until 8pm Thurs)

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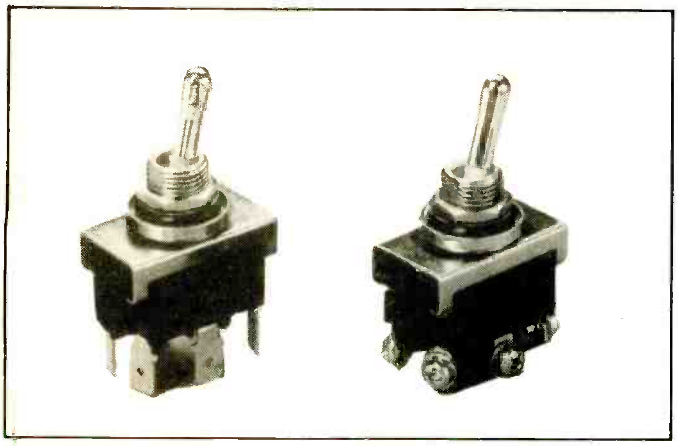
ETI



Waterproof Toggle Switches

Mains-rated toggle switches for use in damp or humid atmospheres are among the new items listed in the latest edition of the B & R Electrical products catalgoue.

The Series AT switches are available with current ratings from 6a to 25a at 125 or 250VaC, come in single and double pole versions and offer eight different switch functions and five terminal styles. They are resistant to cold, vibration and mechanical shock and B & R claim that they will continue to operate correctly even if the terminals are loosened or the case deformed by heat.

The Series At switches arejust one of many new lines included in the fourth edition of B & R's mail order catalogue, which, at nearly 200 pages, is almost twice the size of their previous catalogues. Copies are available free-of-charge from B & R Electrical Products Ltd, Templefields, Harlow, Essex CM20 2BG, tel 0279 4561.

Cortex Users Group

KPH Computaware inform us that they have taken over responsibility for the Cortex Users Group from Powertran.

The group was originally set up by Powertran when they were marketing kits of the Cortex microcomputer based upon the ETI design. In its new guise, the group will offer a quarterly newsletter and a range of software and hopes to be able to supply hardware in the near future. The annual subscription is £5.00 and all enquiries should be addressed to KPH Computaware, 63 Highlands Road, Andover, Hampshire SP10 2PZ.

● RR Electronics can now supply the LB5410 blue light emitting diode from Siemens which was described in News Digest in January 1985. They can also supply the Siemens Light Bar displays which we described in the December 1985 issue. Contact RR Electronics Ltd, St Martins Way, Cambridge Road, Bedford MK42 0LF, tel 0234 - 47211.

● The Royal Television Society are inviting nominations for two of its annual awards. The John Logie Baird Travelling Scholarship is worth £1,500 and will be awarded to a post-graduate student at a UK educational establishment carrying out research in television, electronic engineering or a related field. The money is to be used for a period of study overseas. The Geoffrey Parr Award is presented in recognition of an outstanding contribution to television engineering or an associated science. Contact Francesca Smith, the Royal Television Society, Tavistock House East, Tavistock Square, London WC1H 9HR, tel 01-387 1970.

● The London Electronics College celebrates its 80th anniversary this year and plans to mark the occasion by tracking down its oldest former student. It was founded in 1906 as the British School of Telegraphy and reckons to have trained some 5,000 students. If any elderly ex-student is so hip and up-to-the-minute as to be reading this magazine, the college would love to hear from you on 01-373 8721.

Digital Meters for less than a Moving Coil

SPECIAL OFFER

Digital Panel Meters

BRAND NEW

and Surplus to Manufacturers' Requirements.

EXCLUSIVE

We have a small number of these 3½-digit LED panel meters supplied to us by a well-known manufacturer and as used in professional equipment. The bright, 0.5" display is easily readable even in low-light conditions. The units are powered from a single 5V supply to give, without any external circuitry, a full-scale reading of 199.9mV. They are supplied complete with instructions giving details of calibration and range-setting via on-board links and trimmers.

These units are accurate and sensitive and can be used as the basis of any kind of meter. They are unbeatable value at the offer price, which is inclusive of VAT and post and packing, being less than half the price of the cheapest comparable unit available from regular suppliers. In fact, they cost no more than a reasonable quality moving-coil panel meter.

As mentioned last month, we plan to bring you some applications circuits for these units. Unfortunately, illness has prevented us including such circuits this month.

Cut out and send to ASP Readers' Services (RO ET2), PO Box 35, Wolsey House, Wolsey Road, Hemel Hempstead, Herts. HP2 4SS. Or telephone your ACCESS or VISA number to 0442-41221.

Please supply .... digital panel meters at £9.95 each.

I enclose a cheque/Postal Order/International Money Order made payable to ASP Ltd.

Or please debit my ACCESS/BARCLAYCARD No:

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to the amoung of £ .... (valid from .... to ....).

ORDER CODE: RO ET2

NAME ....

ADDRESS ....

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SIGNATURE .... DATE ....

PLEASE ALLOW 28 DAYS FOR DELIVERY

Offer valid until 4 April, 1986, or while stocks last. Order Code: RO ET2

NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

A COMMUNICATIONS SPECIAL

'I wonder,' said Eitenne Scrooge, making his long-awaited return to these pages, 'whether anybody noticed the second April Fool joke in last month's ETI?' There came no reply, which was hardly strange since Etienne was talking to himself. 'But hold hard, varlet,' said Etienne. 'This himself is well known as a most voluble character, verbose even, talkative certainly, loud-mouthed and brash almost indubitably ....'

Himself could stand it no longer. With the sort of startling verbal dexterity and wit which had gained himself an enviable reputation as a raconteur, after-dinner mint and general conversationalist, he leapt to his own defence. 'Shut up!' he said to Etienne, displaying the sort of loquaciousness and vocabularistic facility which had made himself justly renowned in at least two and a bit continents. 'I will not hear myself slandered,' he said. 'But I was slandering himself,' protested Etienne, 'and if you prefer, I'll do it in the next room.'

Confusion reigned and the rain rained while la Reine reined in the horses. 'What we need is a little clarification on the question of communication,' Etienne thought to himself. Himself didn't know why Etienne couldn't have spoken like everyone else, but he guessed that his friend had been experimenting with telepathy. Unthinkingly, but not thoughtlessly, himself flung a copy of the May ETI in front of Etienne. It was something of a communciations special and, perhaps, Etienne could earn a thing or two. Just then, General Conversationalist burst into the room ....

The Troglograph

The Troglograph is a very low frequency communications transceiver, designed expressly for transmission through rock. VLF is creating a great deal of interest and we hope to show why. The Troglograph has been field tested in a Pennine cave, but should be useful in a number of different situations.

Modem Baud Rate Converter

This unit will allow almost any serial communication protocol to be used for data transmission and reception. Originally designed so that a back-channel MODEM could be connected to a Sincalir QL, the circuit can be used in practically any context. It will allow switchable control of 1200/75 and 30/300 baud rates. It can be used to interface a home micro to a 110 baud TTY printer. It will allow conversion to 50/300 baud rates and more. A very useful project.

PLUS

An 80 metre direct conversion receiver, lasers and optical communication and do-it-yourself automatic testing of TTL chips using some simple electronics and software suitable for the Spectrum or similar computers. And lots, lots more.

Also

All our usual features, Tech Tips, News Digest, Read/Write, Circuit Solution, Reviews, Open Channel, Trains of Thought, Playback etc. etc. etc.

THE MAY ISSUE OF ETI, ON SALE APRIL 4th COMMUNICATING ALL THAT'S BEST IN ELECTRONICS

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

NEWS: NEWS: NEWS

DIARY

Digital Techniques In Television: Recording — March 4th
The IBA, Bromptom Road, London SW3, 6.30 pm. Ninth in a series of lectures organised by the Royal Television Society. Cost is £13.80. Contact Liz Rankin on 01-387 1970

Power UK '86 — March 4–6th
Kensington Exhibition Centre, London. See March '86 ETI or contact TCM Expositions Ltd, Exchange House, 33 Station Road, Liphook, Hampshire GU30 7DN, tel 0428-724 660.

Telecommunications R&D: The Door To Tomorrow — March 5th
The IEE, London, 5.30 pm. Lecture given by W.T.G. Jones of BT, in association with the IERE. Contact the IEE at the address below.

The Application of Surface Mounting Techniques in Broadcast Engineering — March 6th
The IEE London, 5.30 pm. Lecture by A.M. Stark of Mullard Ltd. Contact the IEE at the address below.

System-On-A-Chip Seminar — March 6th
The Meeting Rooms, London Zoo. Seminar by Hitachi on their 64180 microprocessor. Includes introduction of a single-board evaluation system for the 64180. Cost is £25.00 plus VAT. Contact Miss S. Walker at Hitachi, tel 01-861 1414.

Electronic Production Efficiency Exposition — March 11–13th
Olympia, London. See November '85 ETI or contact Network Events Ltd, Printers Mews, Market Hill, Buckingham MK18 1JX, tel 0280-815226.

Digital Techniques In Television: Advanced 625-line Broadcasting — March 11th
The IBA, London, 6.30 pm. See entry for March 4th above.

Digital Techniques In Television: High Definition Television — March 18th
The IBA, London, 6.30 pm. See entry for March 4th, above.

Electro-Optics/Laser International — March 18–20th
Metropole Convention Centre, Brighton. See March '86 ETI or contact Cahners at the address below.

Low Energy Ion Beams — April 7–10th
University of Sussex, Falmer, Brighton. See March '86 ETI or contact the Meetings Officer of the Institute of Physics, 47 Belgrave Square, London SW1X 8QZ, tel 01-255 6111.

Design of Printed Circuits — April 7–11th
Cranfield Institute of Technology, Bedford. Course aimed at draughtsmen/designers starting work and at those converting from mechanical to electrical design. Contact Brian Phelps on 0234-750113 extension 2737.

British Electronics Week — April 29–May 1st
Earls Court and Olympia, London. Single event combining the All Electronics/ECIF Show, Fibre Optics, the Circuit Technology Show and Electronic Product Design. Contact Evan Steadman Services Ltd, The Hub, Emson Close, Saffron Walden, Essex CB10 1HL, tel 0799-26699.

Electrical Insulation Conference — May 19–22nd
Brighton. See March '86 ETI or contact the British Electrical and Allied Manufacturers Association, Leicester House, 8 Leicester Street, London WC2H 7BN, tel 01-437 0678.

Advanced Infrared Detectors And Systems — June 3–5th
Institution of Electrical Engineers, London. See March '86 ETI or contact the IEE at the address below.

Addresses:
Cahners Exhibitions Ltd, Chatsworth House, 59 London Road, Twickenham, Middlesex TW1 3SZ, tel 01-891 5051.
Institution of Electrical Engineers, Savoy Place, London WC2 0BL, tel 01-240 1871.
Online Conferences Ltd, Pinner Green House, Ash Hill Drive, Pinner, Middlesex HA5 2AE, tel 01-868 4466.

ETI

01-208 1177 TECHNOMATIC LTD 01-208 1177

BBC Micro Computer System

BBC Master Series
- AMB15 BBC MASTER Foundation computer 128K ... £435 (a)
- AMB12 BBC MASTER Econet computer 128K (only ANFS) ... £348 (a)
- AMC06 Turbo (65C102) Expansion Module ... £87 (b)
- AMC03 32016 Expansion Module with 0.5Mb RAM ... £POA (b)
- ADF13 Rom Cartridge ... £13 (d)

ACORN COMPUTER SYSTEMS
- BBC B PLUS with DFS ... £369 (a)
- BBC B PLUS with 128K ... £389 (a)
- BBC B PLUS Econet (No DFS) .. £360 (a)
- BBC B PLUS Econet & DFS ... £399 (a)
- BBC Dust Cover ... £4.50 (d)

UPGRADE KITS
- Econet Kit ... £55 (d)
- 1770 DFS Upgrade for Model B £43.50 (d)
- 1.2 OS ROM ... £7.50 (d)
- DNFS ROM ... £17.50 (d)
- ADFS Rom (for B with 1770 DFS & B Plus ... £26 (d)
- 64K Upgrade Kit for B Plus ... £35 (d)

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

COMMUNICATION ROM
- Termulator ... £25 (d)
- Communicator ... £49 (d)
- Commstar ... £28 (d)
- DATABEEB ... £22 (d)

BBC FIRMWARE & SOFTWARE
Database Management Systems
Word Processors
Spreadsheets
Languages
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 ... £254 (a)
- PD800 (2 × 400K/2 × 640K 40/80T DS) ... £224 (a)
- TS400 1 × 400K/1 × 640K 40/80T DS £99 (b)
- PS400 with psu 1 × 400K/1 × 640K 40/80T DS ... £120 (b)

3.5" DRIVES
- 1 × 400K/1 × 640K 80T DS TS35 1 ... £99 (b)
- 2 × 400K/1 × 640K 80T DS TS35 2 ... £174 (b)
- PS35 1 with psu ... £119 (b)
- PS35 2 with psu ... £189 (b)

3M FLOPPY DISCS

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

5¼" DISCS		3½" DISCS
40 SS DD £12 (d)	40T DS DD £16 (d)	80T SS DD £30 (d)
80T SS DD £21 (d)	80T SS DD £22 (d)	80T DS DD £38 (d)

DISC ACCESSORIES

FLOPPICLENE Disc Head Cleaning Kit with 20 disposable cleaning discs ensures continued optimum performance of the drives ... £14.50 (c)

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

PRINTERS

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

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

TAXAN KAGA:
- KP810 80 Col NLQ ... £195 (a)
- KP910 156 col NLQ ... £339 (a)
- JUKI 6100 Daisy Wheel ... £279 (a)
- HR15LX (Serial) ... £310 (a)
- HR15LX (Serial) £365 (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 ... £6.00 (d)
- Spare pens for H180 ... £7.50/set (d)
- FX80 Tractor Attachment £37 (c)

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

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

BROTHER HR15:
- Sheet Feeder ... £189 (a)
- Tractor Feeder ... £99 (a)
- Ribbons Carbon or Nylon ... £4.50 (d)
- 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.

MICROVITEC

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

14" RGB
- **1431** Std Res ... £185 (a)
- **1451** Med Res ... £240 (a)
- **1441** Hi Res ... £375 (a)

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

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

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

KAGA TAXAN 12" RGB
SUPERVISION III Plus with amber/green option ... £345 (a)

MITSUBISHI 14" RGB Med Res IBM & BBC Compatible ... £229 (a)

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

MODEMS
— All modems listed below are BT approved

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

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

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

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

Data Cables for above modems available for most computers.

SPECIAL OFFER
- **2764-25 ... £2.00**
- **27128-25 ... £2.75**
- **6264LP-15 ... £3.75**

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 ... £71 (b)
- UV141 as above but with a timer ... £88 (b)

CONNECTOR SYSTEMS

I.D. CONNECTORS
(Speedblock Type)

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

D CONNECTORS
No of Ways

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

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

EDGE CONNECTORS

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

EURO CONNECTORS

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

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

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

AMPHENOL CONNECTORS

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

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

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

RS 232 JUMPERS
(25 way D)
- 24" Single end Male £5.00
- 24" Single end Female £5.25
- 24" Female Female £10.00
- 24" Male Male £9.50
- 24" Male Female £9.50

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

RIBBON
(grey/metre)

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

DIL HEADERS

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

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

READ/WRITE

New Rads for Old

Dear Sir,

In reply to your invitation to contact you about Newrad Instruments, I have now received nearly all of the parts for the enclosures for the Linsley Hood amplifier. The parts still to come are the front and rear panels and wooden edges. As I have been waiting 1½ years for the complete kit it doesn't seem likely that I will get them now, so it looks as if I will have to make my own panels, unless you know of anyone else who could supply them.

I have been buying your magazine for three years now and I still think it is tops. It leaves the competition standing. I also totally agree with your politics and attitude towards defence establishments etc. Don't change; more power to your elbow!

Yours faithfully,
D. Lucas,
Glasgow.

Too much, Mr Lucas. You make us all blush! You have obviously realised that the one sure way to get your letter into READ/WRITE is to shower us with compliments. I wish we could give some help with your amplifier case, but I'm afraid we don't know of anyone else who makes them. If anyone does know who could make the panels, or even the complete enclosure, please write to us and we'll pass the information on. – Ed.

Cubic Equations

Dear Sir,

I read with interest Chris Fenn's solution to the resistor cube problem in READ/WRITE, ETI March 1986. I have an easier way to reach the same result. Referring to Mr. Fenn's diagram, if you consider a current, I, flowing into A and out of G, by the symmetry of the network, this would give currents of I/3 through each of the branches AB, AD and AE. The current would subdivide further into I/6 flowing down each of the six intermediate branches, then combine into currents of I/3 flowing down each of thre three paths into G. Taking any route through the cube, A-B-C-G for instance, and adding the voltage drops, we get:

$V = (1/3) \times I + (1/6) \times I + (1/3) \times I = (5/6) \times I$ Volts. Since V is the total voltage drop across the cube for a current, I, Ohm's law gives the resistance r of the cube as: $r = (5/6) \times I/I = 5/6$ Ohms.)

Yours faithfully,
Mr S.P. Patel, C.Eng, MIEE,
Ilford,
Essex.

Lost Knight of the PROMs

Dear Sir,

I was interested in the Digital Barometer project published in the February issue of ETI. However, although I am an experienced constructor I do not possess the equipment necessary to program the EPROM. Since I have been unable to find anyone to do the programming for me, it makes the project useless to me, and, I suspect, to many others.

Could you give some thought to arranging for an independent firm to provide an EPROM programming service to ETI readers, or at least advise me on how best to overcome what must be a simple problem to those computer buffs more attuned to software techniques?

Yours faithfully,
S.T. Payne,
Gt. Missenden,
Bucks.

Although we do not have a formal arrangement with anybody to supply EPROMs for ETI projects, a firm you will find very helpful is: EPROM Services, 126 Milton Grove, London N16 8QY. They can supply ready blown EPROMs for many projects, and will also program them to your specifications. – Ed.

AUNTIE STATIC'S PROBLEM CORNER

Dear Auntie,

I have built the System A pre-amplifier from ETI, July 1981, and find that the DC offset at the output is about 450mV. I would like to DC couple the last stage of the pre-amp into my power amplifier, so will you please tell me how to reduce the offset? Thank you.

G. Ferrari,
Watford,
Herts.

Normally I am not encouraged to answer questions about specific projects, but as the System A is so popular the Editor has made an exception in this case. The DC offset in the pre-amp arises from two sources: a few tens of mV from differences in V_{be} between Q15 and Q16, but much more significant is the bias current for these transistors flowing through substantially different resistances.

The bias current for Q15 flows through a 100k resistor (R30) giving a voltage drop of 10mV per µA. The situation at Q16 base is a little more complicated. Imagine that R37 is removed from the circuit. The bias current for Q16 would flow through R36 and a portion of RV2 — a resistance of around 1k0, giving a voltage drop of the order of 1mV per µA — about 100 times less than that of R30. Now, the DC action of the feedback is to maintain roughly equal collector currents in Q15 and Q16 by keeping their bases at the same voltage (ignoring, for a moment, Vbe differences which will be an order of magnitude less than the voltages we are concerned with). Since the voltage drop in R36/RV2 is only about 1% of the drop in R30, the circuit must be balanced by the potential divider action of R37 with R36 and the selected portion of RV2. The net result of all this is that the output will be below 0V by roughly ten times the voltage drop in R30. The figures are rough, but they illustrate the mechanism involved.

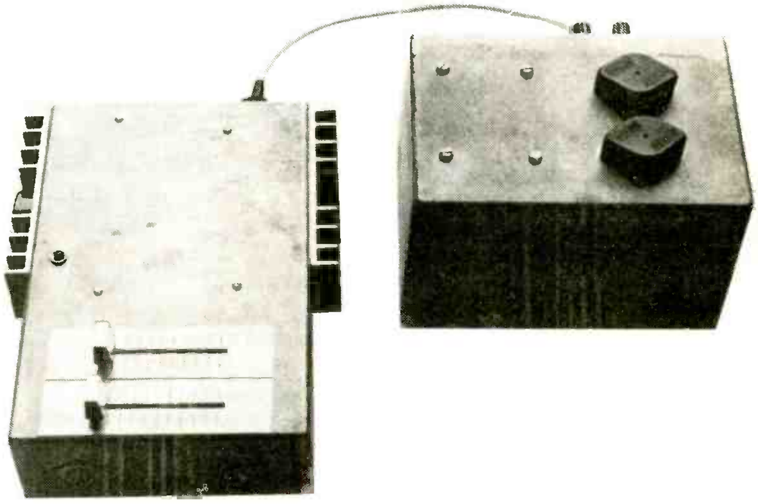
There are several possible solutions. The offset can be reduced by a factor of ten or so by inserting a large electrolytic capacitor between R36 and RV2. The advantage of this method is that the results are stable and predictable, since the improvement occurs because of a substantial increase in DC feedback. The disadvantage is that you must find room for a capacitor of several hundred µF, since R36 has such a low value, to prevent excessive low frequency rolloff.

Another solution is to insert a 100k resistor between the junction R36/37 and Q16 base. There will still be some residual offset from differences in V_{be} between Q15 and Q16 and from differences in their bias currents, but this would be tens of mV rather than hundreds. If you are determined to remove every bit of offset, use a 200k preset instead of the 100k resistor. Offset cancellation achieved in this way will drift to some extent with time and temperature variations, so please bear this in mind. – Auntie.

ETI

CONVERTER FOR PA AMPLIFIERS

A portable public address system of reasonable quality would prove useful at many outdoor events, but the absence of a mains supply poses a problem. John Linsley Hood paves the way for his PA amplifier design with a DC-DC converter which produces 55V from a 12V car battery.



One usually sees electronic circuit designs only in their final form, as though the designer had put down on paper precisely what was required and then, perhaps, instructed some minion to assemble and test the design — just to make sure it did indeed perform exactly as specified.

If the design required is very simple or if the designer has had considerable experience in producing similar designs, the above procedure might be followed. More often, without the services of a careful and trustworthy minion and where the requirements are fairly straightforward, the circuit will probably go straight from brain to hardware and nothing will be put on paper until all is complete and satisfactory.

However, especially when working in unfamiliar territory, a prudent designer will look through the files and the back numbers of electronics periodicals to see if anyone has done something similar before. If the previous author has also described all the snags, much trouble can be spared.

In the case in point, the design of the audio ampifier would be quite straightforward for me but the provision of a DC supply would be much less familiar territory. Since the final design involved a couple of false starts, abandoned because of afterthoughts, it occurred to me that it might be interesting to describe the thought processes involved as the final design took shape.

The DC-DC Converter

The process began with the decision that the required audio power output was to be 50 watts into a 4 ohm load. Four ohms is a fairly common value for public address speaker units and 50 watts does make quite a loud noise, especialy when you bear in mind that PA driver units are usually a lot more efficient than their hi-fi equivalents.

This power/load combination would require an output AC drive voltage of 14.14V RMS ($V = \sqrt{P.R}$). This is 40V peak-to-peak. Since the power amplifier output stage will inevitably have a DC voltage drop at full power of some 12-15V, a DC power supply of 55V will be needed. A similar calculation shows that the RMS current into the load will be 3.54A, which implies a half-peak (average) DC supply current of some 1.77A. Allowing for other amplifier needs, some 2A should be allowed.

Since 2x55 = 110W, the overall efficiency of the system will be 45% and the heatsinks will need to be able to dissipate some 50 watts (1.77x55-50.) Also, because the DC-DC converter will be only 85% efficient at best, the demand from the battery will be 10.5 amperes at maximum output. If the converter system is reasonably well designed, the quiescent current demand at zero or low volume levels should be a good bit less than this, say 0.5A. However, the thought of a battery drain of 10.5 amperes makes one feel that there is a good case for not making it a 100W or 200W system.

The Circuit Design

Inverter circuits consist of some form of power oscillator driving a coupling transformer, usually at a frequency well above 50Hz in order to make the transformer a smaller and lighter unit. The several forms which this oscillator can take include single-ended or push-pull, self-oscillating or driven from some external source, forward or fly-back, and I have shown the layouts employed in Fig. 1.

The forward converter system is that in which the output transformer secondary voltage is generated during the period in

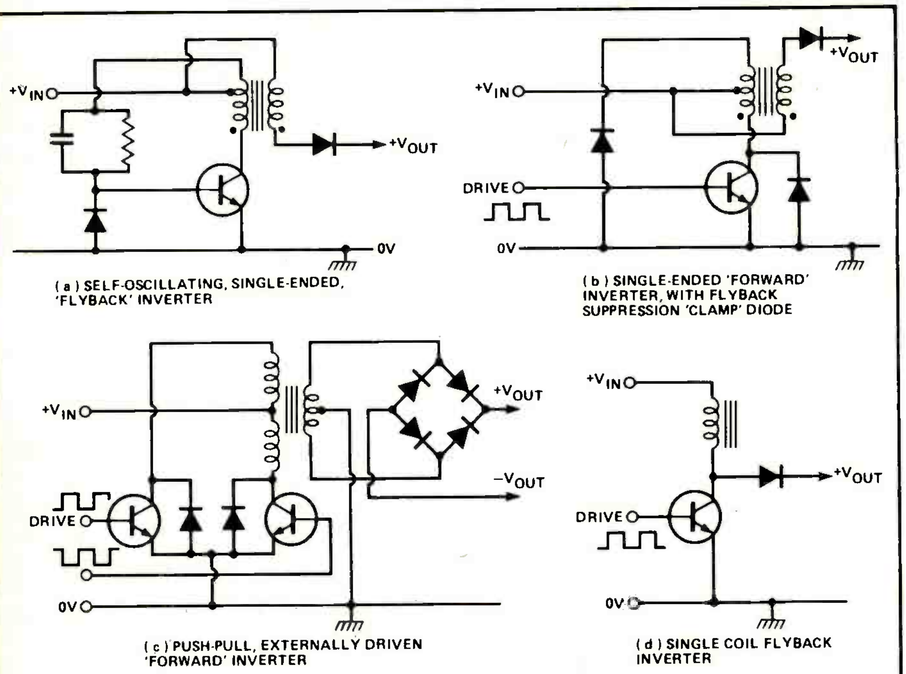


Fig. 1 Various circuit arrangements for an inverter.

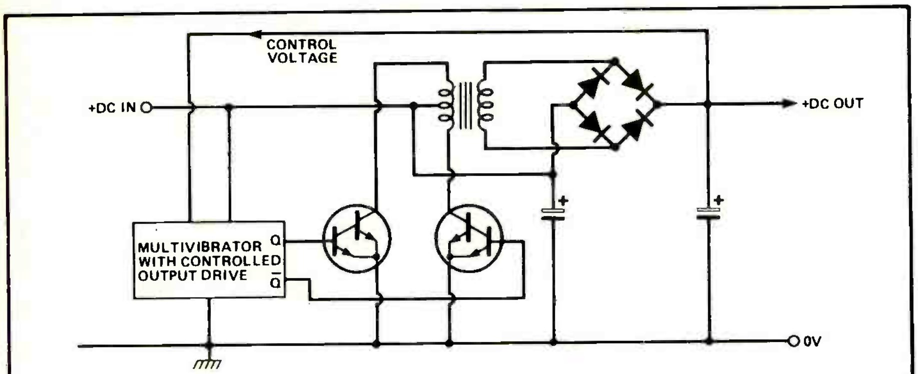


Fig. 2 A DC-DC converter with push-pull drive.

which current is flowing in the primary circuit — as in normal transformer operation. In general, this is a more efficient system than the flyback converter in which the secondary or even the primary, output voltage is that developed when the primary current is suddenly interrupted. The conventional motor car ignition coil is an example of a flyback converter.

Since we are hoping for the best practical efficiency in order to minimise battery drain, the forward system is to be preferred. Again, in the interests of efficiency, a push-pull system will be preferable, especially since there will then be two (or four) power switching transistors to cope with the 10 A primary current demand. This suggests the layout of Fig. 1c.

The next choice is between a self-oscillating circuit, in which the base excitation signal for the switching transistors is derived from a separate small winding on the step-up transformer, or one in which the switching waveform is derived from some external circuitry. This is also an easy choice to make. Self oscillating systems are notably dependent on the output load, and this means that their operating frequency can fluctuate, or that they can stop oscillating or even fail to start in the first place.

Also, if the excitation voltage is derived from some external small signal circuitry, it will be much easier to manipulate this to provide output power or voltage control. This leads to a circuit layout of the kind which I have shown in Fig. 2. The choice of power Darlington devices as the switching transistors, Q1 and Q2, is suggested because they are not a lot more expensive than ordinary power transistors but have drive requirements that are so small (10mA for full output) that the control circuitry need only use small signal transistors.

The Drive Circuit

Having decided upon the switching transistor configuration to be used at the output of the converter, the next thing was to decide what kind of mulitvibrator I should use to drive it.

The symmetrical emitter-coupled free-running multivibrator of Fig. 3, using a pair of PNP transistors, can directly drive the output (switching) transistors. Power control could be achieved by the circuit modification shown in Fig. 4, in which the current through the current source transistor, Q1, could be throttled back by way of the potential divider R6/R1 and D1 if the output voltage exceeded some predetermined value. This circuit works well, but requires that the supply voltage to Q1 (R7) should be held at a fixed level, to provide a reference voltage.

Unfortunately, for a power switching circuit it is essential that the switching devices should be

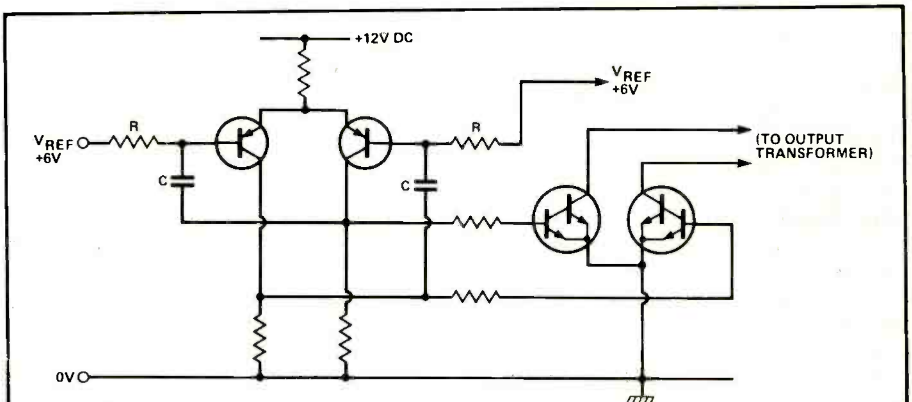


Fig. 3 A simple multivibrator drive circuit.

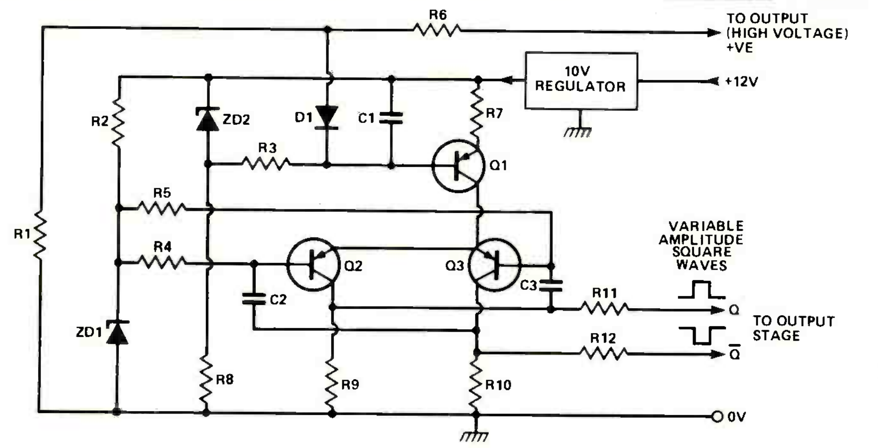


Fig. 4 A multivibrator arrangement with controlled output drive voltage.

either fully on or fully off. In any intermediate state they will dissipate unwanted amounts of power, which will reduce the low output power efficiency of the system.

What is required for such a system is a pulse-width modulator drive circuit, in which the output devices are either hard on or hard off but where the duration of the on pulse to each switching transistor could be varied from a 50/50 duty cycle (for maximum output power/voltage) to a 1/99 duty cycle (for minimum output power/voltage) as shown in Fig. 5.

Looking through my notebooks, I found I had built a circuit of this type for another application using the layout I have sketched in Fig. 6. In this, a square-wave generator feeds a sawtooth generator and a divide-by-two circuit. The output of the sawtooth generator is then sliced by a circuit having variable 'slice' level, to give a repetitive rectangular pulse waveform output whose duration can be altered from 0% to 100%. The Q and $\bar{Q}$ outputs of the divide-by-two stage can be used to control a pair of AND gates which feed the output pulse to either one or other of the output switching devices via a suitable buffer.

This circuit works very well, and could be implemented using standard CMOS logic, but it looked a bit over-elaborate for what I had in mind.

My thoughts then turned to the simple astable multivibrator, using a pair of junction FETs (Fig. 7). This would give the output waveforms a and b at the points x and y in the circuit, and these could be sliced, squared, and inverted to give an alternate drive pulse to each output device.

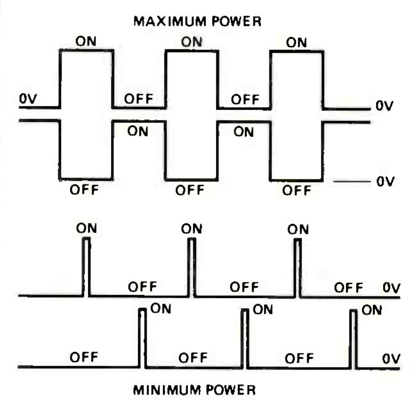


Fig. 5 Controlling the output power by pulse width modulation.

This does work, but cheap junction FETs vary enormously in their turn-on threshold voltage, and in order to get an equal mark-to-space ratio the FETs would have to be selected or R1 and R5 would have to be made adjustable. Also, the use of a Zener diode to provide the source reference voltage makes the circuit too sensitive to changes in the supply voltage.

This can be resolved by replacing the FETs with junction transistors, which are more consistent in their turn-on voltage. For silicon devices, this will always lie between 0.5 and 0.6V in the forward bias sense. Unfortunately, silicon transistors are not ideal for multivibrators because, if their bases are driven more than about 5V negative, the base-emitter junction acts as a Zener diode and can cause collector current to flow, even when the transistor is supposed to be turned hard off.

This problem can be avoided by adding protection diodes, D1 and D2 to stop Q1 and Q2, from being reverse biased (Fig. 8). Then, when the multivibrator action drives the lower ends of R1 and R6 negative, the diodes disconnect and the transistors are left with zero forward bias but with bases returned to emitters through

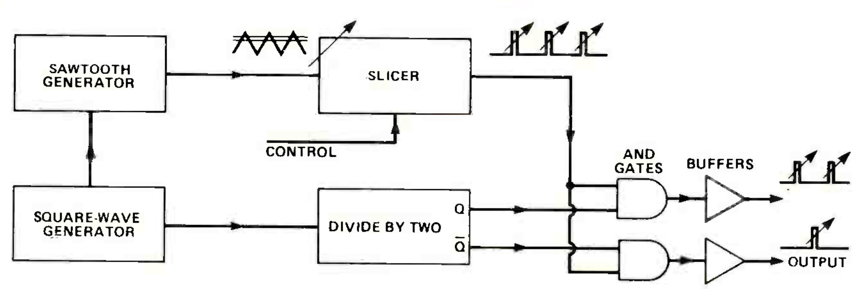


Fig. 6 Block diagram of a pulse width modulation drive circuit.

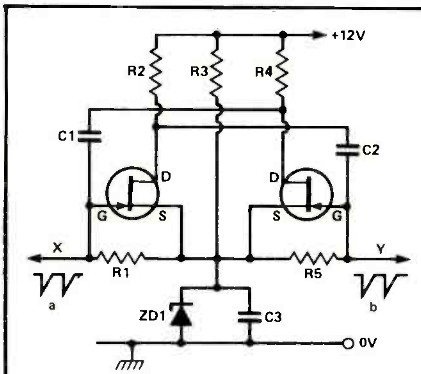


Fig. 7 Simple astable multivibrator using junction FETs.

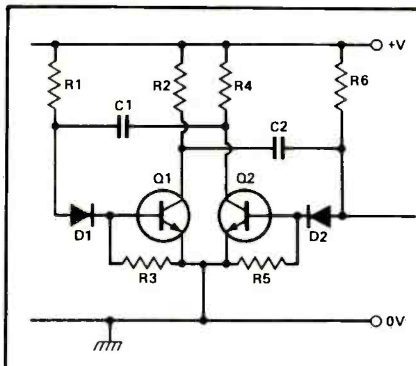


Fig. 8 An improved bipolar multivibrator.

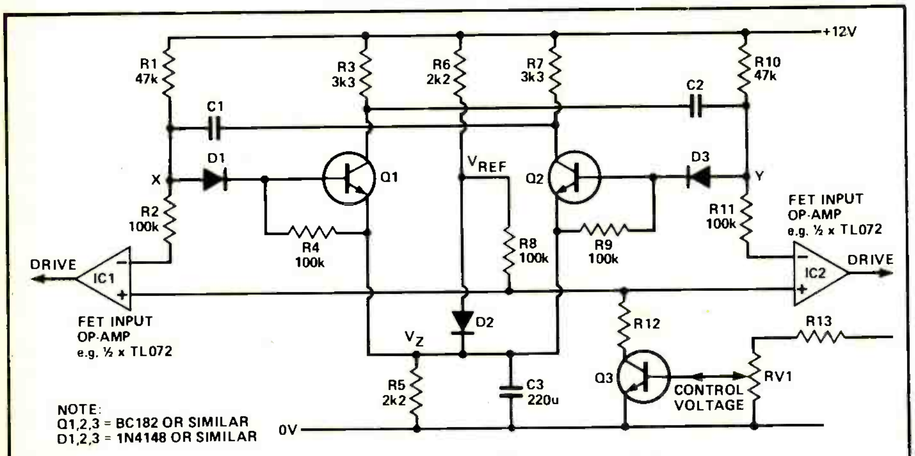


Fig. 9 A bipolar multivibrator with pulse width control of the output waveform.

R3 and R5 to prevent unwanted leakage currents.

A final version of the driver circuit based on this layout is shown in Fig. 9, in which a pair of FET input op-amps is used to sample the outputs at x and y, and deliver an alternate output rectangle drive pulse to the output switching devices.

If the output voltage from the inverter rises too high, it can be sampled by R13 and RV1 which will turn on to lower the input reference voltage applied to the op-amp. This will reduce the on time as the switch point slides down the slope of the waveforms a and b in Fig. 6.

By taking the op-amp reference voltage from the top end of D2, the maximum on time is made nearly 50%, but cannot exceed this. This is because the turn-on voltage, measured at x and y, is Vz plus two forward silicon PN junction potentials (D1 and Q1 b-e, or D3 and Q2 b-e), whereas Vref is Vz plus only one forward junction potential, (D2).

This circuit works as anticipated, but is not yet in a final form simply because it is not fail safe. If the oscillator were to stop oscillating for some reason — device failure, perhaps, or too low a supply voltage — the outputs of IC1 and IC2 would be left permanently high and the drive transistors would both be turned hard on.

This snag can be avoided by the adoption of the coupling circuit of Fig. 10. This is AC coupled and the signal waveform is DC restored positive by the networks D1R1 and D2R2. If the input drive waveform disappears, the output drive voltage will collapse to zero and both the output devices will be turned off.

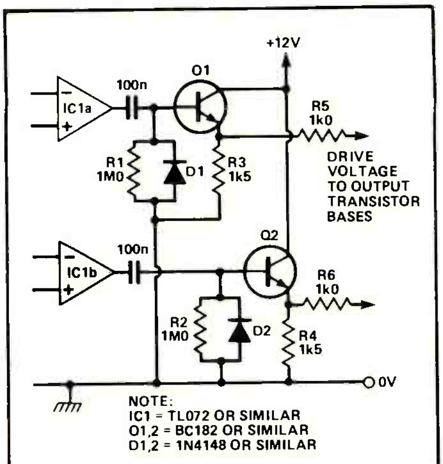


Fig. 10 An output coupling arrangement.

Other Snags

I had hoped to use a standard mains transformer as the step-up unit, which would save a lot of trouble. However, having got the prototype to work quite well on low power outputs, I started to do some serious power output and efficiency measurements at the projected output power levels and using a car battery instead of a stabilised DC power supply. The results were very disappointing unless I used a really large, high-power (and high cost) toroidal unit. For the record, the ILP 62033 (240V/50-0-50) was not too bad, but still not as good as I had hoped in terms of output power regulation.

The difficulty is that the effective secondary leakage inductance of a standard 240V unit is too high. The 'leakage' inductance is the value seen at the low voltage secondary terminals when the primary (240V) winding is short-circuited. This depends on the total number of turns in the windings, the type of core, and the way it is wound. Toroidal cores are generally better than E/I cores, and bifilar windings (side by side and wound together at the same time) are better than separate ones. However, the main problem is the number of turns in total.

With too high a leakage inductance as seen at the collectors of the switching transistors, the current at switch-on takes too long to rise to the necessary value and this means that the secondary current also takes a considerable time to build up. This is exaggerated by the fact that, in the interests of low power losses in the switching devices, we are using a square wave input drive to the transformer rather than a sinusoidal drive.

In spite of my best intentions, it looked as though I should have to wind a transformer. The choices here are whether to use a laminated iron core or a ferrite core. Ferrite-cored transformers only work well above about 15KHz where the efficiencies of power transistors, op-ams, and standard rectifier diodes are beginning to deteriorate. Laminated iron cored transformers are at their best from about 50Hz to 1000Hz, which is not too high a

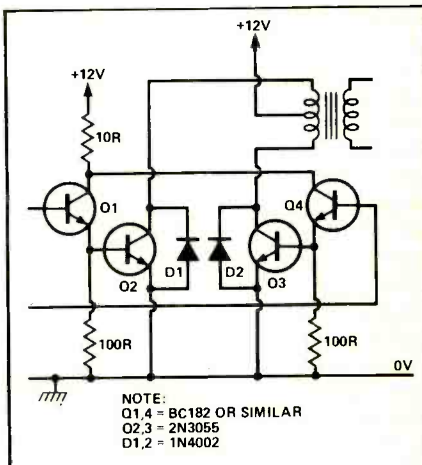
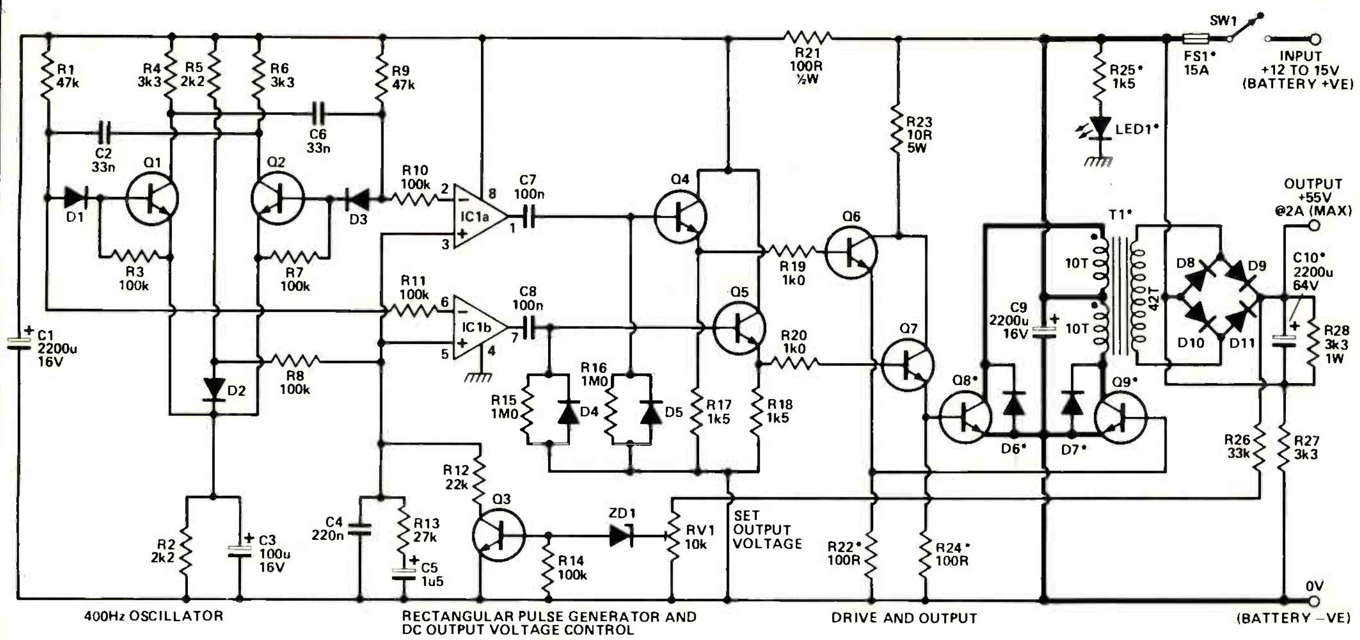


Fig. 11 The output transistor arrangement.

frequency for the other components.

If one were to operate at 300-500Hz, the number of turns needed wouldn't be very large and the transformer shouldn't be too difficult to wind — given a suitable core. I therefore used as the starting point a commercial 100W transformer kit which has a 28mm square core. On this I formed two 10T windings of 1mm copper wire wound as a doubled strand to



NOTE:
IC1 = TL072
Q1,2,3,4,5 = BC182
Q6,7 = BD537
Q8,9 = 2N3055
D1,2,3,4,5 = 1N4148
D6,7 = 1N4002
D8,9,10,11 = 1N5402
ZD1 = 10V ZENER (BZY88 OR SIMILAR)
ITEMS MARKED WITH AN ASTERISK ARE NOT MOUNTED ON PCB
Q6,7,8,9 REQUIRE HEATSINKS

Fig. 12 Complete circuit diagram of the DC-DC converter.

lower the DC resistance, and a secondary of 42T also of 1mm wire insulated from the primary by a layer of PVC tape.

The ratio of 1:1:4.2 is dictated by the fact that, with substantially square voltage waveforms, the peak rectified output voltage will be the same as the mean. If we are using a single +ve rectified output rather than a dual-rail supply, we can sit the rectified output on top of the 12V DC input. We then only need to provide some 50V DC rectified output — giving a nominal 62V total — to be sure of obtaining the +55V supply specified earlier. It is necessary to have a little in excess to allow for poor load regulation, and to allow the control loop to have some surplus voltage upon which to work.

This transformer was much more satisfactory for the purpose, and also much less bulky. I tried varying the drive frequency a bit and found that higher frequencies made more core noise on load while lower frequencies increased the quiescent load current as the primary inductive impedance decreased. I eventrually settled for 400 Hz as a compromise.

For the output power levels required, and with the output efficiencies eventually obtained (70-80%), the peak switching currents will be about 11A. This is too high for the MJ3001 or TIP141 Darlington transistors which have a 10A current limit. To double-up these devices would be needlessly costly, as would the use of a heavier current Darlington type, so I finally opted for a pair of 2N3055s which are easy to come by and have a 15A peak current capability. These I used in the circuit layout shown in Fig. 11.

The driver transistors (Q1 and Q4 in Fig. 11), are not critical as to type. Any small power NPN device capable of handling 1A peak collector current will serve. The 10 ohm resistor in their collector circuit limits the peak currents which can flow in these devices, and also limits their dissipation to 1W or so.

Output Voltage Stabilisation

Any system which makes some measurement and then uses the result to effect a control function is a servo-mechanism, and as such may suffer problems of loop stablility. The servo loop consisting of the output DC voltage across the reservoir capacitor, sensed by ZD1 and Q3 which control the reference voltage for ICs 1 and 2, is just such a case, and the loop stabilisation components are C4, C5 and R13. They hold the output voltage constant within its working load range, with very little bounce on step changes in loading. This is helped by the 3k3 resistor which is

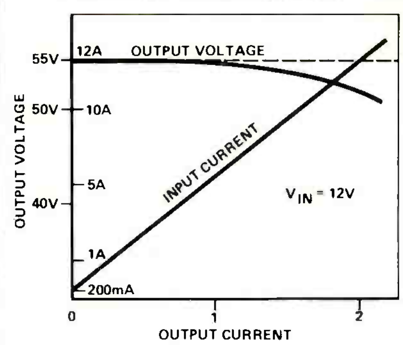


Fig. 13 Measured output voltage regulation of the prototype.

connected as a permanent output load and which also prevents the reservoir capacitors retaining a charge on switch-off.

The voltage regulator circuit holds the output voltage constant over an input supply range from +12V to +15.5V, which should cope with the expected variation across a car battery off load or on charge. Also, on low load (that is under stand-by conditions) the duration of the on pulses is very brief and the consequent quiescent current drain only of the order of 200-300mA, which is a trifling load on the average car battery.

The final circuit of the DC converter is shown in Fig. 12 and a graph of the output voltage/current regulation characteristic shown in Fig. 13.

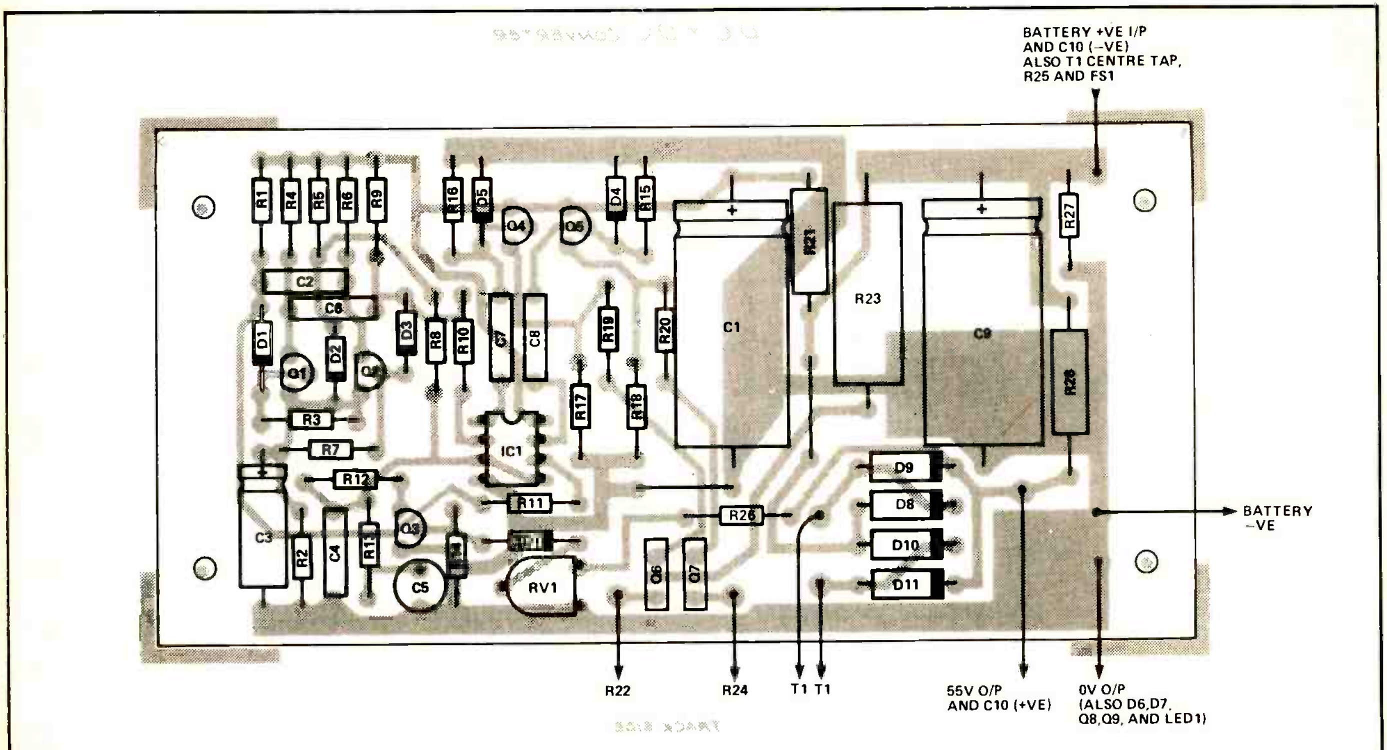


Fig. 14 Component overlay for the printed circuit board.

Construction

The component overlay for the converter is shown in Fig. 14. Assembling the board should present no problems but take care that the electrolytic capacitors, diodes and transistors are installed the right way around. The op-amp should be installed last of all and again, care should be taken that it is the right way around. A socket may be used for this component if desired.

The transformer winding details are given in Fig. 15, and the wire used should be 1mm enamelled copper. Most of the transformer kits available are supplied with a coil former which already has a 120/240V mains winding. This must be discarded and a new former made up from stiff cardboard. The E and I laminations are then fitted into the former and the completed core secured as recommended by the kit supplier, usually by means of end-cheeks which are bolted together through the laminations.

The DC converter is built into its own diecast metal case rather than being assembled in the same enclosure as the amplifier. This is advisable for safety reasons and

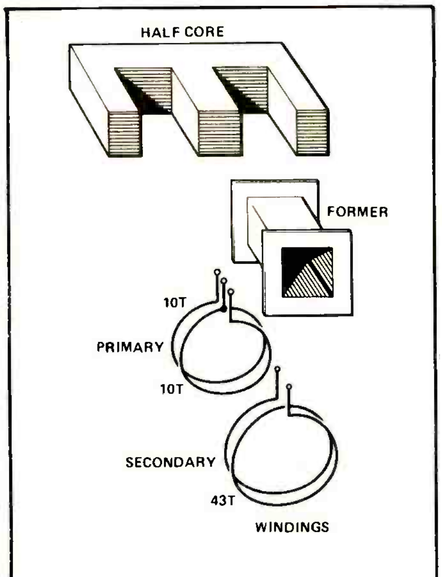


Fig. 15 Construction of the step-up transformer.

PARTS LIST

RESISTORS (¼W, 5% Unless otherwise stated)	
R1, 9	47k
R2, 5	2k2
R3, 7, 8, 10, 11, 14	100k
R4, 6, 27, 28	3k3
R12	22k
R13	27k
R15, R16	1M0
R17, R18, R25	1k5
R19, 20	1k0
R21	100R ½W
R22, 24	100 R
R23	10R 5W
R26	33k
RV1	10k horizontal skeleton preset
CAPACITORS	
C1, 9	2200u 16V axial electrolytic
C2, 6	33n
C3	100u axial electrolytic
C4	220n
C5	1u5 tantalum or radial electrolytic
C7, 8	100n
C10	2200u 64V axial electrolytic
SEMICONDUCTORS	
IC1	TL072
Q1-5	BC182
Q6, 7	BD537
Q8, 9	2N3055
D1-5	1N4148
D6, 7	1N4002
D8-11	1N5402
ZD1	10V 400mW zener diode, BZY88C10 or similar
LED1	panel-mounting LED
MISCELLANEOUS	
FS1	panel-mounting fuseholder and 15A fuse
SK1	red 4mm terminal
SK2	black 4mm terminal
SK3	2 (or 3) pole polarised connector of 2A rating or higher (eg., Bulgin P650 and P649 plug to suit)
SW1	12V 15A toggle switch
T1	see text

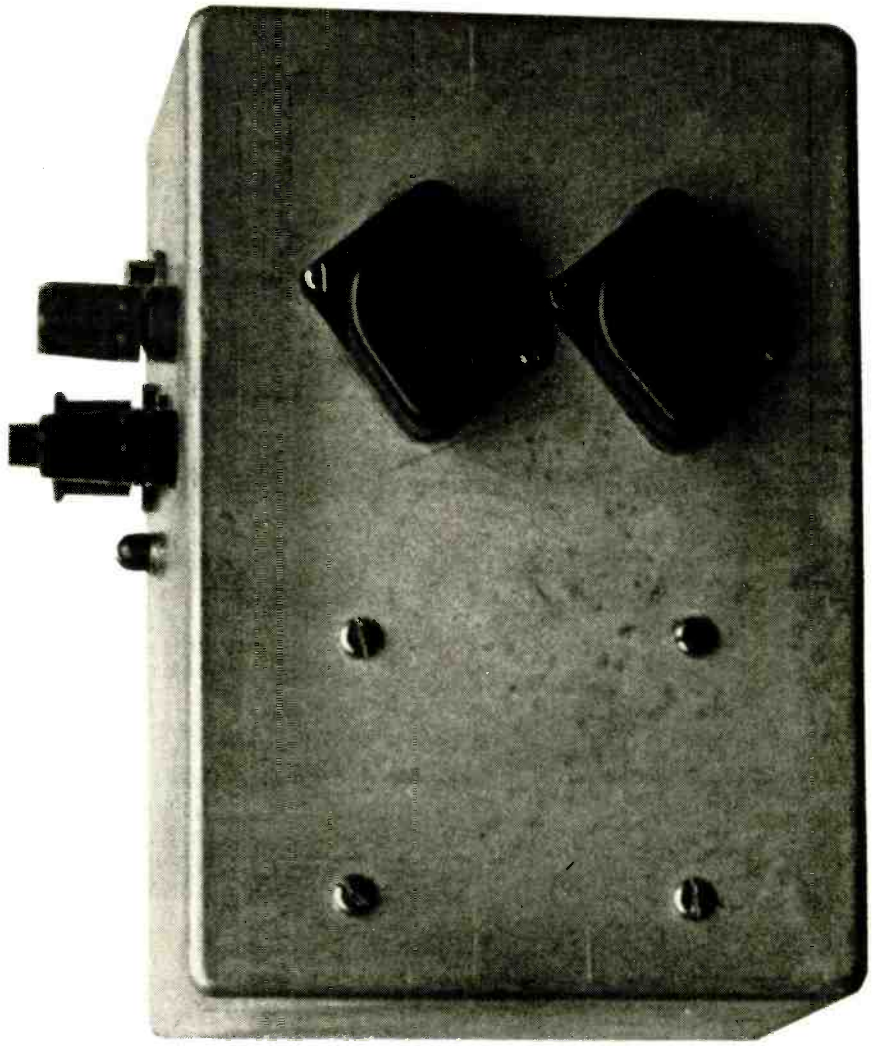
PCB; diecast box; capacitor mounting clamp (for C10); 8-pin DIL socket; clip-on heatsinksz for Q6 and Q7; plastic insulating covers for Q8 and Q9; PCB mounting pillars; nuts, bolts, etc.

also helps reduce the audibility of any transformer core noise. The power transistors are bolted to the case to ensure adequate heatsinking and a mica washer must be placed under each to provide electrical insulation. A plastic cover should be placed over each transistor to remove the risk of a short circuit should the transistor cases accidentally come into contact with any external metal object.

The positioning of the other major components within the case can be deduced from the external view in the photograph. When wiring up, bear in mind that quite heavy currents will be flowing and that too much resistance in the wiring will quickly produce an unnaceptably high voltage drop. The critical areas are represented by the heavy lines on the circuit diagram (Fig. 12). These connections should all be made using reasonably heavy-gauge wire and should not be any longer than is strictly necessary. The same goes for the wiring used to connect the converter to the car battery when in use.

Note that R22, R24, D6 and D7 are among the components which are not mounted on the board, and don't forget to attach clip-on heatsinks to Q6 and Q7.

Testing is a simple matter of connecting the unit up to a car battery and checking that an output of approximately the right voltage is present. If there is no output or the power transistors rapidly get hot, disconnect the leads from the battery immediately and check carefully for the fault. If all is well, adjust RV1 to set the output at exactly 55V and the converter is ready for use.



BUYLINES

The majority of the components for this project should be very easy to find. 100VA transformer kits are available from Maplin among others, and those who supply the kits can usually supply suitable winding wire. The PCB will be available from our PCB Service, see page 59.

Next month we will be presenting a 50W amplifier design produced by John Linsley Hood specifically for use with this converter and developed with outdoor PA systems very much in mind.

ETI

TV OR NOT TV

A 14-pin IC promises to change our television and video viewing habits utterly. Chris Giles examines it and its implications.

How many times have you been watching a video-taped TV programme and cursed as yet another string of adverts interrupts the action? You have three choices: sit through the messages (SUBSCRIBE TO ETI); fast forward to the next bit of action (SBSCBTI); or watch only BBC. In view of the current debate about the BBC showing ads, the third solution may turn out to be not only restrictive but short-lived, too. There is now, however, an elegant answer to the question of how to avoid the ads — thanks to an ingenious piece of electronics.

This absurd situation has happened because technological developments have outstripped our legal, economic and social practices...

The Adzap was launched quietly in January this year by a formerly little-known West Country company, Specialist Semiconductors. In a moment, we'll take a look at how it works, concentrating on the remarkable new IC at its heart, but the controversy surrounding this device is well-worth a brief digression. For some time now, television companies have been disturbed at a growing tendency to use VCRs as a means of 'time shifting' — that is, watching programmes after their initial broadcast. In itself, this reduces the efficacy of TV as an advertising medium, since ads are carefully placed by agencies to attract the right audience at precisely the right time. Worse still, time shifters are known to avoid watching ads at all, if they possibly can. For the independent companies, a device like the Adzap devalues their major source of revenue. Even the BBC, whose present output includes numerous trailers, licence fee reminders and the like, are worried.

It's not just time shifting that produces the problem. The Adzap itself is a single-function device, intended only for use as a VCR add on. With a recommended retail price of £69.95, it is a piece of equipment many VCR owners would find attractive. But with a little extra circuitry and for a little extra cost, a device like the Adzap could be installed *inside* television sets to remove adverts or other broadcast material from the screen. The simplest sort of device could switch channels as soon as an ad came on. A more complicated arrangement might use a framestore to produce, say, a two-minute delay in screening received signals and edit out ads practically in real-time. A television set with that sort of facility would probably cost upwards of £2000 — even with memory as cheap as it is — but it is technically feasible, as we shall see. Television programme makers are so worried by these possible developments that they have formed a defensive organisation to fight for changes in the law to protect what they describe in publicity leaflets as 'the integrity of broadcast material".

This association, the Joint Organisation of Small-screen Production Houses (JOSEPH), has over the last few weeks been lobbying MPs in order, as they say, 'to obtain legislative clarification of the status of broadcast material'. Their aim — as stated in their leaflet 'Joseph's Coat — The Need For Protective Measures In the Television Industry' — is to introduce an Act of Parliament creating a class of licensed programme producers and expressly forbidding the unlicensed editing of broadcast material. Of course, such a law runs the risk of overkill — preventing users of VCRs from recording parts of a programme or even threatening our right to switch off the television.

This absurd situation has happened because technological developments have outstripped our legal, economic and social practices. The Adzap itself, currently unavailable in this country due to an injunction granted to the members of JOSEPH in the high court in February, can only work because the TV companies themselves introduced Teletext systems in an effort to boost their profitability. So how *does* it work?

How It Works

Happily, ETI received an Adzap shortly after its launch and before the device was withdrawn from the market. Our technical wizards have taken it apart and put it back together again. Although details of the new chip at its heart are being kept under wraps, we've been able to fill in some of the blanks. The secret is in the Teletext format.

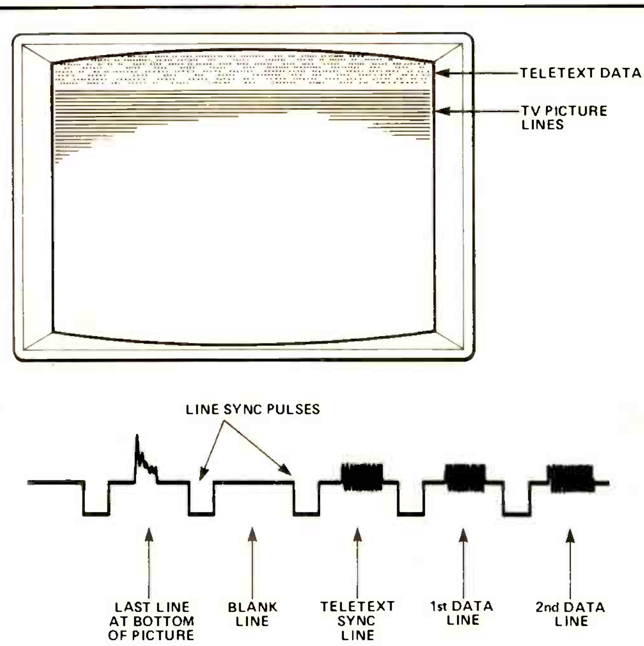


Fig. 1 Teletext data as seen on an ill-adjusted TV (a) and in relation to sync pulses and picture lines (b).

The Teletext system sends out all sorts of information on top of the ordinary television signal by utilising the normally unused top few lines of the frame sync and blanking regions of the signal, normally invisible on correctly adjusted TV receivers. The position of the Teletext data in a TV field (one picture) is shown in Fig. 1.

Thanks to extensive advertising, most viewers are familiar with the normal Teletext service of Ceefax, Oracle and 4-Tel, but it is not widely known that along with these magazine services, all the channels carry a lot of engineering and associated information, inaccessible to the domestic Teletext decoder because of its high transmission rate and its position in the sync.

For the independent companies, a device like the Adzap devalues their major source of revenue. . .

Most of this information is pretty uninteresting to us, being mostly digital transmitter keys, status information and channel locking codes. But some of the information can be really rather useful to the ordinary viewer — which is where the Adzap comes in.

Data Format

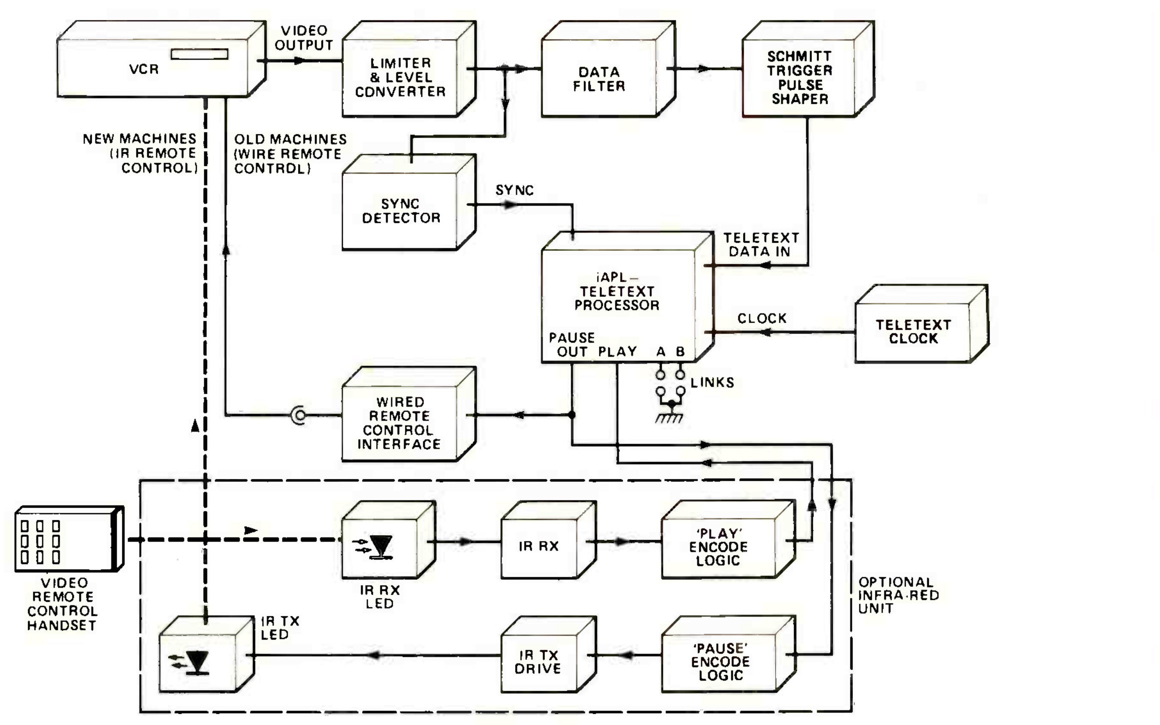
The second line of Teletext information carries the various system codes (the first is for synchronisation purposes only), and the fourteenth byte on that line is the Transmitted Signal Status Byte (TSSB). Even remembering its difficult location, the TSSB is a very underrated piece of information. Bits 1 to 4 contain the Material Content Register (MCR) which indicates what type of programme material is being broadcast. If it is set, then ordinary domestic material is on the air. If bits 1 and 2 are both zero, then engineering material is on the air. So-called 'intermediary material' (station ID, links, trailers, public information announcements and party politicals) is indicated by bits 1 and 2 being both low. Bit 1 information is used by automatic polling devices for audience research purposes, since bit 1 low material is specifically excluded from the viewer ratings.

MCR bit 1	2	3	4	Programme Type
0	0	0	0	close down — no broadcast
0	0	0	1	colour bars
0	0	1	0	black screen
0	0	1	1	full test card
0	1	0	0	future expansion — unused
0	1	0	1	station identification
0	1	1	0	party political broadcasts
0	1	1	1	links, trailers and public information
1	0	0	0	news, religion and current affairs
1	0	0	1	educational and scientific
1	0	1	0	children's programmes
1	0	1	1	chat shows
1	1	0	0	variety and music
1	1	0	1	drama
1	1	1	0	films
1	1	1	1	advertisements

Table 1 Material Content Register Bit Patterns.

Bits 3 and 4 are used to indicate the exact type of material being broadcast. All four bits set means a commercial break. Because of the lack of suitable decoders, all the information contained in the MCR has been of limited use. TV companies can easily find room and money for large boards of microprocessors, PALs, TTL devices and other chippery and, as noted above, MCR information has been quite liberally used for statistical investigations. The domestic user has not, so far, had access to the technology, largely for economic reasons. Conventional MCR decoders are bulky and expensive and, because of the high speeds and bandwidths

Fig. 2 Adzap block diagram.



involved in television signal processing, of very limited application.

Fast Byte

Now all that's changed, thanks to new developments in Indium Gallium Arsenside manufacture. At least three major manufacturers are offering custom chips in this material, making possible the design of very fast VLSI devices. Specialist Semiconductors of Gwent (with the aid of a Welsh Development Agency grant) have grabbed the bull by the horns with their design for the iAPL series of custom chips. This is the chip at the heart of the Adzap, a multi-standard bit-slice Teletext processor with on-board cache memory, provisionally type-coded the LF00 (R). The Adzap uses this chip to detect the status of the MCR byte and, with the help of some external circuitry, to pause a VCR during commercial breaks.

A block diagram of the Adzap system is shown in Fig. 2. (Under the terms of the injunction on the Adzap, we are not allowed to show a circuit diagram). As can be seen, the video output from the VCR is first limited and level-matched to the rest of the circuitry. Next, it is fed to the Very Fast Acting Sync Detector, another novel design using GaAs. The sync detection threshold needs to be about 10dB better than the average domestic Teletext decoder, in view of the increased speed and bandwidth demanded of this application. The output of the VFASD is converted to TTL levels and fed into the Sync Input of the LF00. Meanwhile, the output of the video processor block is fed through a high pass filter to remove the picture information, leaving just the Teletext data stream.

The edges of this signal are squared up by a high bandwidth Schmitt trigger and then presented to the iAPL device. The Teletext Processor examines the incoming Teletext signal, compares it with the clock input and locates the TSSB byte. The MCR bits are stored in cache memory and another part of the chip reads the data. If all four bits are in the correct logic state (see below), the internal MCR flag is set. This is detected and the Pause Out pin goes high. A high on Pause Out is fed back to the video recorder via one of several possible control routes detailed below.

Specialist Semiconductors of Gwent have grabbed the bull by the horns with their design for the iAPL series of custom chips...

Complete Control

If the VCR uses a wired remote controller, a suitable lead can be supplied with the Adzap (or, rather, could have been). An infra-red LED is also built-in to the front of the case for use with modern remote control machines. This will transmit a pause command to the VCR without cables. This IR facility allows for one simple refinement. If the Adzap is equipped with an optional IR receiver, it will detect a play signal from a tape being played back. If a tape recorded without the Adzap system is played back including ads (HAVE YOU ORDERED NEXT MONTH'S ETI?), the Adzap will detect the ads and transmit a fast forward command through the IR LED, returning to the play command when the MCR flag returns from ADVERT state.

At present, the LF00 chip is a fairly simple 14-pin device — a requirement demanded by the economics of producing a domestic unit. But it is still versatile enough to be used with most TV systems.

Two inputs to the chip are used to determine the transmission standard in use. These wire links are set at manufacture of the Adzap (most countries don't change their TV system very often). Input A determines whether the negative modulation system (as used in the UK and most of Europe) or the positive modulation (French) system is in use, while input B determines 625/525 line compatibility.

The importance of knowing whether 525 or 625 lines are being used is fairly obvious, but the need for setting the moduation system is not so clear. When you consider the nature of the Teletext data it should become immediately apparent. With the wrong modulation sense selected, the MCR flag bit would be in the wrong logic state. If the modulation sense input was not provided, this inversion would have the unfortunate effect in France of preventing the VCR from taping any programmes and recording all the adverts (ACHETE ETI). Although anyone who has ever seen French TV would probably not consider this to be a fault.

A top-of-the range version may even be able to reset MCR bits, thus altering the character of broadcast material...

Future developments of the iAPL series of chips (already under way at Specialist's Gwent laboratories) should be able to automatically detect line and modulation standards. An on-chip microprocessor and ROM version is being considered with which it will be possible to program an evening's recording and, ultimately, viewing. By detecting MCR bit-patterns other than 'all set' one could, for example, avoid chat-shows or soaps. Specialist are, apparently, considering an iAPL chip with signal processing facilities able to discriminate programme material using combined analogue and digital techniques down to the level of Wogan or Dynasty. A top-of-the-range version may even be able to reset MCR bits during broadcast thus altering the character of the programme material itself. In this way, Benny Hill could be made funny. No wonder, then, that television programme producers are worried.

A prototype top-of-the-range Adzap.

ETI

MICRO-EXPANSION

Mike Barwise continues his series on up-grading 8-bit micros with a look at factors affecting reliability and the efficient use of hardware.

Reliability and efficiency are rarely spoken of in the context of the home micro. They are, of course, very subjective concepts. The only absolute is that no system is perfectly reliable and that all systems are more or less inefficient in some respect or other. The degree of reliability and efficiency expected depends on the nature of the application. In the design of the home micro, which is viewed by its producers essentially as a toy, little attention is usually paid to either.

Call Me Unreliable

The main source of unreliability is marginal hardware design. Apparent software unreliability is most often the indirect result of marginal hardware and, in any case, incorrect software (a bug) normally does the wrong thing very reliably!

Marginal hardware design is any configuration which causes your circuit to behave in a manner other than that expected. The most likely cause of such behaviour is a design element which fails to stick within the acceptable limits of some microchip parameter or other. The maximum drive capability of outputs, the voltage of logic levels at inputs, and out-of-spec or excessively noisy power supplies are examples of so-called DC parameters which can cause problems.

These are often glossed over by the 'string-it-together' brigade, but it is dangerous to look on microchips as uniform bricks that can be cemented end-to-end or side-by-side without any restrictions.

When adapting or enhancing a system the slowest component must be taken as a yardstick. For example, there has been a recent fashion for running Acorn Atoms at 2MHz (double speed). It does just about work, but the OS ROMs in the Atom have a 450ns access time and the chances of misread data resulting in incorrect program execution are greatly increased (see Acorn User, December 1985).

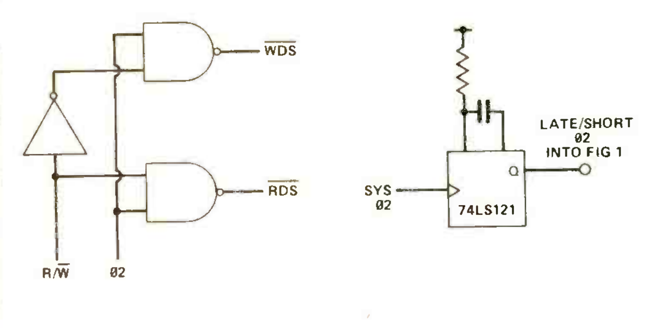


Fig. 1. Matching a 6502 with (a) 8255 and (b) 8080 devices

The real problem is that modern microchips are so forgiving. Very few examples of commercial LSI chips come anywhere near worst case parameters, so an out-of-spec circuit will often work — more or less. Only exhaustive testing or knockabout service life will show the weak spots but the urge to get on to the market before the competition makes this an un-economic proposition for most commercial companies.

If you are going to add your own expansion to a micro, you must really take note of reliability. It is not difficult. Just make sure that the worse case value for every specified parameter is at least 10% better than that specified and you won't go far wrong. This may mean some crafty support circuits if you are mixing chip families, but it's all good instructive fun.

Two fairly simple examples of mixed family device matching are shown in Fig. 1. The first is the standard way of providing a 6502 with a read strobe and write strobe for use with the Intel 8255 and similar devices (Fig. 1a). The second enables the 6502 to be used with certain 8080 devices, which will work with a short write strobe but need a data hold time about three times as long as the 6502 provides (Fig. 1b).

Watchdogs

A watchdog is a subsystem which determines whether or not the main system is functioning as expected, and aborts or corrects departures from the norm as soon as possible after they occur. Some larger systems use software checksums and the like, while advanced hardware watchdogs can actually keep track of the required operations and correct errors. The latter tend to be complex and need to be included in the original design of the system or, as is the current trend, into the CPU chip itself.

For post-implementation, the watchdog is an external discrete hardware solution. The simplest one is a counter which is reset by an event occurring periodically in a properly functioning system, and clocked by a regular event which occurs whatever the active system is doing. If the counter overflows — that is, it has not been reset for a period N — it is assumed that the system has gone wild. The resultant output is normally used as a general reset to the micro.

This type of watchdog can be implemented in a variety of ways. One method uses an address mapped write port which is periodically written to by software to prevent counter overflow (Fig. 2a). This demands that the watchdog be implemented before the software is written, and it also takes some processing time, although not a lot. Another approach is to attach a permanently enabled comparator to the CPU address bus, so that every time an address within a given range is generated, the watchdog is reset (Fig. 2b). The corollary of this is to

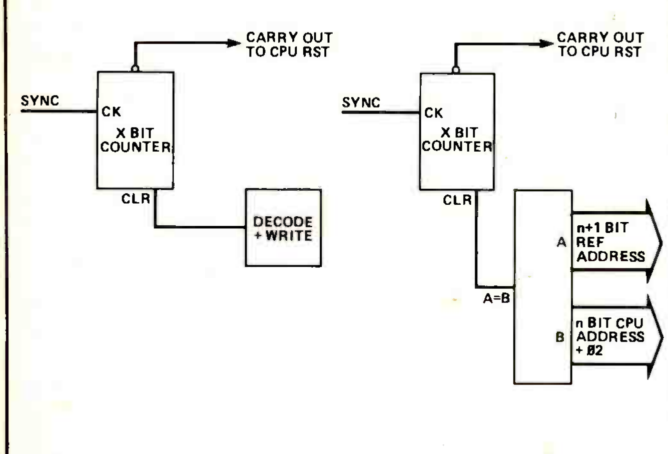


Fig. 2. Watchdogs.

look for addresses which should not be generated, and allow N of them to cause a system reset. This second approach is definitely the more flexible and is totally transparent to software. If you are really crafty, for a small penalty in terms of reliability, you could use write protected registers to hold the comparator settings so that individual applications packages could set the watchdog to suit themselves.

It is possible, with yet more ingenuity, to include a wrap-around RAM which stores the last couple of K of addresses presented to the bus so that the error point can be examined. The device is then, in essence, a logic analyser. A general schematic of such a system is shown in Fig. 3.

Assuming a 6500 based micro, the analyser address counters are advanced by the leading edge of the SYNC signal, which indicates an OP code fetch cycle. While SYNC is active, the Phase 2 clock is used to store the 16-bit CPU address in the analyser RAM. The resulting contents of the RAM amount to an execution address trace of the program. As the counters wrap around, only the last N-1 addresses are stored at any time, where N is the analyser RAM size. In this application, an overflow-type watchdog inhibits the address counters of the analyser either when or until the bus error occurs, depending on the mode of the operation.

In the HALT ON ERROR mode, which is the most useful but needs a little more logic, the address on the counters can be read to determine a 'cursor position' reference within the RAM. If you are very clever indeed, you will add a delay of several counts to the address clock inhibit, so that the start of the actual error is trapped in addition to the valid events immediately before it.

How Does Your Micro Go!

Even if you have the most reliable system you can to start with and your add-ons maintain the standards, you can still get very frustrated by inefficient operation.

We touched on the question of efficiency last month in discussing the modern massive business micro (ETI, March 1986). Efficiency is not the same as speed of operation. A lot of popular fast micros could be many times faster if their operation were tidied up and rendered more efficient.

Efficiency may be roughly defined as the achievement of the best compromise between the amount of code used and the amount of time taken in the execution of a particular task. I stick my neck out here, but I reckon most commercial applications packages are grossly inefficient. It is noticeable that the package size doing any given job has grown and grown over the last few years. The extensive use of high level compilers and the almost entirely software-orientated application has caused manufacturers to reach for 16 and 32 bit CPUs running in the 10MHz region to compensate for the inefficiency of the results.

Inevitably, the code used for driving hardware must be really efficient, particularly where bulk data transfer deivces such as disk controllers, data loggers, etc, are concerned. Often you have only a few microseconds to perform an operation if the system is to stay running, so well written assembler and the intelligent sharing of tasks between software and hardware are the order of the day.

There are, of course, times when the choice between hardware and software is obvious. Nobody in their right mind would control a floppy disk drive enitrely by host software when they could use an FDC interface of some sort. (Oops! Sorry. I think someone did!). The necessary functions were itemised in part one, and it is obvious that the CPU would get little else done. On the other hand, a low cost universal EPROM programmer is better off using software and passive control latches, as the number of permutations of mode would make a hardware solution pretty complex and the speed required is very low (20Hz).

There is a much less clearly defined area where the use of either hardware or software could appear to be the obvious solution, depending on your personal bias. A lot of designs that look neat at first sight can be improved upon. The real answer is to consider all the alternative combinations of hardware and software that present themselves, and to avoid the temptation to use something because it's available or to be satisfied with an answer just because it works.

A real-life example of this from my own experience concerns the WD1770 Floppy Disk Controller. My own board was to be used in either an interrupt or polled interface configuration. The interrupt outputs are always operational, so the interrupt driving solution is obvious. The WD1770 status register contains bits which indicate data requests (comparable with the DRQ interrupt) and FDC busy (approximating to the INT terminal interrupt).

At first sight this presents no problem, but the design was for 6500 series processors, and the bit positions (0

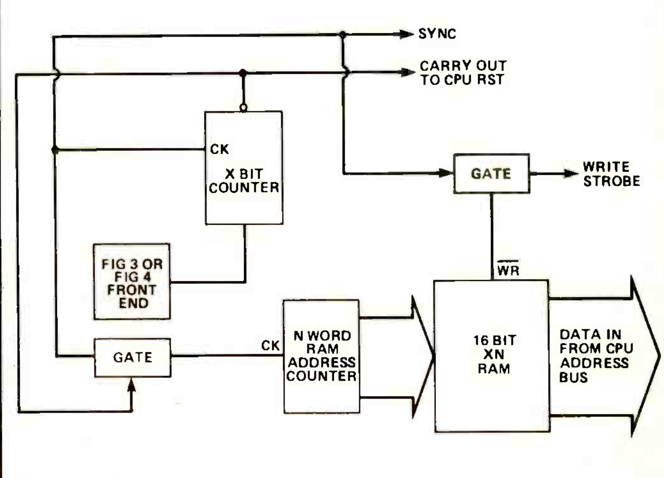


Fig. 3. Logic analyser schematic.

and 1) are exactly the wrong bits for convenient fast polling during data trasnfer. Furthermore, the data request bit doubles as an index pulse indicator for non-data commands.

Worse is to come, as supplementary information showed that 64 microseconds must be allowed between writing a command and reading the DRQ bit in the status register. The FM byte time is 64 microseconds, so on read and write operations you can't poll the DRQ bit for the first byte to be transferred.

The solution was to tie the real interrupts to the inputs of an addressed external buffer register, put them in bits 6 and 7 (which suits 6500 series devices just fine) and poll that! The register was needed anyway, to hold drive and side parameters.

Examples of this type are endless, and I won't bury you in details, but I think this shows how a little rethinking can not only improve performance, but also make the software writer's task easier.

Interrupts

When you get around to the multi-processor configuration outlined in part one, each intelligent peripheral or module will have to be able to talk to any other as well as to the real world. Keeping control in the time domain is then your problem. Yes, I can hear you muttering "interrupts; interrupts ...". Are interrupts the universal best answer, though?

A superficial look will suggest that you can do anything with interrupts, but you can't. They are probably the most over-used and misused features of the eight-bit generation of processors.

When you need occasional asynchronous transfers of a few bytes between the micro and the outside world, there is nothing more useful than the interrupt. There are a few rules to observe, but in general the maskable type of interrupt is very easy to use for this kind of work.

Interrupts cause most problems when they are used to handle large volume transfers at high speed, or when used to drive multiple asynchronous events simultaneously without proper prioritising. The two main points to remember are that:

(1) their response is not instantaneous, even in their most efficient implementation;

(2) they are demands, not requests. You may be able to inhibit service, but you cannot abort a recognised interrupt except by returning as normal.

The underlying point is that interrupts absorb time. In 6500 terms, an interupt which points directly to an RTI (return instruction) absorbs around 20 clock cycles.

Suppose for convenience that we are running a 6502 at 1 MHz (BBC 1 MHz bus, Acorn Atom, Tangerine, etc.). An MFM (double density) disk interface requires data transfers every 32 microseconds, and each transfer must be completed within the first 28 microseconds.

Of the 20 cycles required by the interrupt 14 occur before the address bus points to the first byte of user code, and six after the last user instruction to return to the point where the interrupt occurred. Half of the allowable byte transfer time is thus taken up before any useful work is done if interrupts are used to synchronise the data transfer. I guarantee that a 1 MHz 6502 cannot pass a byte and increment its data vector within the remaining time. On the other hand, polling by use of the BIT instruction and a relative branch takes only seven clock cycles, so you might just get away with it. Even more cunning would be the use of the 6502 SO (Set Overflow) pin, which would allow the polling loop to take over three cycles (see Acorn User September 1985).

Using our floppy disk controller example, suppose we find a way to drive data transfers under interrupt. Even in FM (single density) we must transfer a byte every 64 microseconds, and the best code I have come up with takes about 28 clock cycles to perform the transfer. At 1 MHz this is 28 microseconds, and we must add to this the 20 microseconds required to fetch the interrupt vector and return. The 58 microsecond result is, of course, three quarters of the total CPU time, so any foreground task might as well just stop for the time being. The moral of all this is: keep your interrupt service time short in proportion to total CPU time, ideally never more than ten per cent.

Multiple Interrupts

So far we have assumed only one device as a source of interrupts. This is a very severe limitation. If we require a real-time plot of a graph of selected data from a data logger, we would need interrupts to drive keyboard input, input from the logger and output to a pixel plotter simultaneously. Each of these devices has an infrequent but time-limited data transfer window caused by an asynchronous outside world event.

This introduces a problem. How do we control the various interrupts to ensure that they all get services whenever they need it?

As soon as we have more than one source of interrupt, there must be a very clearly defined method of identification of the device currently in need of service. The very simplest answer is to provide all the interrupting devices with a register bit which acts as an interrupt flag. On interrupt, the device registers are each read in turn, and the first device with set flag is serviced. As soon as an interrupt is serviced, the device flag is cleared by the CPU, so another interrupt can be identified by continuing the flag register scan.

The big catch to this simple approach is that it is terribly slow. The more complex the system and hence the more devices it contains which can cause interrupts, the longer the time taken to establish which device needs service. You will rapidly reach a point where, by the time the correct device has been identified, its need for data is long gone and the system fails.

We can solve this by providing a separate interrupt for each device. One option is to design the hardware so that each module puts a unique address into the register at a fixed point in the address map. A set of bus lines would have to be dedicated to this, but as you would rarely need more than 16 interrupt driven devices in an 8-bit system, only four lines would need to be allocated. Now the CPU has only to read the contents of a fixed single register to determine where to go for the device driver code. The time overhead is short and constant, regardless of the number of devices generating interrupts.

But what happens if two devices generate interrupts simultaneously? Obviously, there will be contention between their output codes, and the register contents will be invalid.

There is a very simple hardware solution to this problem. A Priority Encoder (for example, a 74LS147 and 74LS148) provides a binary coded output which depends on the most significant active input at any time. If, for example, you drive inputs 0, 3 and 6 active, the outputs read six and the state of inputs 0 or 3 will have no effect until input 6 has been de-activated. Thus no contention can occur in our interrupt register. The priority encoder will need a bus line allocated to each interrupt input so it will use up more space, but it prevents so many problems that it is well worthwhile. **ETI**

CONSTANT CARE

Audio designer Graham Nalty has been investigating constant current sources. This is his report.

Constant current sources, like individual components, are often taken for granted in electronic design. If we wish to keep the current in part of a circuit constant, we simply make up a constant current source to a known recipe and assume it does its job. But the constant current source is a complex circuit in its own right, and requires quite detailed specification to describe its performance.

Constant current circuits are used in a number of situations:

1) On equipment subject to wide fluctations of supply voltage, where we wish to maintain adequate current for operation of the circuit at the lowest suppply voltage, but must keep heat dissipation within limits at the highest;

2) In amplification circuitry, a constant current load increases the gain of an amplification stage and enables high open loop gain to be achieved in a feedback amplifier;

3) In instrumentation amplifiers, the use of a constant current source to supply the input differential pair decreases the error at the output due to a common mode input voltage. When a sensor with a balanced output is used, the interference picked up by the cables is a common mode signal and will be rejected by an amplifier with a high common mode rejection ratio;

4) A constant current source in an audio amplifier reduces the effect of power supply ripple on the audio signal. In practice, the ripple we wish to eliminate is not the AC ripple from rectification circuits, which is not really a problem but the ripple caused by other parts of the amplifier drawing current from the power supply due to the signal;

5) Constant current circuits are used in discrete regulator circuits and their use improves the line regulation, reducing the change in output volgage due to a change in input voltage.

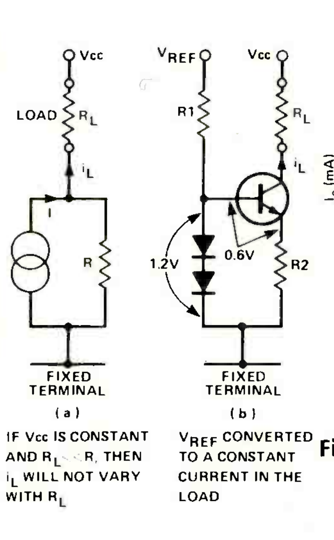


Fig. 1 Two and three terminal constant current sources.

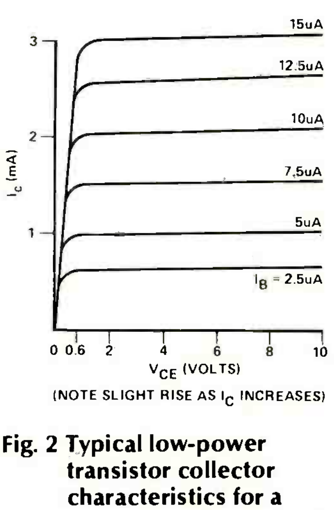


Fig. 2 Typical low-power transistor collector characteristics for a common emitter circuit.

Terminal Zone

Most constant current sources are either two or three terminal devices. The two terminal device may be regarded as a resistor substitute comprising a current generator and high value resistor in parallel (Fig. 1a). The three terminal device has a third pin which needs to be held at a reference voltage in relation to the fixed terminal (Fig. 1b shows a typical example).

To assess performance, we need to measure how constant the current delivered is in relation to the applied voltage and the other variables. For a two terminal device, we can measure the change in current in relation to the change in voltage across it which gives a figure for the source's dynamic impedance, Z_D. The dynamic impedance, which can be considered a measure of the way in which a device's impedance changes under different operating conditions, is equal to the change in voltage across a source, dv, divided by the associated change in current, dI. A good constant current source will offer substantially the same current over wide range of applied voltages. So, dI will approach zero over the device's useful range and the dynamic impedance will approach infinity. In fact, an ideal constant current source would appear as an infinite impedance delivering a finite current.

The collector characteristic of an ordinary transistor in common emitter mode (Fig. 2) shows that it approximates an ideal constant current source. In fact, the common emitter circuit appears as an impedance of something in the order of 10k — a figure derived from the slope of the characteristic curve which is the common-emitter output conductance, h_{oe}:

$$h_{oe} = dI_C/dV_{CE}$$

and

$$Z_D = 1/h_{oe}.$$

The common emitter circuit is a three terminal constant current source, the base having to be held at a constant potential in order to achieve a constant current through the collector-emitter circuit. The series diode arrangement of Fig. 1b is designed to hold Q1 base at a suitable constant potential. This sort of arrangement is fairly complex — certainly when you consider that some designs use nothing more than a high value resistor as a constant current source. It is, however, to be preferred over simpler arrangements if only because a considerably lower voltage is required to deliver a useful current. In the tables that follow, the dynamic impedance of a constant current source is compared to the equivalent resistor value. This latter is the resistance which will deliver a current equal to that produced by the constant current source when connected across the DC Power rails. As will be seen, an active circuit displays a far higher impedance at a given current and voltage than would be associated with a simple resistor.

The major problem with the Fig. 1b circuit is to make sure that the transistor base voltage actually is constant. If the reference voltage is taken from power rails, as it usually is in audio designs, there is almost certain to be variation. Real, rather than ideal, diodes will respond to variations. To judge the performance of a constant current circuit, then, it is important to see how it responds to changes in reference voltage. I have done this with the aid of the arrangement shown in Fig. 3.

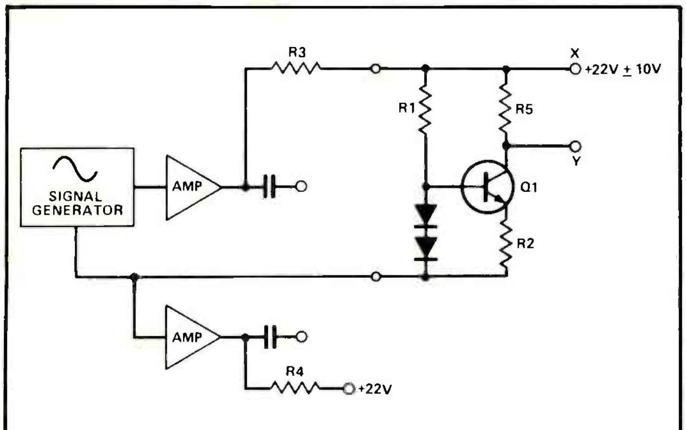


Fig. 3 Test rig showing Fig. 1b circuit in position.

Testing Times

The circuit of Fig 1b is typical of the simplest and most widely used constant current sources. Resistor R1 and diodes D1 and D2 hold the voltage at a the base of Q1 at 1.2V above the fixed terminal. Allowing for V_{be} of 0.6V at Q1, we have 0.6V across resistor R2. This sets the current through Q1 collector at (0.6/R2) A.

To test the circuit we need a stereo power amplifier with a very clean ripple-free power supply. The amplifier used in actual tests was a Classic series 2 A25 which uses a single rail supply and has a DC output level before the output capacitor of 22V. By feeding a sine wave of 7V rms (20V peak-to-peak) to the constant current source under test, the voltage across it is made to vary from 12V to 32V. This variation also affects the reference terminal.

Most constant current sources deliver something in the order of 1mA, and this was my target value for tests and comparisons.

R3 and R4 are low value resistors (20R) to protect the amplifier — and the constant current circuits — from damage due to accidental shorts whilst making measurements. R5 is the test resistor which was arbitrarily set at 4k7. The current was measured with a digital voltmeter across R5. Change in current could also be observed using an oscilloscope in the AC position across R5.

The test configuration is not a practical constant current arrangement. No practical circuit would actually look like Fig 3. However, it serves to gauge the performance of the constant current source under widely differing conditions. The results of the tests should be considered comparatively rather than as absolute measurements of practical performance.

Table 1 shows the results of measurements taken on the Fig. 1b circuit. The first point to note is that variations in the bias resistor, R1, have hardly any effect on overall dynamic impedance. This is because the dynamic impedance of the diodes is inversely proportional to the current through them — so that increasing R1 has the effect of increasing diode dynamic impedance and holding the base bias voltage constant.

R1	R2	R5 V DC	Q1 mA	R5 V AC	Z_D	R Equ.
220k	470R	4.2	0.9	1 p-p	94k	24k
100k	470R	5	1.06	1.1	85k	21k
47k	470R	5.8	1.23	1.1	85k	17k8
22k	470R	6.4	1.36	1.1	85k	16k3
J503	470R	5.6	1.19	0.033	2M7	18k5
47k	1k0	2.5	0.53	0.48	196k	40k
47k	220R	11.8	2.5	2.1	42k7	8k8

Table 1 Dynamic impedance (Fig. 1b) — AC signal, 1kHz.

The dynamic impedance figures in the table were calculated by dividing the load resistance, R5 (=4k7), by the proportion of AC voltage across the source as a whole appearing across R5. Or, to put it more simply, by dividing the AC voltage across the constant current source by the AC current in the load. While this cannot be considered to be 100 per cent theoretically sound (for one thing, the figures invovled are averages rather than instantaneous values), assuming a linear response in the circuit and a stable and regular AC signal it does give a realistic estimate. The equivalent resistor value was calculated, as mentioned above, by dividing the DC voltage across the source by the resultant collector current.

R6	R8	R7 V DC	Q3 mA	R7 V AC	Z_C	R Equ.
47k	470	6.2	1.3	0.28 p-p	330k	17k
22k	470	6.3	1.34	0.28	330k	16k4
220k	470	5.7	1.22	0.26	360k	18k4
J503*	470	6.1	1.3	0.004	23M5	16k9
74k	470	12.9	2.7	0.52	170k	8k5

*Compare with Table 3.

Table 2 Dynamic impedance (Fig. 4) — AC signal at 1kHz.

Having noted the effect of changing R1's value, we should observe that the fluctuating voltage across R1 due to the signal injected by the sine-wave generator has considerably more impact. Since the emitter resistance of Q1 is small compared to R2, the AC voltage seen at the base of Q1 appears across R2, affecting the AC voltage across R5 and, therefore, the dynamic impedance. Replacing R1 with a constant current diode, J503 (rated at 0.56mA±20%), had the effect of considerably reducing the AC voltage across R5 and therefore giving something very much better in the way of dynamic impedance.

Another common constant current circuit is the two transistor configuration of Fig. 4. The current is equal to V_{be} (Q2)/R8. The collector of Q2 is held at 0.6V above its base by the base-emitter voltage of Q3. Table 2 shows that this circuit will have a higher dynamic impedance than the circuit of Fig. 1b, because feedback action

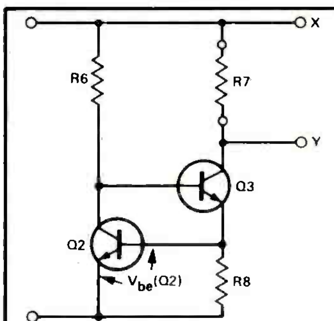


Fig. 4 Two transistor constant current source.

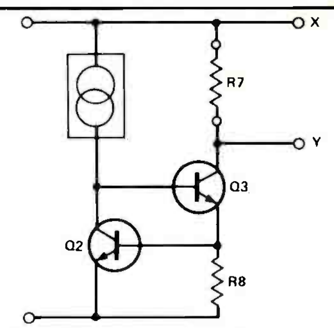


Fig. 5 Using a constant current diode improves performance.

stabilises Q3's base more effectively. The dynamic impedance of the two transistor circuit is 20 times the impedance of its equivalent resistor compared with about four times for the single transistor circuit. Further tests showed that with resistor R6 in circuit the impedance was constant up to 100kHz. If R6 was replaced by a J503 constant current diode the impedance decreased with increasing frequency (Table 3).

Constanter Still

A common economy when using several constant current sources is to share the base bias voltage between them. The two circuits in Fig. 6 show ways in which a shared bias might be employed with discrete op-amps in, say, an audio power-amp. We shall ignore the effects of

AC kHz	R7 mV AC	Z_D
(1)*	(4)	(23M5)
(2)	(5)	(18M8)
5	8	11M7
10	13	7M2
20	25	3M7
40	53	1M9

*Compare with Table 2.

Table 3 Dynamic impedance against frequency (Fig. 5).

power supply ripple in the circuit and consider the effect of large output voltage swings. We can use the circuit of Fig. 7 to make the measurements we require. R9 and R11 are the load resistors, used for measuring.

To represent the circuit of Fig. 6a, we supply points A and B with 22V from the unused channel of the power amplifier and point C with 22V ± 10V p-p. An oscilloscope will show a voltage of 3mV p-p at the base of Q6 and also across R12. A 20V p-p voltage at the output will change the current in the long tail pair by 3mV/R12(=6.4μA p-p). If we supply the sine wave voltage to point A, while keeping B and C at 22V, we measure a voltage of 3mV p-p across R13 but the AC waveform at Q4 base or across R11 is not visible on the 'scope — it is well below 1mV. The point of this test is that the circuit of Fig. 6a does allow a small measure of feedback from the output to the input of the long tailed pair, but the feedback is considerably reduced in the circuit of Fig. 6b.

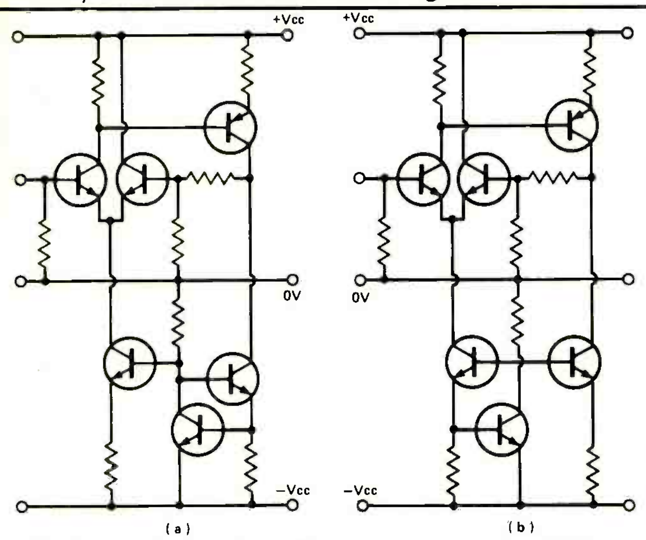
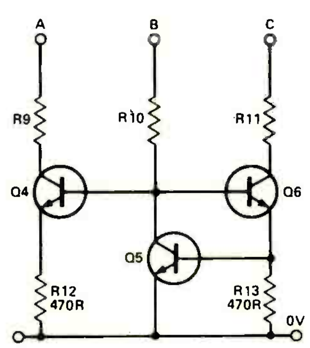


Fig. 6 Two designs for a discrete op-amp using CCS.

Fig. 7 Two sources using a single biasing arrangement.



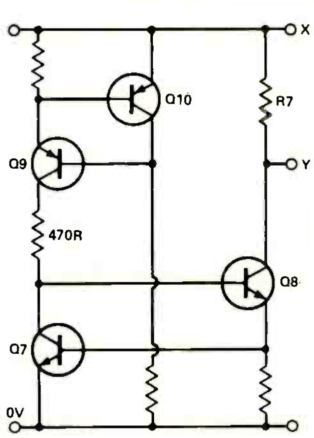


Fig. 8 You can replace the bias resistor in Fig. 4.

The circuit of Fig. 8 is a natural progression from the circuit of Fig. 4. Tests on the two transistor circuit showed that replacing the resistor R6 with a constant current source greatly increased the dynamic impedance. Constant current diodes are quite expensive and Q9 and Q10 are an alternative at a lower cost. A particular feature of this circuit and the similar circuit in Fig. 9 is the use of 470R resistors between the separate constant current sources. In the test circuits, omission of these resistors produced results which were rather doubtful. The 470R resistors were chosen because they were closest to hand and of a value which would enable the AC voltage across them to be measured on a 'scope. Their position produced credible readings, shown in Tables 4 and 5, for reasons which are unclear. A similar resistor in series with the J503 in the circuit of Fig. 5 had no apparent effect.

AC kHz	R7 mV AC	Z_D
5	16	5M8
10	18	5M3
20	25	3M7
50	52	1M8
100	100	0M9

Table 4 Dynamic impedance against frequency (Fig. 8).

FET Up

Field effect transistors can also be used to generate a constant current. In the N-channel JFET, the gate is held at a voltage negative to the soruce and the value of this voltage, V_{gs}, determines the current, I_d flowing from the drain to the source.

Figure 10 shows a JFET connected as a constant current source. The current flowing through RV1 raises the voltage of the source above the gate. The transfer characteristic of a JFET suitable for constant current generation operating with a drain-source voltage of 15V is also shown.

The cut-off voltage, $V_{gs\,(off)}$, is reached when I_d= 0 and is, in the example −4V. The saturation drain current, I_{dss}, is the drain current when V_{ys}=0 and is 8mA (In the data books, a JFET such as the J232, which is one of the best for constant current circuits, has $V_{gs\,(off)}$ specified to be between −3V and −6V and I_{dss} to be between 5mA and 10mA).

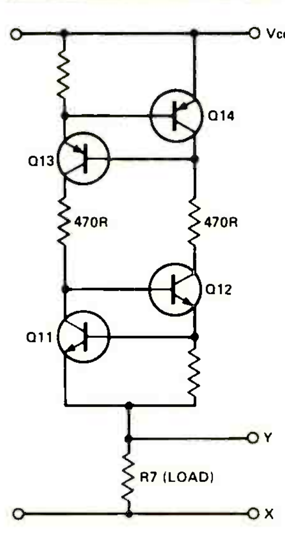


Fig. 9 Another configuration providing constant current biasing for a CCS.

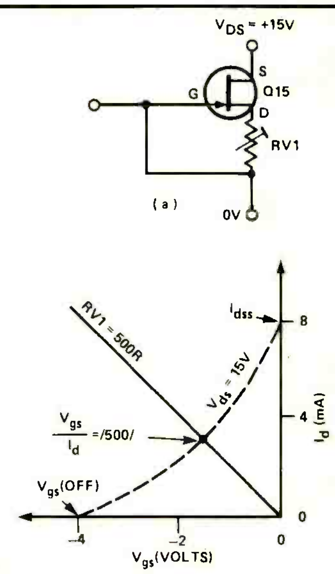


Fig. 10 Using a JFET as a constant current source.

If we look at Fig. 10b and draw a 'load line' for RV1 = 50 ohms, it intersects the transfer characteristic curve where V_{gs} is just over −2V and I_d just below 4mA. These values satisfy all the circuit parameters. The output charateristic curves in Fig. 11 show that drain current remains almost constant for large changes in V_{ds} while this voltage is above 4V. In our case, V_{ds} was 15V, so the circuit will deliver a constant 4mA.

AC kHz	R7 mV AC	Z_D
(2)	(8)	(12M)
5	14	6M5
10	27	3M5
20	57	1M6
50	120	0M8

Table 5 Dynamic impedance against frequency (Fig. 9).

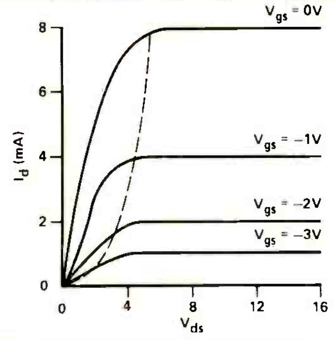


Fig. 11 N-channel JFET drain characteristics. (cf. Fig. 2).

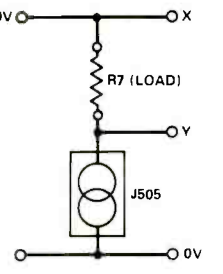


Fig. 12 A J505 constant current source.

Because of the wide spreads in $V_{gs\ (off)}$ and I_{dss} for different FETs, a variable resistor is used to set the current. This is not very satisfactory as it adds extra time and costs in manufacturing. An alternative is to manufacture FETs with built in resistors to give a fixed current from a two terminal device (Fig. 12). These can be obtained from Siliconix for currents from 200mA to 5mA. Tolerances vary from 10% for the CR022-CR470 devices down to 30% for the J553-J557 devices.

Table 6 shows regulator current and dynamic impedance for five randomly selected J505 devices. Table 7 shows the variation in dynamic impedance with frequency for one sample.

R7 V DC	1 mA	R7 mV AC	Z_D
3.0	0.83	40	2M4
4.1	0.87	40	2M4
3.9	0.83	33	2M8
4.4	0.94	48	1M9
4.8	1.02	45	2M1

Table 6 Performance of five sample J505 devices — AC signal at 1kHz, circuit of Fig. 12.

The variable resistor in a FET current source could also be replaced by a constant current device (Fig. 13). Table 8 shows the dynamic impedance of a J505 with a J232 FET at various frequencies. A point to note is that in this configuration the voltage across the J505 (measured with a DVM) was 2.6V and 2.9V in two separate samples. The impedance of the J505 would be much higher at higher voltages, but the combination of, effectively, two FETs gives a very high overall dynamic impedance (Table 8).

AC kHz	R7 mV AC	Z_D
5	40	2M4
10	42	2M2
20	45	2M1
50	77	1M2
100	140	0M7

Table 7 Dynamic impedance against frequency (Fig. 12).

AC kHz	R7 mV AC	Z_D
(2)	(3)	(31M)
5	5	16M
10	11	8M5
20	23	4M0
50	60	1M6
100	130	0M7

Table 8 Dynamic impedance against frequency (Fig. 13)

The circuit of Fig. 14 uses a bipolar based constant current soruce in place of the J505. The results were not significantly different from those of the previous, simpler, circuit (Table 9).

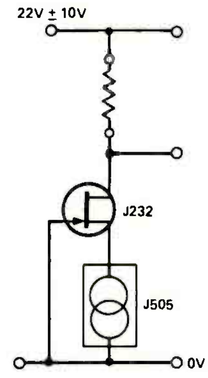


Fig. 13 Replacing the variable resistance in a JFET CCS configuration improves reliability and performance.

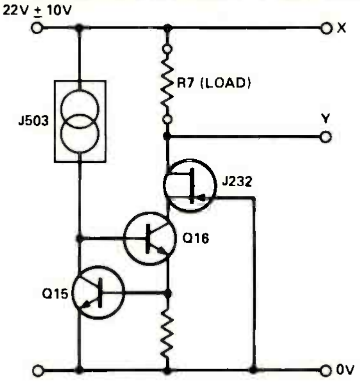


Fig. 14 Composite CCS using bipolar and FET devices.

AC kHz	R7 mV AC	Z_D
(2)	(3)	(31M)
5	7	13M
10	14	6M5
20	28	3M3
50	65	1M4
100	105	M9

Table 9 Dynamic impedance against frequency (Fig. 14)

Conclusion

A number of general trends seem to emerge from these investigations. Firstly, all the circuits revealed that dynamic impedance falls with increasing frequency — in some cases, very considerably. Secondly, the dynamic impedance of the more complex circuits is much greater than the simple one and two transistor regulators. Not unexpectedly, the performance of three terminal sources can be very ineffective when variation occurs between the reference voltage and the 'fixed' terminals of the device, and this can have significant consequences.

When designing current sensitive circuits, we must realise a further disadvantage of using three reminal regulators. The reference terminal carries a current which has to be taken somewhere. If it is take to ground, it should not share the signal earthing arrangements as it may contain ripple which will modulate the signal due to the impedance of the earth returns.

Perhaps the most important consideration is cost. It is clear that bipolar current regulators are inexpensive, but use a substantial number of components to achieve effective results. FET current regulators, on the other hand, are fairly expensive, but can achieve excellent results with simple circuitry and a low component count.

ETI

MTE CIRCUIT PROBE

This neat little board conforms to the four boards we produced recently under the title Modular Test Equipment. You can use it to poke around digital and analogue circuits to see what's going on. Design — as ever — by Mike Meakin.

The two circuits on this board are separate and only share common power supply connections. Apart from being good value-for-money, this means that they will be described individually.

Logic Probe

This circuit gives an audible and visual indication of correct TTL/CMOS logic levels. A pulse catcher circuit can capture fast pulses and either expand them or hold them in a memory circuit. This is particularly useful for detecting glitches or spikes not easily visible on an oscilloscope.

The audible indication allows the user to concentrate on holding the probe without having to glance at the LEDs. It can even provide a somewhat un-musical signature analysis!

Note that the top pin of SK1 must be connected to the positive supply of the circuit under test. This ensures that the CMOS thresholds of 30% and 70% V_{cc} are referenced to the supply of the circuit under test. When testing TTL circuitry on the standard 5V supply the thresholds are set to 0.8V lower and 2.25V upper. Again the top pin of SK1 should be connected to the 5V TTL logic supply to establish these thresholds, although if not connected the levels will be approximately correct.

In order to achieve a flexible input arrangement some compromises are necessary and the input stage is somewhat limited in speed. The response time of the LM311 is 200ns and this will be the shortest pulse that can be reliably detected. This is quite adequate for most CMOS and TTL circuitry used by the average hobbyist and represents a 5MHz signal.

Analogue Probe

This handy circuit is the equivalent of the logic probe but

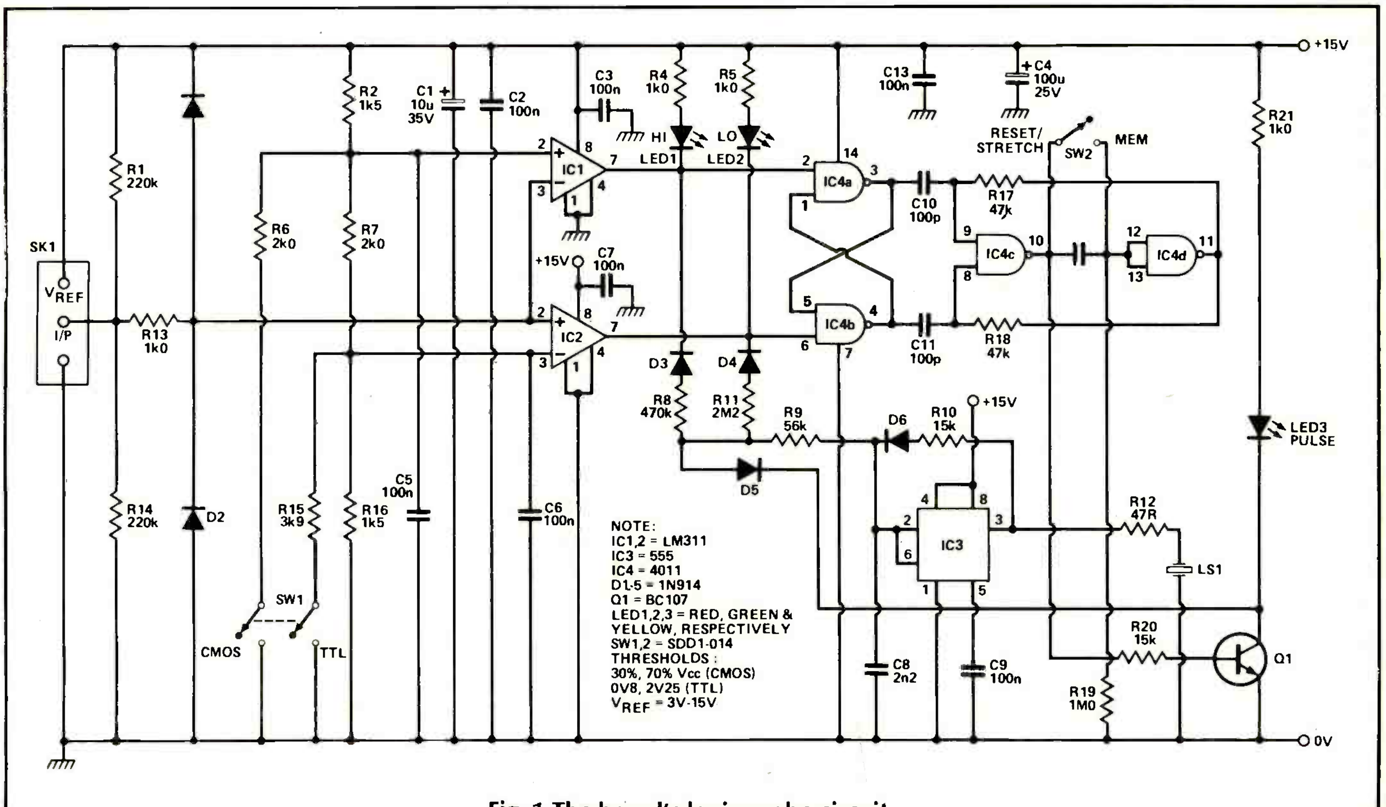


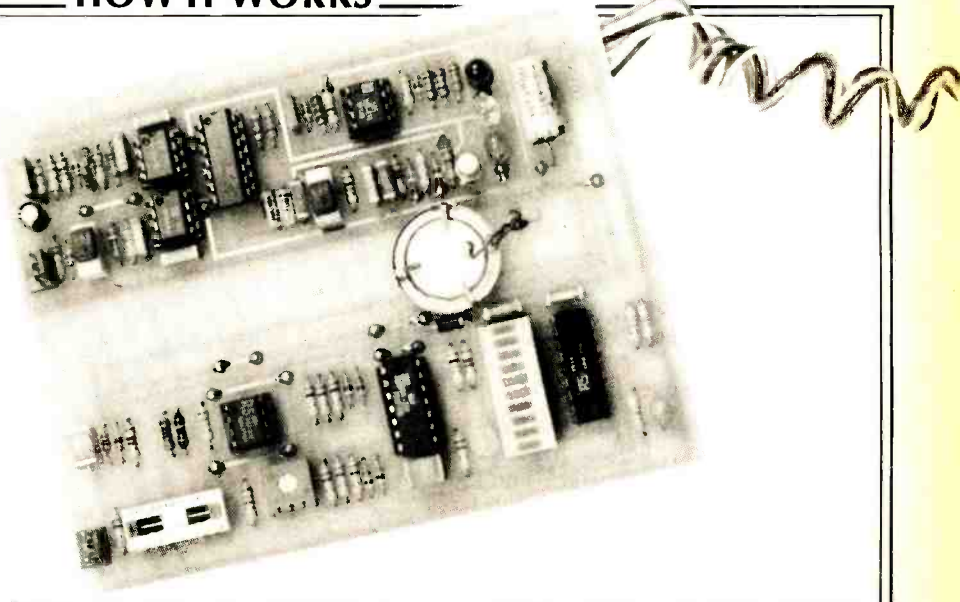
Fig. 1 The board's logic probe circuit.

HOW IT WORKS

LOGIC PROBE

The input stage consists of two LM311s forming a window comparator. The non-inverting input of the lower threshold comparator and the inverting input of the upper threshold comparator are biased to mid supply voltage of the circuit under test by R1 and R14 giving an input impedance of approximately 100k. Input protection is afforded by the combination of R13 and clamp diodes D1 and D2. The upper and lower thresholds are established by the potential divider R2, R7 and R16. When SW1 is closed additional resistors are shunted across the divider to set TTL thresholds. If the input voltage is below the lower threshold then LED2 will light, if it is above the upper threshold then LED1 will light and if it is between the thresholds then neither LED will light. The set-reset latch formed by IC4a and IC4b detects positive and negative transitions that correctly cross both thresholds and triggers the monostable formed by IC4c and IC4d, stretching pulses to approximately 50ms which are then indicated by LED3. If SW2 is closed the monostable is converted into a latch which memorizes input pulses. It is reset by momentarily opening SW2.

IC3, a 555 timer, is configured as a voltage controlled oscillator whose freqency is governed by the inputs connected to D3, D4 and D5. If D4 is low, a low tone is emitted. If D3 is low, a high tone is emitted. If D5 is low, a very high tone is emitted overriding inputs to D3 and D4. If none of the



inputs are low the oscillator is inhibited. The frequency of the oscillator thus indicates the input logic levels. Low for logic low, high for logic high, off for indeterminate and a pip-squeak for pulses and transitions! A piezo sounder is used as the transducer.

ANALOGUE PROBE

A non-inverting amplifier with presettable gain of eiether 1, 10 or 100 is configured around IC1. It has an input impedance of 100k and is protected from input over-voltage by the combination of R10 and D1, D2. The input may be AC coupled, DC coupled or shorted to ground. The output of this amplifier drives a precision full-wave peak detector formed by IC2a and IC2b. The output of the detector is connected to a LM3914 bar graph driver arranged to give a full scale display of plus 10V and a LED current of 25mA per segment. When all segments are lit some 250mA is required from the 5V supply. Also connected to the output of IC1 is the polarity and null detector. This circuit requires either plus or minus 100 mV on the input to R16 to light the bi-colour LED. Thus at maximum sensitivity, 1mV on the input to the probe will be indicated. When an AC signal is detected the LED glows yellow.

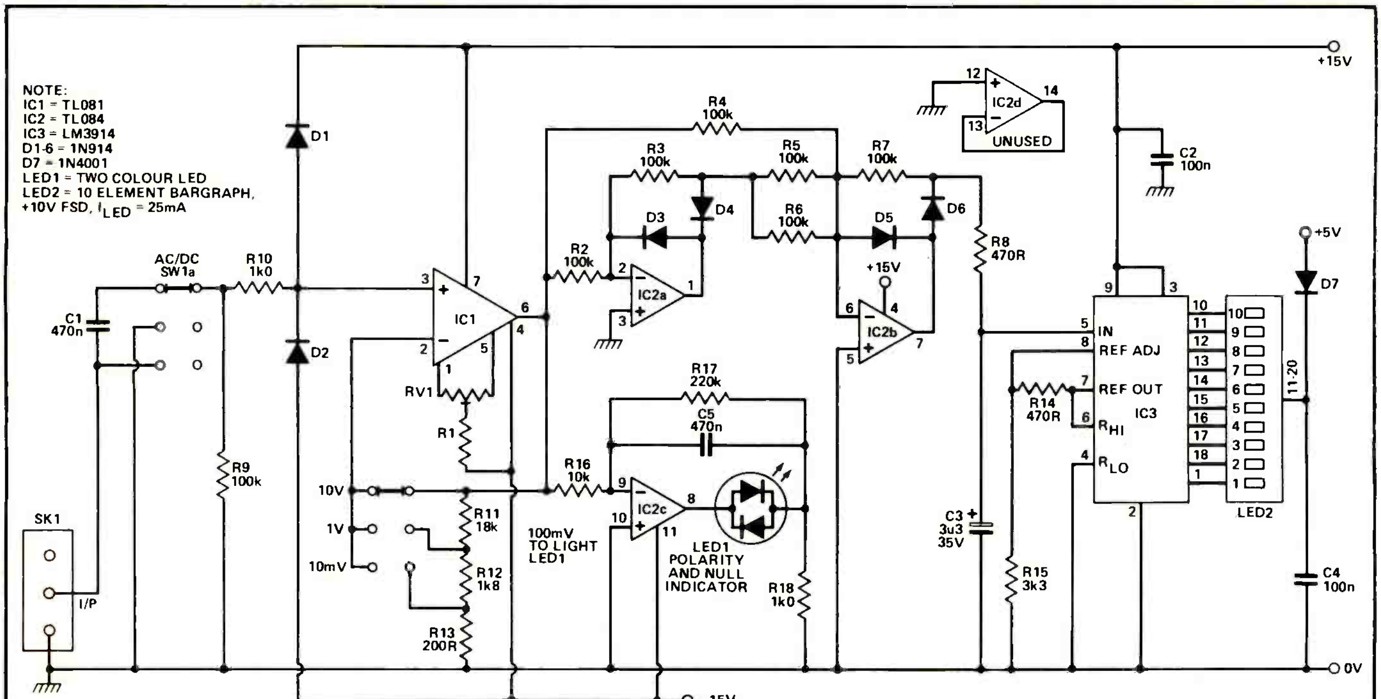


Fig. 2 The board's analogue probe circuit.

for poking around linear circuits!

It will indicate both AC and DC input voltages with a selectable sensitivity of 100mV, 1V or 10V FSD. A bi-colour LED indicates the polarity of the input signal and is useful as a null indicator for setting up op-amp offsets. The peak reading display is well suited for audio monitoring. Finally, the flashing lights of the bargraph together with those on the logic probe do look rather impressive.

Construction

As with the universal counter timer (ETI, January 1986) the board used is double sided. Track pins are used to make the through connections and these should be inserted and soldered first. It is very easy to miss soldering the pins both top and bottom and careful checking at this stage will save much time later. Check the polarity of diodes, the LEDs and electrolytic capacitors.

The bi-colour LED should be aligned so that the flat on the LED faces the bargraph display. This ensures that for positive inputs the LED glows red and for negative inputs the LED glows green. Logical, eh!

The only special point to note is the orientation of the bargraph driver IC. This is placed unusally with pin 1 at bottom, which makes for a more logical PCB layout. The bargraph display itself must also be correctly orientated with the chamfer at the top left. If the display is not marked then a little experimentation with a power supply and a suitable current limit ring resistor should be used to establish its polarity. The piezo sounder is attached to the board by a double-sided adhesive foam pad.

Testing

The board requires + and −15V supplies and a +5V supply. Note the current requirements for the 5V supply (250mA maximum). An understanding of how it works should suggest suitable tests for the board. The only adjustment is the offset of IC1 on the analogue probe. This is easily done by shorting the input with SW1, switching to maximum sensitivity and adjusting RV1 until the null LED is extinguished.

The logic thresholds can be checked with a variable input voltage and a digital voltmeter monitoring the input.

PARTS LIST

LOGIC PROBE

RESISTORS (all ¼W, ±5%)

R1, 14	220k
R2, 16	1k5
R3	10k
R4, 5, 13, 21	1k0
R6, 7	2k0
R8	470k
R9	56k
R10, 20	15k
R11	2M2
R12	47R
R15	3k9
R17, 18	47k
R19	1M0

CAPACITORS

C1	10µ 35V tantalum
C2, 3, 5, 6, 7, 9, 12	100n polyester
C4	100µ 25V electrolytic
C8	2n2 polyester
C10, 11	100p polystyrene

SEMICONDUCTORS

IC1, 2	LM311
IC3	555
IC4	4011
D1-5	IN914
Q1	BC107
LED1	Red LED
LED2	Green LED
LED3	Yellow LED

MISCELLANEOUS

SK1 3-way Molex plug; SW1, 2 ERG SDD1-014 DIL switch; PCB; IC sockets - 3 x 8 pin DIL; 1 x 14 pin DIL; PCB track pins; LS1 piezo sounder.

ANALOGUE PROBE

RESISTORS (all ¼W, ±5%)

R1	1k5
R2-7, 9	100k
R8, 14	470R
R10, 18	1k0
R11	18k
R12	1k8
R13	200R
R15	3k3
R17	220k
RV1	100k enclosed horiz. preset

CAPACITORS

C1, 5	470n polyester
C2, 4 100n polyester	
C3	3µ3 35V tantalum

SEMICONDUCTORS

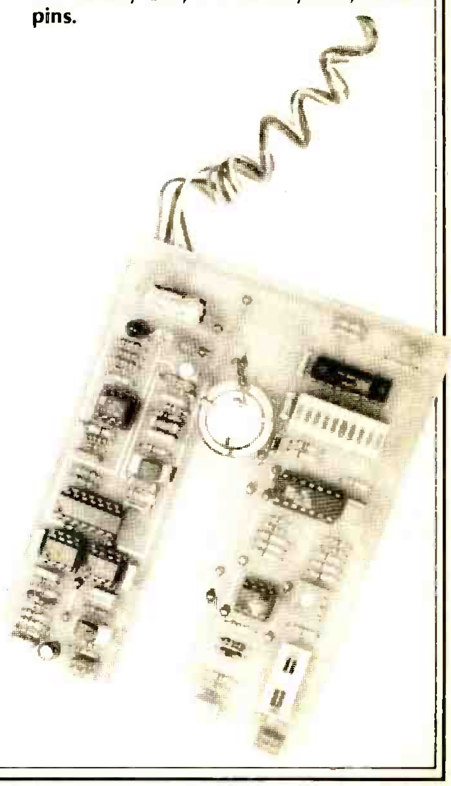
IC1	TL081
IC2	TL084
IC3	LM3914
D1-6	IN914
D7	IN4001
LED1	Red/green bi-colour LED
LED2	10-element LED bar display

MISCELLANEOUS

SK1 3-way molex plug; SW1 ERG DS16D 1-3 +1-3 DIL switch; PCB; IC sockets 1 x 8-way DIL, 1 x 14 way DIL, 1 x 18-way DIL, 1 x 20-way DIL; track pins.

BUYLINES

None of the semiconducutors or passive components should prove difficult to obtain. Bi-colour LEDs and 10 element bar-graphs are obtainable from Maplin, PO Box 3, Rayleigh, Essex SS6 8LR (tel: 0702 552911). The switches specified are available from ERG, who only deal with trade and professional customers, and we do not know of a dealer who will obtain parts from them. However, the SDD1-014 DIL switches may be replaced by 2-way DIL switches which are available from Maplin or Circkit (Park Lane, Broxbourne, Herts. tel: 0992 444111). Farnell sell a ganged 2-way DIL switch which would be more suitable (order code: SDD2 023). Like all Farnell stock, it can be obtained through Trilogic Ltd., 29 Holme Lane, Bradford BD4 0QZ. There is no very satisfactory alternative to the DS16-D 1-3 + 1-3 DIL switch as specified. The best option is to use an octal SPST DIL switch and carefully set the required range and input signal type before powering up the board. The risks of this approach are that, by setting more than one range switch (or none at all), your analogue reading will be inaccurate or that you may ground the signal taken from the circuit under test. To avoid this latter, cut the track to ground from SW1a after calibration.



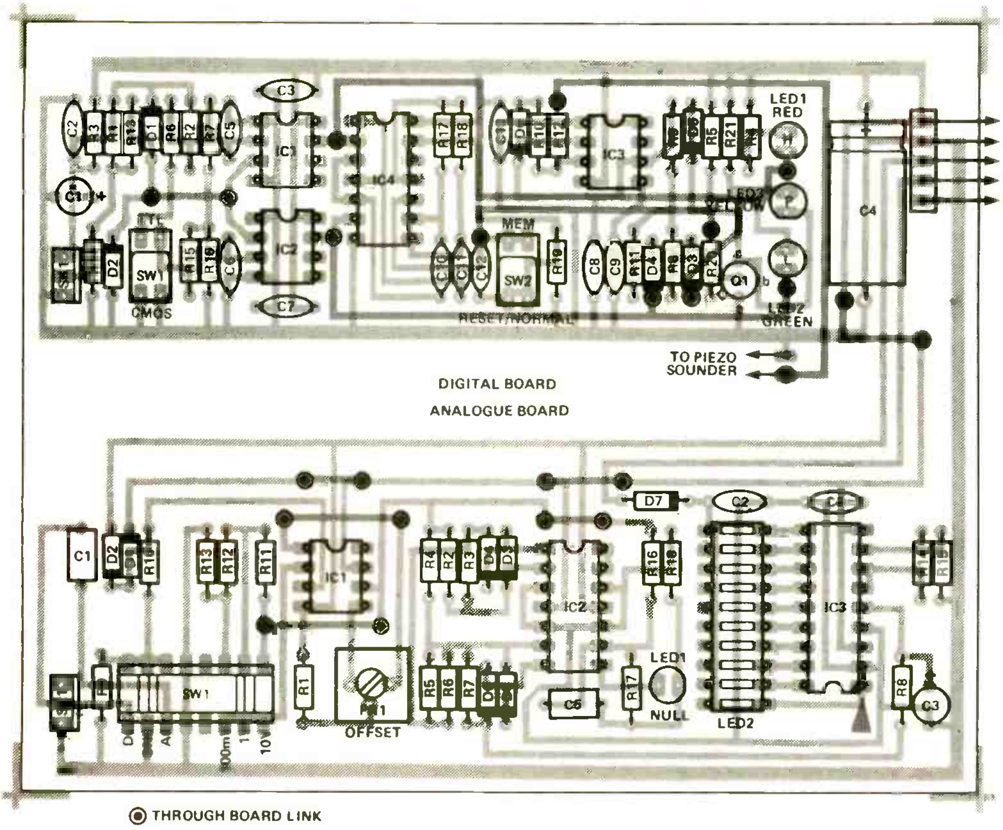
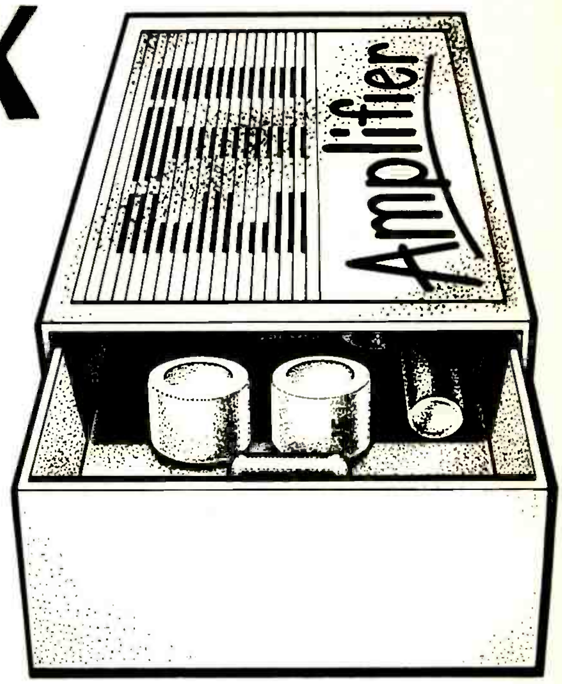


Fig. 3 Component overlay for the board (both circuits).

ETI

MATCHBOX AMPLIFIER



Whether it's a rock band in a hat-band or a PA in the Portaloo, Paul Chappell's Matchbox Amplifier is ideal for providing watts in tight spots.

What projects are on the list for April ETI? Design a general purpose amplifier for the workbench, maximum component cost £10. OK, what else? An amplifier that isn't fussy about power supplies, that will work from batteries or just about any old PSU. Fine. What next? Another amplifier, this time to boost the output of an in-car stereo, and yet another amplifier project to give 50 watts or so for heavy metal fans. And another one still — light enough to be carried around by buskers and walkperson addicts and ... what's that? ... small enough to fit in a matchbox? You must be joking!

Well, this is the result. Being much too lazy to design five separate amplifiers, I offer you two that will do the lot. And they *will* fit in a matchbox.

The circuits are based on the L165V amplifier IC, a very versatile little device indeed. The minimum rated supply voltage is 12V, although it seems quite happy to work below 9V with reduced performance. The absolute maximum supply voltage is 36V, so there's a fair old range to choose from. If you want to get the maximum possible power you will, of course, have to choose a supply voltage towards the top of the range, but if you are prepared to settle for a reduced output you can run it from just about anything.

The first of the amplifier circuits is shown in Fig. 1. If a single rail power supply is used, a large electrolytic capacitor, C6, is needed between the output and the loudspeaker. A split rail supply can also be used, with 0V connected at point G on the board, the positive rail connected to V+ and the negative rail to V−. If you do this, you can leave out R2, R3 and C6 and the speaker can be connected between the output and 0V. The only point to bear in mind is that the tab of IC1 is internally connected to pin 3 and will be at the negative rail voltage, so be careful what you bolt it to for heat sinking. Use an insulating set if necessary.

The second amplifier, Fig. 2, uses a bridge arrangement to get more power, particularly at low voltages where the output will be limited by the maximum voltage swing. This arrangement will give about four times the maximum power of the single IC version since the voltage seen by the speaker is doubled. This feature makes it useful as a booster for car stereo systems, if your speakers can handle the extra power!

You can also use a split rail supply with this circuit if you wish, although there is not much benefit from doing so. Once again, 0V would be connected to point G, the positive rail to V+ and the negative rail to V−, and the warning about the IC heat sinking

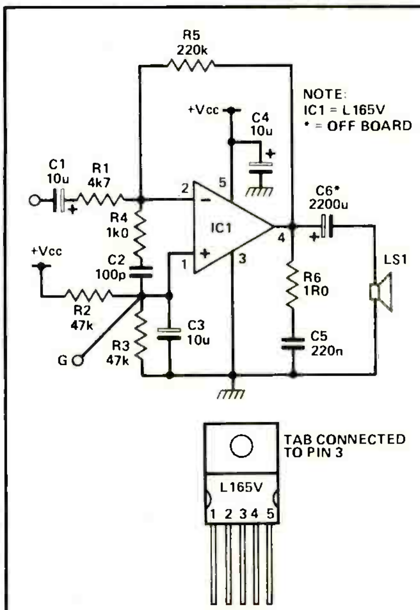


Fig. 1. Circuit diagram of single IC amplifier.

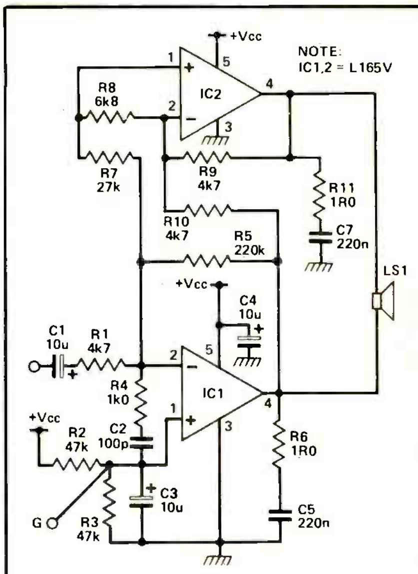


Fig. 2. Circuit diagram of the bridge amplifier.

tabs still applies. With a split rail supply they will be at V−, so don't bolt them to metalwork at 0V. If you are not absolutely sure, check with a voltmeter that the tabs and the metalwork are the at the same voltage.

Heat And Power

As far as heat sinking is concerned, the rule is the larger the better. By all means use finned extrusions if you wish, but otherwise just bolt the heat sinking tabs to the metalwork of the case, to a sheet of heavy gauge aluminium, or even to the loudspeaker chassis. A touch of heatsink compound and a clean mounting surface won't go amiss. Don't panic if the ICs seem to run rather hot — you can boil water on the heatsink before they get too unhappy, and an internal thermal shutdown should prevent them from coming to any harm. Having said that, they will work more efficiently if you can keep them cool. Don't run them without heatsinks, even at low power.

The power supply can be just about anything you like although if you are looking for outputs around 50W from the bridge circuit a supply of 30V or so at 3.5 amps will be needed. Avoid using supplies above 32V — although the ICs will work at up to 36V, anything above this may damage them, so leave a safety margin to allow for ripple and overvoltages of one sort or another on the supply.

HOW IT WORKS

The first amplifier circuit is much the same as the series feedback circuit commonly used with op-amps, with the gain being set by R5 and R1. R2 and R3 provide a voltage at a half of Vcc as a reference for the non-inverting input of IC1. R4 and C2 form a lag network to improve the damping and phase margin of the circuit. Without these components, the amplifier would oscillate when the input was left floating and would be prone to overshoot on transients. R6 and C5 form a Zobel network to minimise the variations in load impedance seen by the amplifier output.

With a split rail supply, the speaker can be connected between the output and 0V and C6 can be omitted. The output voltage offset, which will consist of the input offset ± the voltage across R5 developed by the bias current, will be around 2mV at the most. This is negligible, so no offset trimming is needed.

The bridge circuit is essentially the same as the single IC circuit, but has a second amplifier with a gain of −1 to provide an inverted signal for the other end of the loudspeaker. R9 and R10 give series feedback around IC2 for this purpose. The non-inverting input of the amplifier is connected to the virtual earth point at IC1 pin 2 to avoid having to adjust the output offset. R8 is included for stability.

PARTS LIST

RESISTORS		**C5, 7***	**220n polyester**
R1, 9*, 10*	**4k7**	**C6**	**2,200u 35v electrolytic (see text)**
R2, 3	**47k (see text)**		
R4	**1k0**		
R5	**220k**		
R6, 11*	**1R0**	**SEMICONDUCTORS**	
R7*	**27k**	**IC1, 2***	**L165V**
R8*	**6k8**		
CAPACITORS		**MISCELLANEOUS**	
C1, 3, 4	**10u, 35V tantalum**	**PCB (single IC or bridging version as required); heatsink (see text).**	
C2	**100p ceramic**		

***Additional components required for bridging version. Not needed for single IC amplifier.**

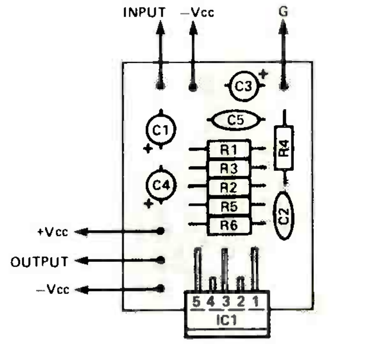


Fig. 3. Component overlay for the single IC amplifier board.

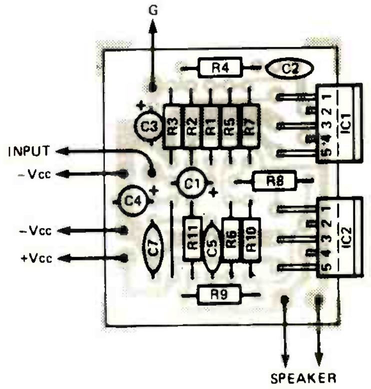


Fig. 4. Component overlay for the bridge amplifier board.

Applications

I hardly need to point out the applications of amplifier modules in general, but the small size, high power and tolerance of supply variations make these little units very versatile indeed.

The bridge amplifier can give a useful boost to car stereo systems, and will also find a home in other applications where a reasonable output is required and the supply voltage is low. Both modules are ideal for use in any project that needs a sound output. They will work from any old supply voltage, and they won't take up much space!

They won't disgrace themselves as part of a hi-fi system either. The frequency response is excellent — at quite high power levels there is no appreciable drop in output up to several hundred kHz (measured on a 'scope, since my ears and speakers give up long before that!). Noise and distortion are astonishingly low for such a simple circuit, and if your taste leans towards rock msuic, they certainly pack quite a punch. Don't underestimate them!

If you play in a rock band, you can sack the roadies. Who needs them when you can carry your amp about in your pocket? Of course, you'll also need matchbox-sized speakers and power supplies ....

BUYLINES

Kits for both amplifiers, including PCB and all components, are available from Specialist Semiconductors, Founders House, Redbrook, Monmouth, Gwent. The single IC amplifier kit costs £6.50 and the bridge version £8.95. The L165V ICs are available separately from the same source and cost £3.90 each. Postage on the complete order is 60p. The PCBs will also be available from our PCB Service, see page 58 for details.

ETI

TOUCH SWITCH

Paul Chappell, who designed all the free PCB circuits, goes over the top. Some say he's touched ...

Current trends in touch technology have far reaching implications for any dynamically balanced meta-system, with particular reference to their immediate spheres of utilisation and deployment. One may envisage major consequences arising from extended and/or prolonged disbursement techniques; moribund in nature, yet not without a certain attribution in the context of a pseudo-dictatorial stance — the details of which elude many who are otherwise conversant with the 'methodology' (**sic**) involved.

This project is a touch switch. You touch it. It switches. It has a delightful little LED in a tasteful shade of puce (unless that's something Alf spilled on it) and a very earnest TTL output. One of its most pleasing aspects is the little snippity-snap noises it makes when you break it in half. Oh, joy! I'd like to tell you more, but I'll quickly hand you over to Auntie Static who would like to leak some confidential information about the LM358. I'm off to get some more of my special green tablets. Over to you, Auntie.

Digression

It probably hasn't escaped the attention of our readers that all the FREE PCB projects have been based on the same IC — the LM358. The editor has expressed the opinion that a few details about the IC may be of interest, and who am I to disagree?

When we decided to make the project battery operated, our first concern was to find an op-amp that would work from a low voltage and consume very little current. The LM358 fits the bill nicely on both counts — it will run from voltages as low as 3V (and up to 30V) and draws only 500μA from the supply. The current drain is essentially independent of the supply voltage since most stages apart from the output have constant current loads, as you can see from the schematic in Fig. 1.

Split rail power supplies can be a nuisance to arrange in battery powered circuits. Two batteries can be used, of course, if there's room in the case for them, if they are evenly loaded so that they both run down at a similar rate, and if you're prepared to mess about finding out which one is flat when the circuit stops working or you don't mind throwing away the good one with the bad. In short, it's not an entirely satisfactory arrangement. The usual alternative is to arrange a suitable voltage bias for the op-amps with a pair of resistors. With the LM358, you don't even have to bother with this. The input common mode voltage range of the IC includes 0V, so for many applications it is possible just to ground one of the inputs. This was particularly useful, for instance, in the current to voltage converter used in the frequency and capacitance meters.

Have a go at designing a circuit to do the same job using a 741 (say), and you'll soon see the

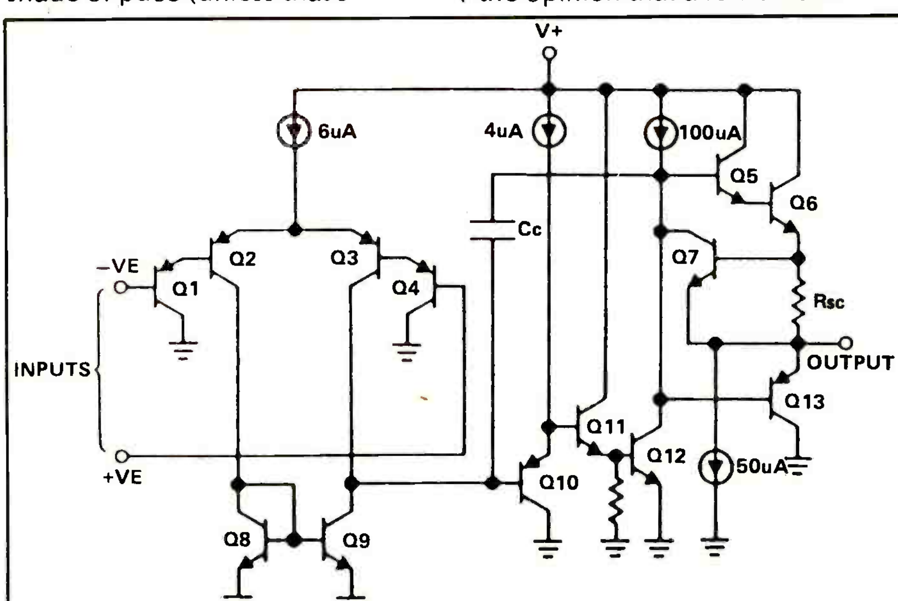


Fig. 1 Internal diagram of one half of an LM358 (courtesy of National Semiconductor).

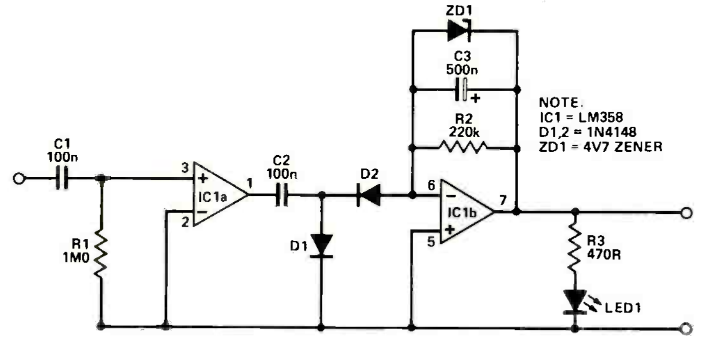


Fig. 2 Circuit diagram of the touch switch.

HOW IT WORKS

IC1a amplifies the electrical grunge that is coupled to the circuit from the touchperson's body — mostly mains hum. As we are not particularly concerned with hi-fi, the amplifier uses a bare minimum of components and no feedback whatsoever. C2, D1 and D2 act as a charge pump in much the same way as the equivalent section of the frequency meter, except that C2 is much larger so that the current will be high enough to drive IC1b output hard up to the positive end of its range (or would do if not for ZD1) at low frequencies.

ZD1 is included to give a suitable positive output voltage to drive TTL, and also to make sure the output stage functions correctly. Without the zener, the output would rise to within about 1.5V of V_{cc} and no higher — limited by the operation of the output stage of the LM358.

At this point, any further current through D2 would result in a drop in voltage at pin 6 of the IC. The voltage drop would be held between cycles by C3, so the voltage at pin 6 would get progressively lower. The op-amp is being taken outside its operating limits, and sooner or later it will get upset.

What actually happens is that the op-amp has an internal hiccup, the output voltage drops by a few volts, this restores the feedback action which maintains the voltage at pin 6 at 0V, and the output begins to rise again. When it reaches V_{cc}–1.5V, the whole process begins again.

In short, without ZD1 the output would oscillate. ZD1 prevents the output from rising above 4.7V, so this problem does not arise and the output remains stable.

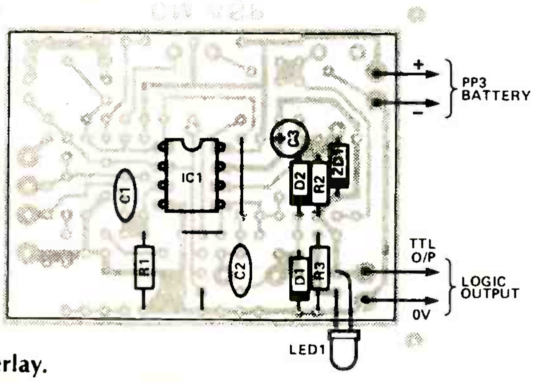


Fig. 3 Component overlay.

PARTS LIST

RESISTORS (all ¼W 5%)		SEMICONDUCTORS	
R1	1M0	IC1	LM358
R2	220k	D1, 2	1N4148
R3	470R	ZD1	4V7 zener diode
		LED1	red LED
CAPACITORS		MISCELLANEOUS	
C1, 2	100n	PP3 battery and connector	
C3	500n tantalum		

difference. In some circumstances this feature is not quite so useful, as in the input stage of the frequency meter, but nothing is perfect.

The output voltage swing of the LM358 also includes 0V, the full range being 0V to V_{cc}–1.5V. Having said that, the output won't quite pull all the way to 0V of its own accord. If you look again at the schematic in Fig. 1, you'll see that the combination of Q12 and Q13 will pull the output down to about 1V. If the output is very lightly loaded, the 50µA current sink will take it even lower, but even so the sink itself will take a certain minimum voltage to operate, so it won't quite make it all the way. A resistor from the output to ground is needed, as in the frequency meter circuit.

The difference between the LM358 and (why not?) a 741 in this respect is that if you want the output of a 741 to reach the negative supply rail, you'll have to short-circuit it! The arrangement of the output stage is such that it will continue to drive current into a load connected to the lower supply rail under all circumstances, whereas the current from the LM358 shuts off. A useful consequence of this is that the output of the IC is directly compatible with TTL logic (with a 270R resistor from the output of the amplifier to ground). Most op-amps won't pull low enough to give a good logic 0.

Other features of the IC are a fairly low input offset voltage of 2mV — not really spectacular when you consider more specialised circuits like the OP37 with around 30µV offset — but no cause for complaint. The input offset current of 5nA is quite respectable, too. The output can source and sink a reasonable current — up to 40mA, which should be more than adequate for most purposes.

BUYLINES

All the parts for this project are readily available and the LM358 will be supplied to ETI readers at the special price of 5 for £2 by Specialist Semiconductors, Founders House, Redbrook, Monmouth, Gwent. Spare printed circuit boards are also available but see the note in News Digest.

ETI

TEMPERATURE ALARM

This free PCB project knows hot stuff from cold. It can tell you when your bath water runs cold, your coffee becomes tepid or your plants are at risk from frost. Design by P. Chappell, MIPBCCMMG (Member of the Institute of Plumbers, Bathminders, Chartered Coffee Makers and Marrow Growers).

This little project will be invaluable to those of you who are in the habit of turning on the bath taps and wandering off to make a cup of coffee, build an ETI project, or whatever. Most household plumbing systems seem to have a very unfavourable hot-water tank-to-bath capacity ratio, resulting in a water temperature to volume function which declines rapidly below the Eulenschafft-Muller comfort rating as the bath fills beyond a level L=7V/8 x 1/A where V is the volume of the hot

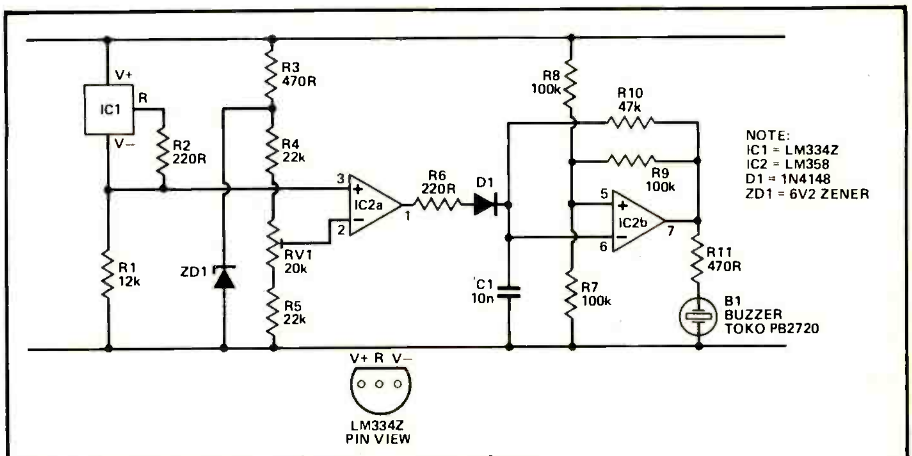


Fig. 1 Circuit diagram of the temperature alarm.

HOW IT WORKS

The LM334Z is a current source IC which has a linear variation in output with temperature. This feature can be a nuisance if you actually want to use it as a current source, but is very useful for making thermometers and suchlike. The current from the LM334 develops a voltage across R1 which is compared with a reference voltage set by RV1.

IC2b forms an oscillator. Let's suppose that the +ve input is at a higher voltage than the −ve input. The output of the op-amp will therefore be high, a little below Vcc, so the +ve input will be roughly 2/3 of Vcc by the action of R7, R8 and R9. Since the output is high, the voltage at the +ve input will rise as C1 charges up via R10, and will eventually reach 2/3 of Vcc. At this point, the output of the op-amp will go low so the +ve input will fall to 1/3 of Vcc and the capacitor C1 will begin to discharge. Eventually, the voltage at the −ve input will fall to 1/3 of Vcc, the output will go high, and the whole cycle will begin again.

Since we have received a number of Tech Tip suggestions containing rather questionable oscillator circuits, it may be in order to say a little more about why this circuit is absolutely certain to oscillate. Let's go back to the point where the −ve input of IC2b has risen to match the voltage of the +ve input. The output of the IC is just about to go low by the normal action of an op-amp. The important thing to notice is that the voltage across C1 is *still rising*, and will continue to rise even as the output of the IC falls, until it drops below (roughly) 2/3 of Vcc. On the other hand, any drop in output voltage at all will immediately pull down the voltage at the +ve input, so the cause of the switching action (the −ve input being positive with respect to the +ve input) will continue, and even increase, as the output falls. By the time the output voltage has fallen to a point where C1 can no longer charge, the +ve input will already be at a voltage well below the −ve input, and any further drop in output voltage can only increase this difference, so the switching action is hard on until the output reaches its lowest level.

Just to avoid confusion with Auntie Static's description of the LM358 (in the Touch Switch project), I should add that the upper voltage limit of the IC is, in fact, about Vcc-1.5V, so strictly speaking the input switching levels will not be quite 2/3 and 1/3 of Vcc, but the principle is still the same.

To return to the bath minder. The oscillator is allowed to run freely when the output of IC2a is low (as it will be when the temperature is low) and is held off by D1 and R6 when the temperature, and therefore the output of IC2a, is high. The transducer specified for the circuit is the one we used, mainly because there happened to be one lying around, so don't feel that you have to stick to the same type. No particular attempt was made to match the transducer frequency or drive requirements, so maybe you'd like to experiment with that for yourselves.

A modification you may like to consider is to increase C1 to 10μ or so, remove R11 and LS1, and insert a buzzer module between the output of IC2b and ground. The alarm will then be an intermittent buzzing sound. This is probably more satisfactory than the specified transducer if you intend to install the circuit permanently.

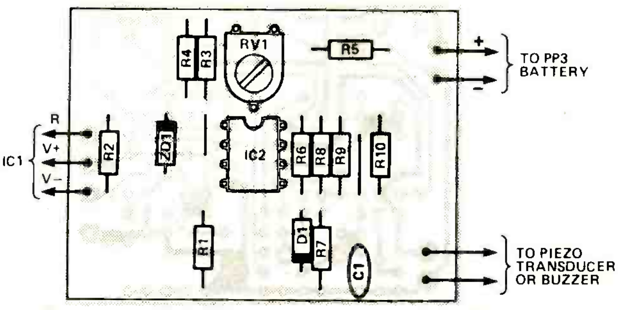


Fig. 2 Component overlay for the temperature alarm.

PARTS LIST

RESISTORS (all ¼W, 5%)

R1	12k
R2	220R
R3	470R
R4	22k
R5	22k
R6	220R
R7	100k
R8	100k
R9	100k
R10	47k
R11	470R
RV1	20k

CAPACITORS

C1	10n

SEMICONDUCTORS

IC1	LM334Z
IC2	LM358
D1	1N4148
ZD1	6V2 zener

MISCELLANEOUS

LS1 piezo sounder (PB2720); PB3 battery and connector; suitable housing for LM334; blob of Araldite; length of 3-core wire for sensor; PCB.

water tank and A is the average cross-sectional area of the bath. The eigenfactor 7V/8 is empirically determined as the breakpoint at which the ingress of cold water into the h.w. tank has reduced the temperature at the outflow, by the process of zonal intrusion, to a level at which it is $%&£@!! cold. In short, even if you return to the bath before it has overflowed, the chances are that it will 'freeze your naughty bits off' (Minsk and Kornbluth, Proceedings of the United Plumbers and Bathminders Conference, June 1983).

The answer, of course, is the auto-bathminder. With commercial models selling at upwards of £240, perhaps this little circuit will be of interest. Under the hot tap, the sensor detects the reduced temperature of the water when the tank is just about empty, and sets off an alarm. You then rush to the bathroom and turn off the tap. The circuit would also be useful as a frost warning device, although I wouldn't like to guarantee the long term stability of the temperature set point if you use the components specified for the bath minder.

Construction

The temperature sensor was housed in an old biro tube (what else?) and waterproofed with a blob of araldite. No doubt you could come up with better ideas yourselves. The circuit board is assembled according to the component overlay in Fig. 2 and once again I would urge you to double-check the layout. It's so easy to make mistakes on this board.

BUYLINES

The PB2720 piezo sounder is available from Cirkit, Park Lane, Broxbourne, Herts EN10 7NQ (Tel: 0992 444111). Otherwise the Maplin FM59P will do the trick. If you want to try the buzzer modification (see text), Maplin supply a suitable module with the catchy title of FL39N. Maplin's address and phone number can be found on their ad in this issue. The particular type of buzzer is not critical and suitable devices can no doubt be obtained from many other suppliers. The LM358 ICs are available from just about anybody, but the best price we have come across is 5 for £2 from: Specialist Semiconductors, Founders House, Redbrook, Monmouth, Gwent.

Extra PCBs can be obtained by sending £1 and a stamped, self-addressed envelope to: ASP Readers Services, PO Box 35, Wolsey House, Wolsey Road, Hemel Hempstead, Herts. HP2 4SS.

See the note in News Digest about this.

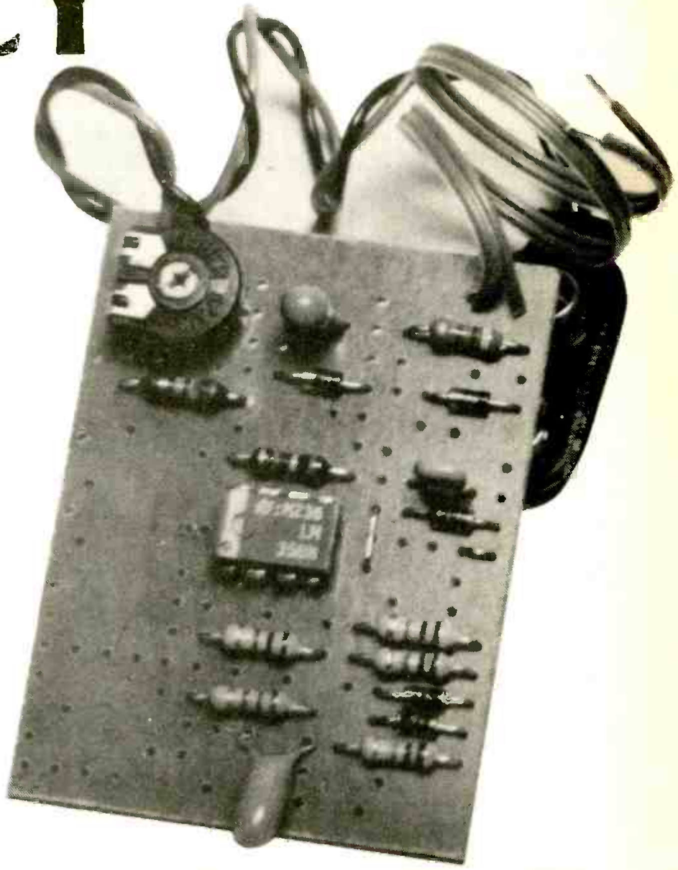
COMPETITION

Why not use your own ingenuity to design a circuit for our free PCB? The sender of the winning entry will receive £40 and the two runners up will win £20 each. We will publish the winning circuits later in the year. The circuit should fit neatly onto the board, without components soldered to the back, and we will be looking for original, well presented and elegant designs.

Entries should include a circuit diagram, component layout, a parts list and a description of the circuit (typed, please, and not more than 750 words in length.) If you are not the kind of person who has circuits published, have a go anyway. You may find out that you are!

Send your entries to: ETI (FP), 1 Golden Square, London W1R 3AB. Please enclose a stamped, self-addressed envelope if you want your entry returned and, please, no submissions after 2 May, 1986.

FREQUENCY METER MODULE



Yes, it's the Not-the-ETI-Cycle-Minder, a 100% re-cycled free- PCB design from Paul Chappell.

A frequency meter can be an expensive luxury for many home workshops and will usually take second (or third) place when essential items like an oscilloscope or a signal generator are needed. There is no doubt that the possibility of making quick checks on frequency can be useful at times (is your ultrasonic transmitter oscillating at 40 kHz or 100kHz?) so perhaps this little circuit will plug the gap for some of you until a more expensive instrument can be bought or built.

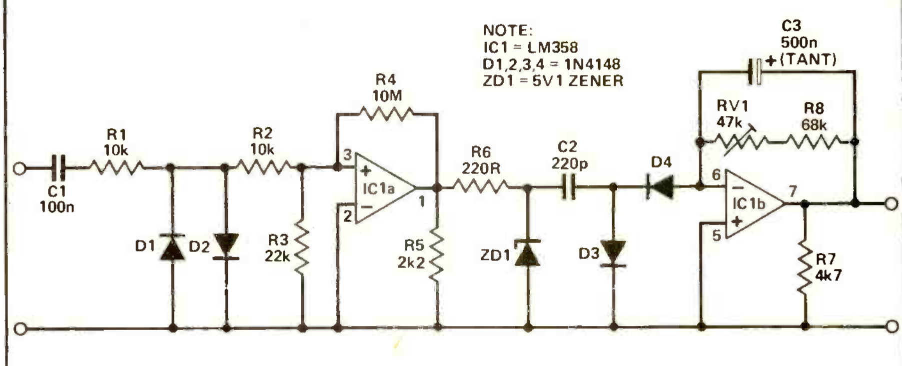


Fig. 1 Circuit diagram of the frequency meter module.

The Circuit

The circuit is essentially a linear frequency to voltage converter, the voltage being read on your bench multi-meter. The output can be adjusted so that frequency can be read directly from the meter scale — 0 to 2V could represent 0 to 10kHz, for instance. As it stands, the circuit will convert frequencies up to 20kHz, but a simple pre-scaler can be added to extend the range to 1MHz and beyond.

The principle of the frequency meter is similar to that of the capacitance meter described last month. The input waveform is squared, clipped and then applied to one plate of a capacitor. Each high to low transition of the voltage on this plate will draw a fixed amount of charge from the virtual earth at pin 6 of IC1 to charge up the other plate (Fig. 1). The current into the virtual earth comes from the output of the op-amp via RV1 and R8, so the voltage across these resistors will be proportional to the current drawn by C2 — or to the average current, since C3 will effectively smooth out the fluctuations.

The higher the input frequency, the more times each second C2 will draw its charge, so the higher will be the average current through RV1 and R8, and therefore also the voltage across them. Since pin 6 of IC1 is maintained at 0V by the action of the feedback, the output voltage of the circuit will be equal to the voltage across RV1 and R8, which is proportional to the input frequency.

RV1 is adjusted to calibrate the circuit. The component values given are for an output covering the audio frequency range 0 to 20kHz at a scaling of 1V per 10kHz, so the output will be in the range 0 to 2V. If you want a different range, the easiest way to achieve this is to alter C2. For 1V per kHz, for instance, C2 would be increased to 2n2. In this case, 1V would represent 1kHz, 2V would be 2kHz, and so on. The upper limit is determined in the first case by the fastest rate at which IC1a will switch, and in the second case by the battery voltage, so with C2=2n2 and a fresh battery, you could expect outputs up to about 8V and could therefore measure frequencies to 8kHz or so.

Pre-scaler

To read frequencies above 20kHz, the pre-scaling circuit of Fig. 2 can be used. The input is squared by IC1 and applied to a dual decade counter IC2, which divides the input frequency by 10 or 100. When the input frequency is divided by 10, 1V at the output of the frequency meter will represent 100kHz, and if divided by 100 the output will be scaled at 1V per MHz. You will certainly be able to read above 1MHz, possibly up to 2MHz, depending on the particular 311 IC used.

To make a multi-range instrument using the pre-scaler, you won't need a separate setting of RV1 for each range (unlike last month's capacitance meter). Just set it up for 0 to 20kHz and it will be just as accurate on the higher ranges.

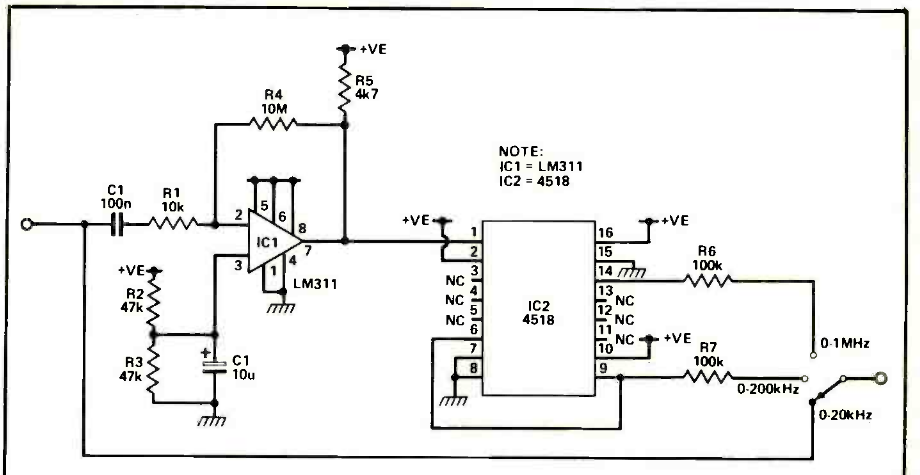


Fig. 2 Circuit diagram of the pre-scaler.

Calibration

If you haven't got a signal generator or any other source of a known frequency, there are two possible ways of calibrating the meter. The easiest, but not entirely satisfactory, way is to use the mains frequency as shown in Fig. 3. This would be quite acceptable for low frequency ranges, but for a 0 to 20kHz range, the output would only be 10mV at 100Hz and you will probably have difficulty reading this accurately on your meter. Also, the linearity of the module is better in the centre of its range than at either extreme, so it's best to use a frequency around 10kHz. A 4060 IC and a crystal can be used to produce an assortment of frequencies (Fig. 4). To find what frequency comes out of any output, just divide the crystal frequency by 2 that many times; that is to say, from Q9 you will get the crystal frequency divided by 2 nine times, from Q14 you will get the crystal frequency divided by 2^{14}, and so on. Choose the output giving a frequency somewhere between 10kHz and 20kHz, connect that output to the frequency meter, and adjust RV1 until the correct reading is shown.

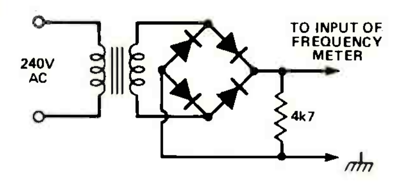


Fig. 3 A simple calibration arrangement using the mains frequency.

Construction

Construction should not present any problems as long as you check carefully to make sure all the components are in the right place. Since there are a lot of

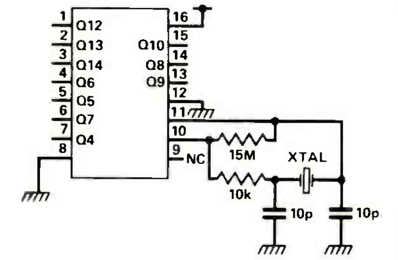


Fig. 4 A crystal and a divider arranged to give a number of calibration frequencies.

HOW IT WORKS

The input waveform is applied via C1 and R1 to a pair of diodes D1 and D2 which allow high input voltages, well in excess of the supply voltage, to be used without upsetting the LM358. R2 and R3 reduce the input voltage further to prevent the op-amp being taken outside its operating limits on negative excursions of the waveform. Strictly speaking, it is already operating outside its limits if pin 3 drops below 0V, but in this application it doesn't matter. If this worries you, or you'd like to know why — ask Auntie Static!

IC1a is used as a comparator and R4 supplies a smidgin of hysteresis to ensure it switches reliably. R5 pulls the output right down to 0V on low outputs and R6 and ZD1 set a fairly well defined upper limit to the voltage applied to C2.

When the output of IC1a is high, current from the 'right hand' terminal of C2 flows to ground via D3. When the output goes low, current flows into the right hand plate of C2 via D4, from the virtual earth at IC1b pin 6. On their own, RV1 and R8 would produce a voltage proportional to the instantaneous current from pin 6, by the action of IC1b, but C3 smoothes this out so the output from IC1b is proportional to the average current. R7 pulls the output down to 0V when no input is present. This is not a good idea in general, but works with the LM358 for reasons which I will also leave Auntie Static to explain.

A quick rule of thumb you can use to calculate component values for other ranges is:

$$v_{out} = fVC_2(RV1 + R8)$$

where f is the input frequency and V is the zener voltage.

C3 is chosen as a compromise between output ripple (reduced if C3 is increased) and settling time (increased if C3 is made larger). To measure very low frequencies you will find that a larger value of C3 will be needed to smooth out the ripple more effectively.

PARTS LIST

RESISTORS (all 1/4W 5%)

R1	10k
R2	10k
R3	22k
R4	10M
R5	2k2
R6	220R
R7	4k7
R8	68k
RV1	47k

CAPACITORS

C1	100n ceramic
C2	220p ceramic
C3	500n tantalum

SEMICONDUCTORS

IC1	LM358
D1–4	1N4148
ZD1	5V1 Zener

MISCELLANEOUS

PCB; PP3 battery connector; PP3 battery; BC3 case with battery compartment; On/off switch, rotary switch and knob and other parts for pre-scaler, if required (see text).

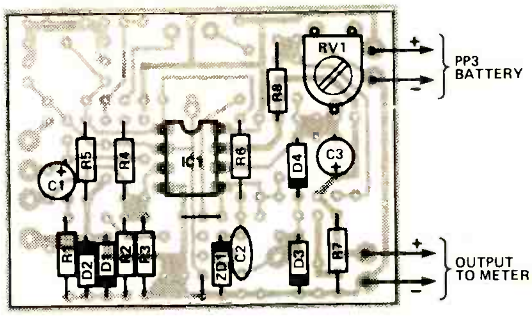


Fig. Component overlay for the frequency meter on the free PCB.

BUYLINES

Obtaining the parts for this project should not present any problems. You may be interested to know, however, that the LM358 ICs are available to ETI readers at the special price of 5 for £2 from: Specialist Semiconductors, Founders House, Redbrook, Monmouth, Gwent. The BC3 case with battery compartment is avialable from the same source at £2.80. Spare printed circuit boards can be obtained from us but stocks are limited. See the note in News Digest.

unused holes, some very close to the correct ones, it's easy to make mistakes. The best idea is to check the connections against the circuit diagram.

We built the final version into a box with a compartment for a PP3 battery — the same type as we used for the capacitance meter last month. The PCB can be held in place with sticky pads, since there are no mounting holes. With a bit of care, there should be plenty of room for the prescaler too although it will not, of course, fit on the PCB.

ETI

6809-BASED MICROCOMPUTER

Gary Mills concludes this series of articles with a discussion of the two main chips used and the software available to run on the machine.

Although the visual star of the show is the NEC7220A graphics controller, the 6809 is itself a very noteworthy chip. It was designed as a sophisticated answer to the 8080 and 8085 Intel chips, and incorporates a vastly improved set of addressing modes.

One of the most important features of the chip is the capacity to use program counter realtive addressing. This allows the programmer to generate Position Independent Code (PIC). PIC can be loaded and run anywhere in the available address space, and is easily ROMable. Both of these features are used to great advantage by operating systems which run on the 6809.

In terms of sheer speed the 6809 compares favourably with the Z80. A straight clock speed comparison is misleading because the Z80 takes an average of four clock cycles to perform instructions while the 6809 takes one. From benchmarks published in the 68XX Micro Journal, a two megahertz 6809 performs at almost exactly the same level as a 6 megahertz Z80. The 6809 in this design switches between 1 and 2 megahertz under software control.

The NEC7220A

The NEC7220A is a state-of-the-art graphics chip. While not a games chip, it has immense power for CAD applications and driving high resolution displays. It is currently used in the Epson QX10 and new QX16, and in the NEC personal computer series.

A full description of its capabilities would require several complete articles, but a brief list may help to convey the general idea:-

line and arc drawing

area fill

zoom and pan

up to four independently scrollable areas

software definable character set

resolution of 768h by 576v (in this computer)

It does all of this at the incredible drawing rate of 80 nanoseconds per pixel. To understand how fast this is, look at the four figures over the page. They can be drawn and erased on the screen in succession in under 7 seconds.

The publications listed below may be of interest to those who wish to explore in more detail the facilities offered by this chip.

uPD7220/GDC, uPD77220-1/ uPD7220-2 Graphics Display Controller

This is a fundamental document describing the chip's capacities and instruction set. However, it is terse and sparse on examples. It is published by NEC and can usually be requested when you purchase the chip, or ordered directly from them.

Product Description Graphics Display Controller uPD7220

Another NEC publication but better furnished with examples of the chip in use. It is available free-of-charge.

Application Note APN — 02 uPD 7220 Graphics Display Controller

Again from NEC, this document contains techniques and hints for programming the chip. It is available free-of-charge.

"Super Graphics Hardware from NEC"

An article by Steve Levin in BYTE magazine, April 1983. It gives a clear and concise summary of the chip's capabilities. A good introduction.

Monitor Routines Supporting Graphics

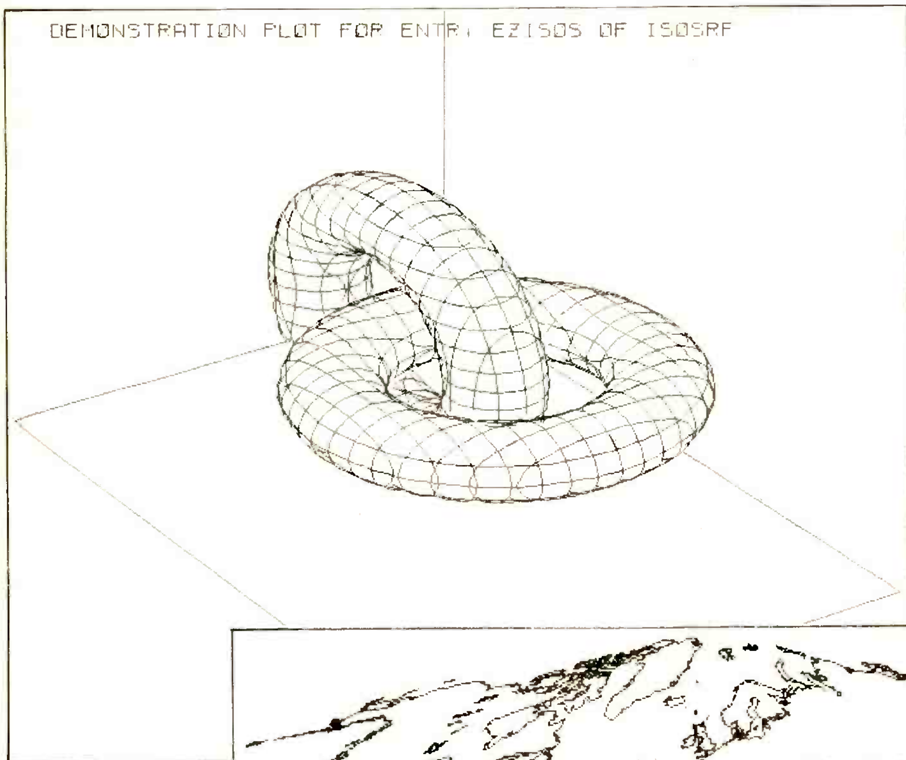
While contemplating the list of literature above, it may help to know that a great deal of work has been done for you. The kit for the project as supplied by Micro Concepts has a full set of assembly level graphics routines delivered in its firmware. They include:

Set graphics cursor position
Plot a point
Plot a line
Plot a rectangle
Plot a circle
Set a text cursor location
Get a text cursor location
Put a character on the screen
Get or set a zoom factor
Set an area fill pattern
Fill an area

These routines can be called directly from your assembly language programs, and are fully described in the Microbox II literature.

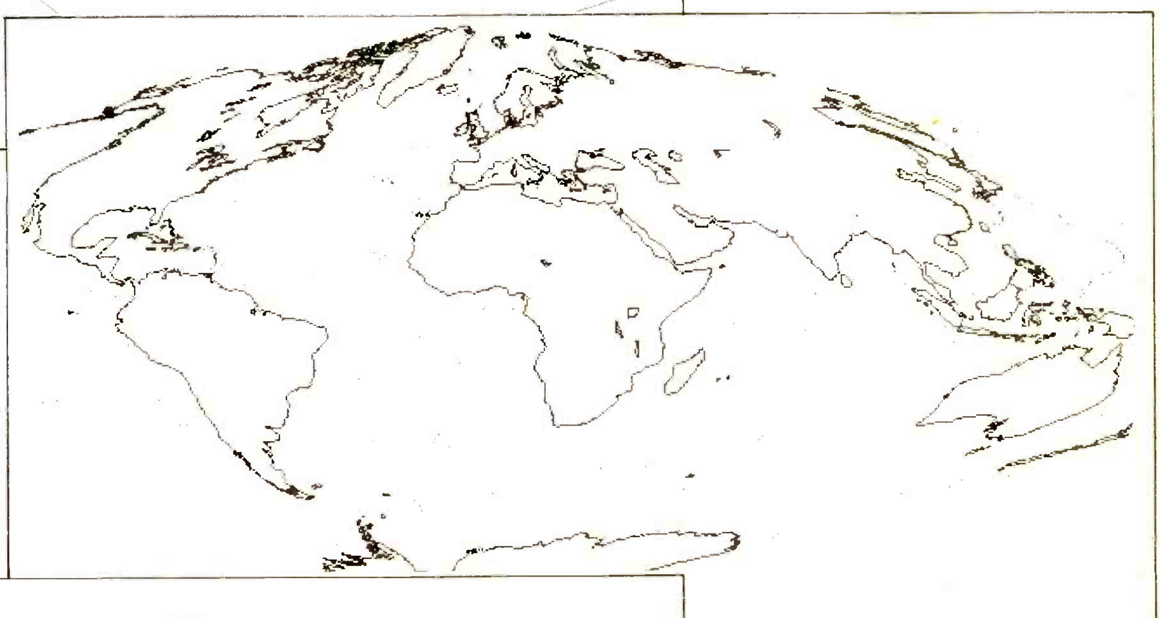
The Flex Operating System

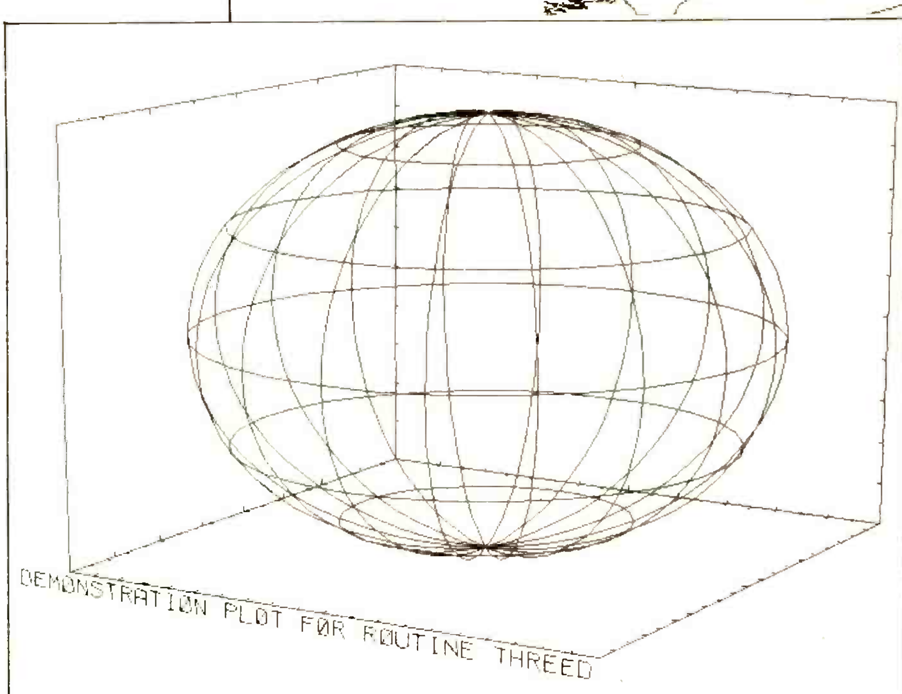
One of the strengths of this design is that it will run FLEX. Flex is a popular, standardised, and very useful operating system. It is perhaps not as well publicised as, for example CP/M because it has had different, less conspicuous areas of application rather than being used as a background for word processors and spreadsheets.



FLEX *can* run wordprocessors and spreadsheets (very good ones, too), but is primarily known as an engineer's operating system. It is consistently found on software development machines. Because of this there is a welter of languages, compilers, interpreters, assemblers and cross assemblers that run on FLEX, and because this machine can look like a standard FLEX machine to them, they all run on it.

The list of languages and applications that Micro Concepts sells is representative. The high-level languages include BASIC, both interpreted and compiled, COBOL, C, Small-C, PL9, Pascal, a Pascal cross-compiler for the 68000, Forth and BCPL. Assembly language packages include cross-assemblers for just about every commercially available chip, relocating assemblers, debuggers, simulators and translators. Applications include word processors, mail merge packages, database managers, and spreadsheets.



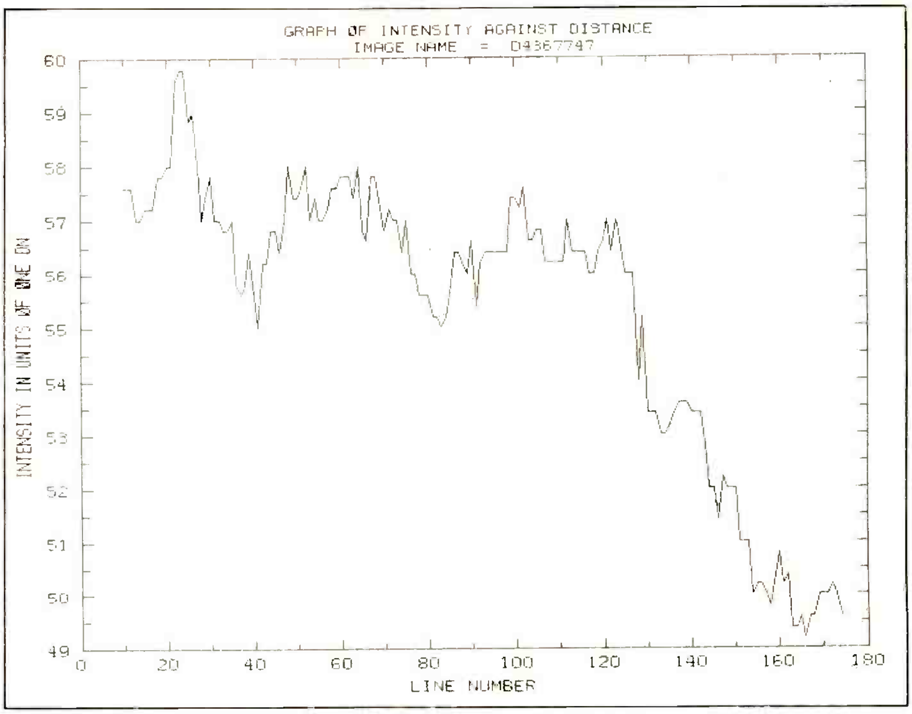


Not only does FLEX support disk, EPROM disk and EPROM programmer in this design, but a graphics macro library compatible with FLEX's native macro-assembler is provided with the kit. Further, two of the FLEX compilers, PL9 and Small-C, have graphics libraries expressly written for this machine. Already there is a character set editor, graphics screen dump, save, and restore routines, several games and an interactive graphics package for The four figures with this article were dumped to printer using the routines above.

Another aspect of a machine or system's useability is the number of people using it, and their availability. For FLEX there are several sources of information and news. One is the "68XX Micro Journal", an American publication that can be purchased in London at Stirling Microsystems on Baker Street or subscribed to directly. There are also various Dragon and Tandy Colour Computer organs.

6809 User's Group

The 68 Micro Group is a very active user's group which includes a large number of user's who have already built this kit. They hold meetings every four weeks in London, and maintain a disk library of around 30 volumes for FLEX and the 6809. You can have access to this library as a member either at their meetings or through the mail. At the moment they have 3 full disks devoted especially to this machine including the character set editor, screen save and dump routines, and the PL9 graphics interface mentioned above. You can contact the membership secretary about joining. Jim Turner, 63 Millais Road, London E11, tel 01-558 3681.



A basic kit for this design (the Microbox II) is available from Micro Concepts, 2 St. Stephens Road, Cheltenham, Gloucestershire GL51 5AA, tel, 0242-510525.

ETI

PRACTICAL DATA ENCRYPTION

As a follow up to our recent feature article on data encryption, Paul Chappell explains how to implement the Data Encryption Standard algorithm on a BBC microcomputer.

Message scrambling, or encryption, is an area of growing interest, set against a background of industrial espionage and ever more sophisticated computer fraud. An introductory article in the September 1985 issue of ETI described some current encryption techniques, and we now present a simple add-on for the BBC micro-computer which will put one particular encryption method into practice. The circuit consists of a single IC, the Western Digital WD2002, which implements the Data Encryption Standard (DES) algorithm. For those who missed the original ETI article, the following is a brief description of the main features of DES.

The easiest way to use DES is known as the 'electronic code book'. The data input is presented to the DES IC in the form of a 64-bit block. This block could be eight successive bytes from an 8-bit computer, or perhaps eight successive samples from our sound sampler circuit if you want to scramble voice transmissions. The DES IC takes this block and performs a complicated mathematical process to produce an output block, also 64 bits long, of scrambled (enciphered or encrypted) data. At the receiving end, the encrypted data block is fed into another DES IC which will reverse the process and give the original (plaintext) data back again.

The term 'code book' is quite appropriate because you could achieve the same result manually by having a list of all possible input data blocks with their encryptions as a huge look-up table. As there are 2^{64} possible input blocks —somewhere around 20,000,000,000,000,000,000 —the table would be rather long. The process, as described so far, could be implemented as a pair of huge ROMs — one of 2^{64} locations of 64 bits each for encryption and another the same size for decryption. To make the system secure you would personalise it by choosing your own permutation of the input block for the encryption process. Unfortunately, ROMs of this size are not easy to come by, and would take about 4,000,000 years each to program (at 1 bit per second)!

The DES algorithm is personalised by means of a 56-bit long 'key' which determines how the encryption process is carried out. The same input block fed into any number of DES ICs, each with a different key, will always produce a different output block. In the electronic code book system, the sender would use a certain fixed key and the receiver would use the same key to unscramble the message. Anyone intercepting the message would find it virtually impossible to 'crack' — even with a DES IC at their disposal — unless they too knew the key. They could certainly have a bash at putting in keys by trial and error, but 2^{56} is an awful lot of possibilities to search through, and it is currently way beyond the scope of even the most powerful computers to decode a message by trying keys at random. The pundits suggest that computers capable of performing a complete search of all keys within a day will be available within the next ten years. Whether or not this need concern you depends on just who you expect to be intercepting your messages.

The security of the DES algorithm is a controversial topic and the subject of a great deal of research. At the time of its adoption by the USA National Bureau of Standards, rumours were rife that the algorithm had been deliberately weakened to allow interception of messages by government agencies, and that a trapdoor in the algorithm would allow rapid deciphering without knowledge of the key and so on. As far as I know, nothing has ever been published to substantiate the rumours.

Anyone intercepting the message ... could certainly have a bash at putting in keys by trial and error, but 2^{56} is an awful lot of possibilities to search through ....

Leaving this aside, it is certainly true that DES encrypted messages will eventually succumb to an attack by statistical methods — given sufficient material encrypted from the same key, a skilled cryptanalyst would be able to deduce the key and decipher the messages. It is also well established that some keys result in weakly encrypted outputs.

A number of ways to improve the security of DES-based systems have been proposed. One is to encrypt the same input block several times under different keys. The plaintext block would be fed into the first DES IC and encrypted; the output would be transferred to the next DES IC where it would be encrypted again with a different key, the output of this IC would feed the next, and so on as many times as you like. Although it seems intuitively obvious that the more times you encrypt the input the more scrambled it will become, this method must be used with caution. There is no guarantee that a sequence of keys chosen at random will, in fact, strengthen the encryption.

The very worst case would be a sequence which took the input block through several encryption processes whereby it eventually emerged unchanged. To see how this might happen, just imagine a very simple encryption process which changed all 1s of the input to 0s and 0s to 1s. If you tried to apply this twice in an effort to scramble it further, all the 0s would end up as 0s and all 1s as 1s. The data would not be encrypted at all! The chances of this happening with the DES algorithm are negligible, but you can see that there is no guarantee of improving security. Satisfactory multiple encryption systems have been devised, however, and you may like to follow the matter up in the paper mentioned at the end of this article.

A second method is to change the key block regularly — the more often, the better. Changing the key manually becomes impractical if it is done too often (remember that the person receiving the message must also know which key you are using at any time). Various ways have been devised to provide automatic key changes, in particular to use the DES IC to change its own key. The chain block system described in the September 1985 issue of ETI is one example.

The method used in this project — output feedback — is yet another way to confuse the issue. In this system the DES IC does not perform the encryption itself, but provides pseudo-random numbers for a Vigenere substitution — a variation of the shift cipher. In its simplest form, a shift cipher involves replacing each letter of the message with another letter a fixed

The advantage ... is that the algorithm has been thoroughly investigated and you can be confident that your communications will be secure ...

number of places away in the alphabet. For a shift of two, every A in the original message is replaced by C, B becomes D, C become E, and so on. A cipher of this form could be cracked within a few minutes by any competent boy scout, yet it forms the basis of some very secure systems, including the unconditionally secure 'one time pad' (again see ETI September 1985).

```
10 REM     ***DES PROGRAM***
20 DIM Key(8),Int(8)
30 REM      ***KEY BLOCK***
40 M=&3000
50 FOR I=1 TO 8
60 READ Key(I)
70 M?I=Key(I)
80 NEXT I
90 REM ***INITIAL I/P BLOCK***
100 M=&3008
110 FOR I=1 TO 8
120 READ Int(I)
130 M?I=Int(I)
140 NEXT I
150 P%=&3100:REM sets aside memory
                 for assembler code
160 [
170 OPT 2
180 .entry LDA #&FF
190        STA &FE62
200        LDA #2
210        STA &FE60
220        LDX #0
230 .loop1 LDA &3001,X
240        STA &FD00
250        INX
260        CPX #8
270        BNE loop1
280        LDX #0
290 .loop2 LDA &3009,X
300        STA &FD00
310        INX
320        CPX #8
330        BNE loop2
340        LDX #0
350 .loop3 NOP
360        INX
370        CPX #&FF
380        BNE loop3
390        LDX #0
400 .loop4 LDA &FC00
410        STA &3009,X
420        INX
430        CPX #8
440        BNE loop4
450        LDA #1
460        STA &FE60
470        RTS
480 ]
490 REM ***MAIN BASIC PROGRAM***
500 INPUT "Input E to encrypt or
              D to decrypt";R$
510 IF R$="E" THEN 540
520 IF R$="D" THEN 650
530 CLS:PRINT "Mistake":GOTO 500
540 REM ***ENCRYPTION***
550 PRINT"Plaintext","Ciphertext"
560 INPUT P$
570 P=ASC(P$)-65
575 IF P<0 OR P>25 THEN 560
580 CALL entry
590 K=?&3010
600 X=K MOD 26
610 C=(P+X) MOD 26
620 C$=CHR$(C+65)
630 PRINT P$,C$
640 GOTO 560
650 REM ***DECRYPTION***
660 PRINT "Ciphertext","Plaintext"
670 INPUT P$
680 P=ASC(P$)-65
685 IF P<0 OR P>25 THEN 560
690 CALL entry
700 K=?&3010
710 X=K MOD 26
720 C=P-X
730 IF C<0 THEN C=C+26
750 C$=CHR$(C+65)
760 PRINT P$,C$
770 GOTO 670
775 REM ***KEY BLOCK DATA***
780 DATA 161,176,193,208,224,241,161,176
785 REM ***INIT I/P BLOCK DATA***
790 DATA 11,22,33,44,55,66,77,88
```

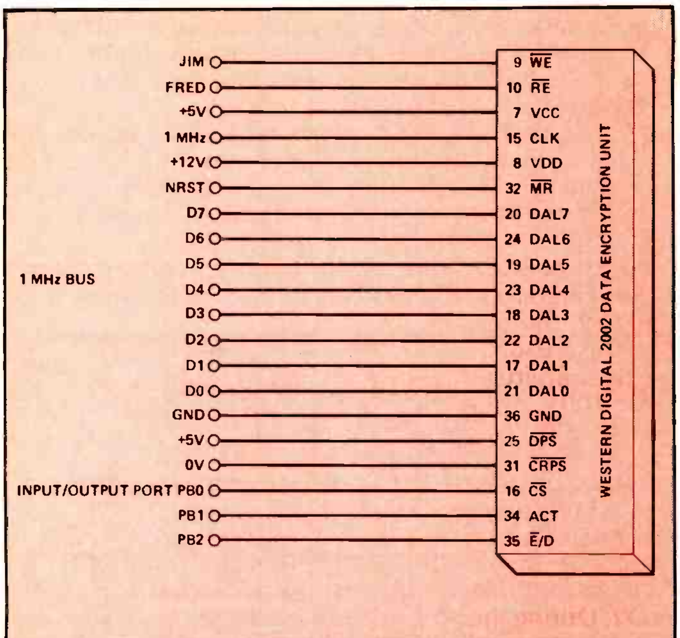


Fig. 1 Connecting a WD2002 to a BBC microcomputer.

The shift cipher is made secure by varying the shift for each letter; the more unfathomable the system for varying the shifts, the more secure the resulting ciphertext. The program for our project alters the shift length from the pseudo-random numbers generated by the DES IC. In the form presented here it will actually substitute one letter of the alphabet for another (instead of substituting one data block for another as required for more general use) and so can be used for ciphering written communications.

When you run the program, the computer will first ask whether you want to encrypt or decrypt. Type 'E' to 'scramble' your message, or 'D' to unscramble one you have received. The computer will then print two column headings: 'plaintext' and 'ciphertext'. Now type in your message, one letter at a time, followed by ENTER. If you are encrypting, the letters you type in will appear under the plaintext heading and the corresponding encrypted characters will appear in the ciphertext column. You will find that if you continuously input the same letter, the ciphertext will be an apparently random series of different letters, which should confuse any boy scouts who may be lurking around. The program, as it stands, will not encrypt spaces and punctuation in any sensible way, but modification of the program to do this should be a trivial matter for anyone moderately fluent in BBC BASIC. If you have received a message, enter 'D' to decrypt and type in the scrambled version, one letter at a time as before. The original message will appear under the plaintext heading.

It may seem that you could produce similar results by writing your own routine to generate pseudo-random numbers, without using the WD2002 at all. So you can, as long as you bear in mind that the receiver of the message must be able to generate the same string of numbers to be able to decrypt your message, which precludes using the computer's own random number generation. The advantage of using the DES IC is that the algorithm has been thoroughly investigated and you can be confident that your communications will be secure, in as much as the number of organisations which have the vast resources of skill, time and hardware needed to make any sense of them — if it can be done at all — is very small indeed. This will not be the case for most home-brew systems.

The DES algorithm is not secret — it is available in FIPS Publication 46, which you can obtain through your local library, by special request. The security of the system depends solely on the secrecy of the key you are using (in the context of this project, the secrecy of the key and the initial input block). The algorithm can be implemented entirely in software if your aim is to produce secret written communications as described above. For serious use, you must bear in mind that steps must be taken to protect your key — it's no good writing it into a BASIC data statement! You should also change the initial input block after each message, otherwise the same sequence of random numbers will be used each time you encrypt, allowing a relatively simple statistical analysis of your messages.

In the program for this project, the DES key is in the DATA statement in line 780. To change the key, you can either select eight bytes at random, as long as each has odd parity (an odd number of 1s in its binary representation) and substitute these for the ones given in the program. Otherwise, you can write down your chosen 56-bit key, split it into eight groups of even bits, add a 1 or a 0 to each group to give it odd parity, then use the eight bytes you end up with in the DATA statement. The initial input block is in line 790, and you can alter this in any way you choose — no need to worry about parity.

At the time of its adoption ... rumours were rife that the algorithm had been deliberately weakened to allow interception of messages by government agencies ...

For data transmission and real-time speech communication, software implementation is much too slow to be of any practical value, even on computers a good deal faster than the BBC. The various DES ICs, since they are pieces of hardware dedicated to that one function, are very much faster, making speech scrambling and high speed encrypted data transmission a practical proposition. I would suggest the analogue board of the sound sampler with a DES IC and some control logic as a suitable starting point for experiments in speech scrambling.

Finally, I have had a metaphorical slap on the wrist from John Pritchard, data encryption expert at the National Computing Centre, for using the term 'scrambling' in connection with the DES algorithm. He tells me that this suggests the output is merely a permutation of the input block, which it certainly isn't. My apologies if anyone was misled.

The Data encryption standard is published in full in: 'Data Encryption Standard', FIPS Publication 46, National Bureau of Standards, Washington DC, USA. (1977).

Further details of multiple encryption can be found in: Merkle, Ralph C., 'On the Security of Multiple Encryption', Communications of the ACM, vol. 24, no. 7 (1981).

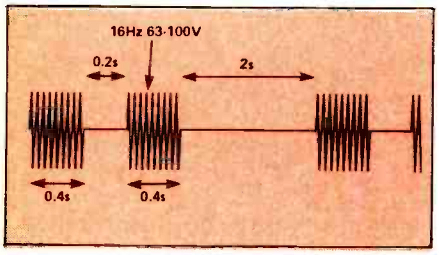
ETI

TECH TIPS

Telephone Answering Device

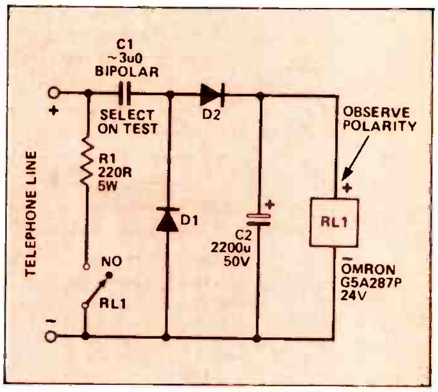
Geoff Phillips
Durham

The phone rings, you answer, and the caller hangs up. It's an uneasy feeling: is somebody checking that you are at home? when you are out you can't help wondering if they are checking again, and whether you'll come home to a burgled house.



This device answers your telephone after a few seconds delay and then hangs up on the caller. The circuit requires no external power but operates on the AC ringing signal which is transmitted by the exchange to your phone. This is usually a 16Hz voltage with an amplitude in the range 63 to 100V with cadences as shown in the first figure.

The answering device consists of a diode pump circuit which energises a high sensitivity relay. During the positive half cycles of the ringing tone, some of the charge on C1 is transferred to C2 via D2. During the negative half cycle, C1 is 'topped up' again via D1. Charge builds up gradually on C2 and when the pull in voltage of RL1 is reached, its normally open contact closes and places R1 across the telephone line. This has the same effect as lifting your handset and answering the call. The exhange then discontinues the ringing tone. The charge on C2 discharges into RL1 and when the drop-out voltage is reached the relay disconnects R1 from the line again. The impression a caller gets is that the line is answered after an acceptable delay, after which there



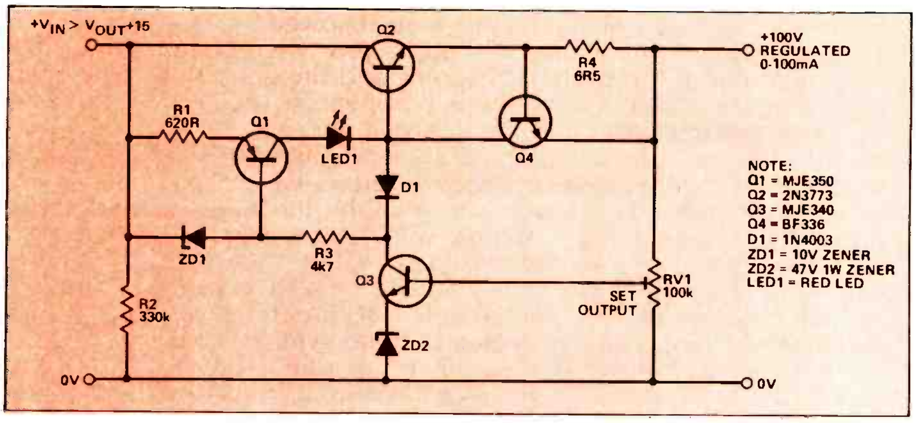
are a few seconds of silence and a subtle click as RL1 drops out.

The delay before answering is controlled by the value of C1 and this may have to be selected on test.

It should be pointed out that BT do not like indiscriminate connection of unapproved paraphernalia to their lines and this circuit should only form the basis of a design submission for approval with BT. the recommended RL1 type is the Omron G5A287P-24V which has BT approval.

Regulated PSU with Current Limiting And Short Circuit Protection

A. J. Holme
York



This design can provide from 50V to 115V and the output is current limited to 100mA maximum. Higher currents may be supplied with simple modifications. A somewhat novel feature is that the supply will switch off if a short circuit or excessively low load resistance causes the output value to drop below its preset value.

Q4 current-limits the output to the desired maximum by depriving the pass transistor Q2 of base current. Within the limits set by the mains transformer you are using, the limiting current can be increased by inserting diodes in the emitter lead of Q4 or by reducing the value of the current sampling resistor, R4.

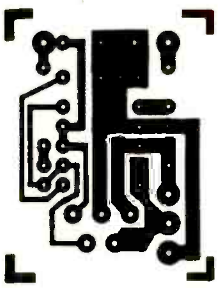
Regulation of the output voltage is controled by Q3 which shunts drive current from the base of the pass transistor, Q2. The resultant voltage is set by RV1 and the 47V zener.

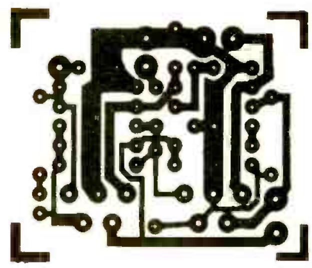
Q1 is a constant current source which produces 15mA for Q2, Q3 and Q4 to share according to load conditions. If the output voltage is pulled low, Q3 switches off and Q1 base current will cease. This causes the whole circuit to turn off, thus providing overload and short circuit protection. Vin must be removed and re-applied to re-start the circuit. The LED extinguishes when the supply is tripped.

Q2 is capable of providing much higher currents if required (provided suitable heatsinking is used), but make sure you understand the consequences of any modification before attempting it. 100V or more can be very destructive!

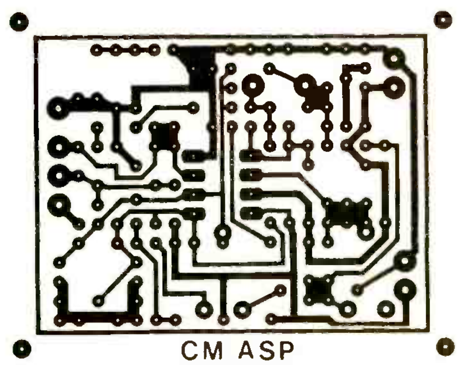
ETI

PCB FOIL PATTERNS

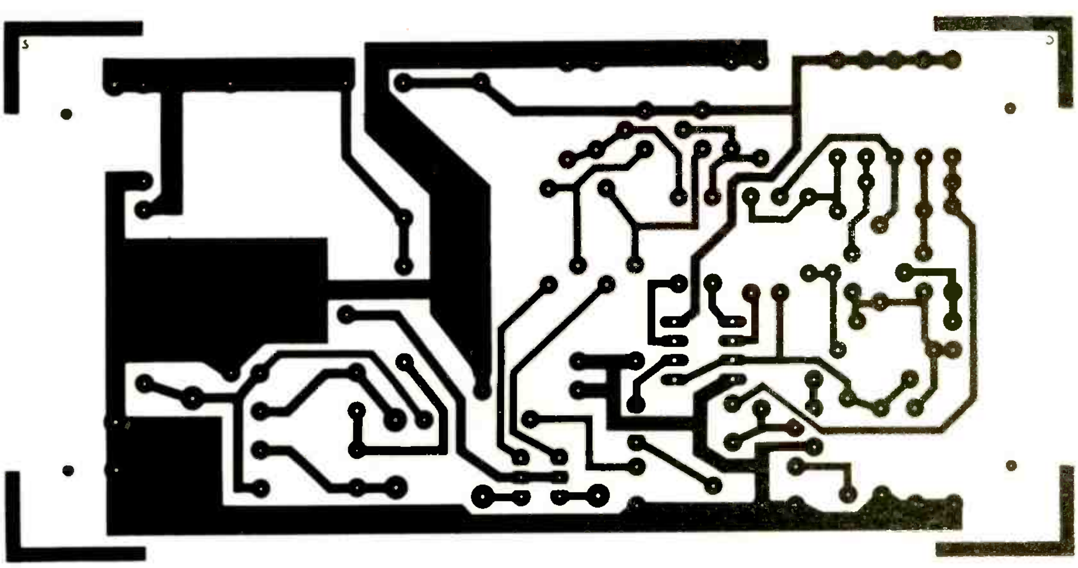




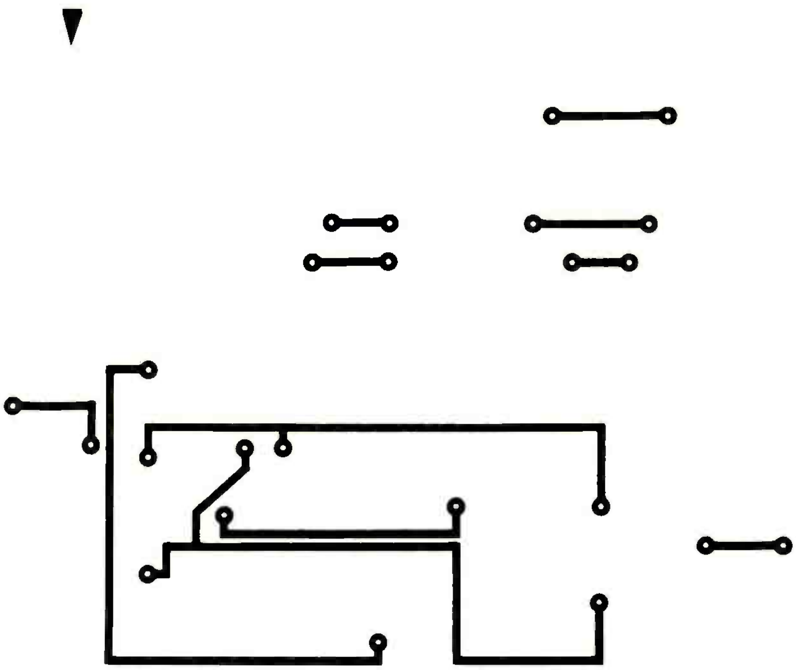
The patterns for the two Matchbox amplifier boards, the single IC version (left) and the bridging version (right).



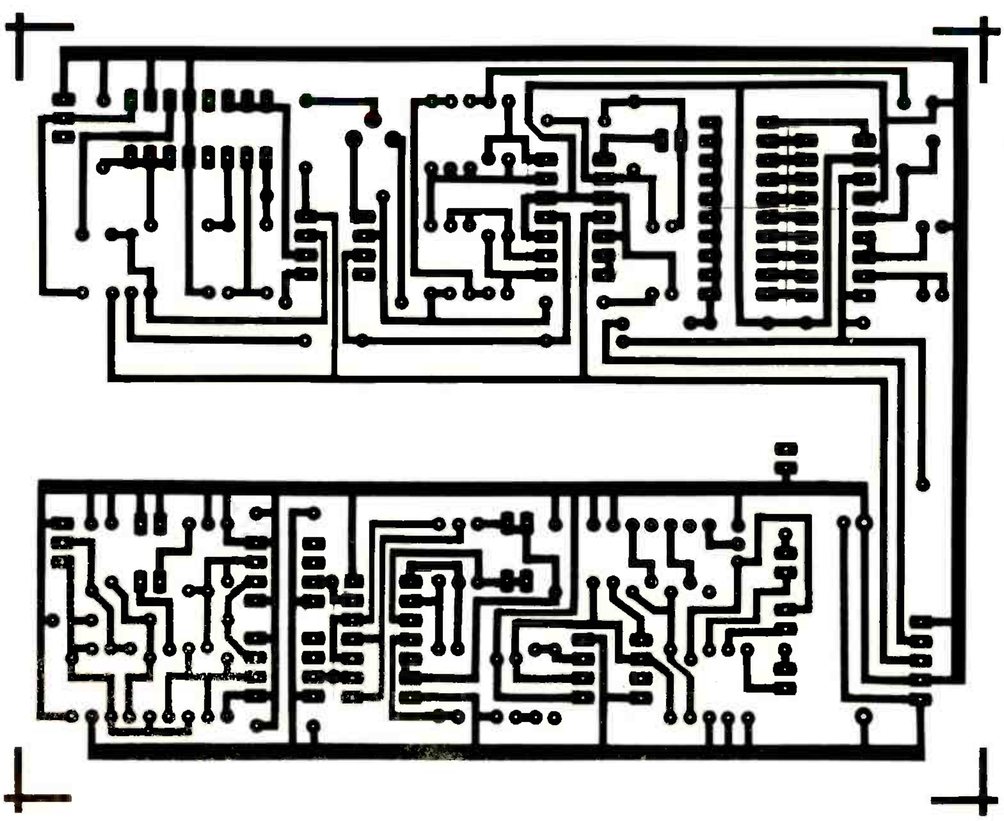
The foil pattern for the free PCB given away with last month's issue. For details of where to obtain more of these boards, see News Digest.



The foil pattern for the DC-DC converter board.



The top and bottom foils for the Modular Test Equipment analogue/digital probe.



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- ☐ E/8412-2 Experimenter's DRAM ... 14.72
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- ☐ E/8412-4 Active-8: Protection Unit ... 3.69
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- ☐ E/8412-6 Active-8: LF EQ ... 3.69
- ☐ E/8412-7 Active-8: Equaliser ... 3.69
- ☐ E/8412-8 Active-8: Delay Unit ... 3.69

1985

- ☐ E/8501-1 Active Bass speaker ... 2.82
- ☐ E/8501-2 DRAM Card Update ... 3.61
- ☐ E/8501-3 Digital Delay (2 bds) ... 27.18
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- ☐ E/8503-3 THD meter mains PSU ... 3.63
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- ☐ E/8503-5 ParaGraph Equaliser IP/MSP & OP/PSU bds ... 10.42
- ☐ E/8503-6 ParaGraph Equaliser filter bd ... 4.93
- ☐ E/8504-1 Framestore Memory ... 12.05
- ☐ E/8504-2 Framestore ADC/DAC ... 6.21
- ☐ E/8504-3 Framestore Control ... 17.26
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- ☐ E/8510-1&2 Sorcerer keyboard and interface‡ ... POA
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- ☐ E/8510-9 Sunrise Light Brightener ... 6.61
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- ☐ E/8511-6 Rhythm Chip ... *
- ☐ E/8511-7 Enlarger Exposure Meter ... 3.86
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- ☐ E/8512-1 Specdrum Connector ... *
- ☐ E/8512-2 MTE Pulse Generator ... 6.62
- ☐ E/8512-3 Specdrum ... *
- ☐ E/8512-4 DI Compression Gate ... *

1986

- ☐ E/8601-1 Autowipe ... *
- ☐ E/8601-2 Walkmate ... £8.97
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- ☐ E/8603-1 Free PCB ... *
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* PCB available from another source. See the original article for details.

‡ Several boards supplied as one. Purchaser must separate.

How to order: indicate the boards required by ticking the boxes and send this page, together with your payment, to: ASP Readers' Services, PO Box 35, Wolsey House, Wolsey Road, Hemel Hempstead, Hertfordshire HP2 4SS, tel 0442-41221. Payment in sterling only please. Prices subject to change without notice.

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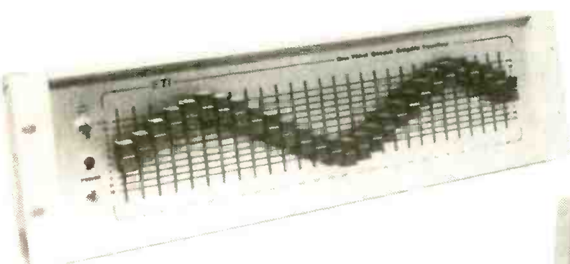
GOLDEN OLDIES

Listed below are all the PCBs which are still available for our earlier projects — along with some pictures to jog your memory! These boards can be ordered in the normal way using the coupon opposite. Just tick the boxes against the boards you require, complete the coupon and send both pages with your payment to the address given.

We will be including this page from time to time when we have space but it won't appear every month, so if something here takes your eye, fill in the coupon and order it NOW!

System A preamplifier (E/8107-2)

Audiophile FM Tuner (E/8101-4, 5, 6, 7, 8 & 9)



⅓rd Octave graphic equaliser (E/8308-1)

1981

- ☐ E/8101-4 Audiophile FM Tuner — switchboard 3.85
- ☐ E/8101-5 AFMT — LED tuning bd ... 3.71
- ☐ E/8101-6 AFMT PSU board 3.62
- ☐ E/8101-7 AFMT stereo level indicator 3.74
- ☐ E/8101-8 AFMT auto search lock ... 3.67
- ☐ E/8101-9 AFMT signal strength meter 3.83
- ☐ E/8107-1 System A disc input, MM/MC 3.58
- ☐ E/8107-2 System A preamplifier 7.10
- ☐ E/8108-1 System A power amp 7.76
- ☐ E/8109-2 System A PSU 3.67
- ☐ E/8110-6 V3 crossover board 11.16

1982

- ☐ E/8202-5 MM disc preamp......... 4.13
- ☐ E/8207-1 Microphone switching unit 3.36
- ☐ E/8208-1 Playmate practice amplifier‡ 7.45
- ☐ E/8209-1 Auto volume control 3.59

1983

- ☐ E/8301-2 ZX81/Spectrum ADC..... 3.87
- ☐ E/8305-1 Stereo compressor/ limiter 8.83
- ☐ E/8305-3 Hi-fi power supply 4.48
- ☐ E/8305-4 NDFL power amplifier... 10.32
- ☐ E/8305-5 Balanced input preamp ... 3.68
- ☐ E/8306-1 PseudoROM‡............ 3.77
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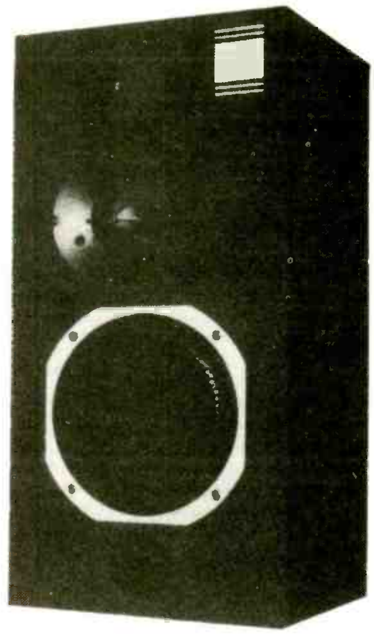
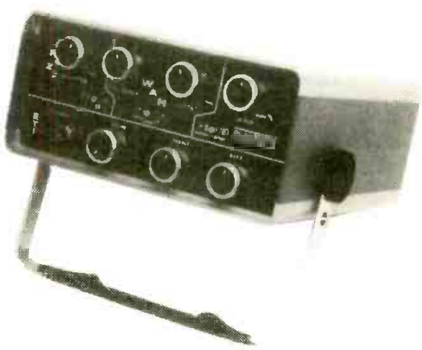
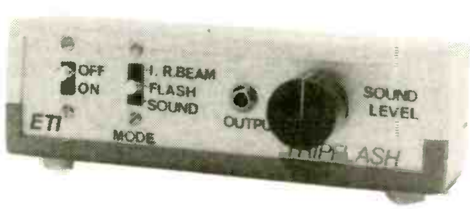
- ☐ E/8307-2 Flash Trigger 3.67
- ☐ E/8307-3 Infra-red transmitter 2.21
- ☐ E/8308-1 ⅓rd octave graphic equaliser..................... 11.59
- ☐ E/8309-1 NiCad charger/ regenerator 3.77
- ☐ E/8310-2 Car Alarm 3.99
- ☐ E/8310-3 Typewriter interface...... 4.11
- ☐ E/8311-1 Mini Drum Synth......... 3.85
- ☐ E/8311-8 JLLH MC disc preamp 3.85
- ☐ E/8312-3 Finesse light chaser 12.48



V3 loudspeaker (E/8110-6)



Playmate practice/effects amplifier (E/8208-1)



Flash trigger unit (E/8307-2)

SERVICE SHEET

Enquiries

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

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

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ETI should be available through newsagents, and if readers have difficulty in obtaining issues, we'd like to hear about it.

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Backnumbers of ETI are held for one year only from the date of issue. The cost of each is the current cover price of ETI plus 50p, and orders should be sent to: ETI Backnumbers Department, Infonet Ltd, Times House, 179 The Marlowes, Hemel Hempstead, Hertfordshire HP1 1BB. Cheques, postal orders, etc should be made payable to ASP Ltd. We suggest that you telephone first to make sure there are still stocks of the issue you require: the number is (0442) 48432. Please allow 28 days for delivery.

We would normally expect to have ample stocks of each of the last twelve issues, but obviously, we cannot guarantee this. Where a backnumber proves to be unavailable, or where the issue you require appeared more than a year ago, photocopies of individual articles can be ordered instead. These cost £1.50 (UK or overseas surface mail), irrespective of article length, but note that where an article appeared in several parts each part will be charged as one article. Your request should state clearly the title of the article you require and the month and year in which it appeared. Where an article appeared in several parts you should list these individually. An index listing projects only from 1972 to September 1984 was published in the October 1984 issue and can be ordered in the same way as any other photocopy. If you are interested in features as well as projects you will have to order an index covering the period you require only. A full index for the period from 1972 to March 1977 was published in the April 1977 issue, an index for April 1977 through to the end of 1978 was published in the December 1978 issue, the index for 1979 was published in January 1980, the 1980/81 index in January 1982, the 1982 index in December 1982, the 1983 index in January 1984, the 1984 index in January 1985 and the 1985 index in December 1985. Photocopies should be ordered from: ETI Photocopies, Argus Specialist Publications Ltd, 1 Golden Square, London W1R 3AB. Cheques, postal orders, etc should be made payable to ASP Ltd.

Write For ETI

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

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So far as we know, all our advertisers work hard to provide a good service to our readers. However, problems can occur, and in this event you should:

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If you exhaust the above procedure and still do not obtain a satisfactory response from the supplier, then please drop us a line. We are not able to help directly, because basically the dispute is between you and the supplier, but a letter from us can sometimes help to get the matter sorted out. But please, don't write to us until you have taken all reasonable steps yourself to sort out the problem.

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OOPS!

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

Low Cost Audio Mixer (June 1985)

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

Noise About Noise (July 1985)

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

Printer Buffer (July 1985)

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

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

Cortex Parallel I/O (September 1985)

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

Intel 8294 Data Encryption Unit (September 1985)

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

Tech Tips — Novel Input Stage (October 1985)

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

Chorus Unit (November 1985)

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

Foil Patterns (November 1985)

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

The Rhyth-ROM (November 1985)

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

Cymbal Synth (November 1985)

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

Digibaro (February 1986)

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

REVIEWS – HARDWARE

SUPERKIT 1 and SUPERKIT 2
Cambridge Learning Ltd., River Mill Lodge, St. Ives, Huntingdon, Cambs. PE17 4BR
Price: Superkit 1 £22, Superkit 2 £16, Both kits together £35

INTRO Introductory Kit
Educational electronics, 28 Lake Street, Leighton Buzzard, Beds. LU7 8RX
Price: £52.94

Superkits

The Cambridge Learning Superkits are intended for beginners in digital electronics to use for self training. Both kits are packaged in plastic wallets and include books of experiments and explanation.

Kit 1 contains a breadboard into which ICs and other components can be plugged, seven TTL chips, a dual in line switch, a few resistors, capacitors and LEDs, some insulated solid core wire, and a 170 page instruction manual.

The manual is well set out, and begins optimistcally by telling the readers what they will know after completing the course. The experiments start at rock bottom for the absolute beginner, and proceed by measured increments to material which would be relevant in the first year of a university course. Material on Boolean algebra and basic electricity is included.

The second kit contains ten extra TTL chips of a more advanced nature — more sequential circuits, and even a 32 x 8 bit PROM. It also includes a seven segment LED display, more passive components and wire.

The subject matter includes a good deal of information which would be useful as a foundation to the study of computer architecture — in particular, descriptions of arithmetic circuits, memory devices, and a variety of sequential logic circuits.

Both manuals include questions, with the answers on a separate page, to allow students to assess their progress. There is a section in each book entitled 'Fun Circuits' which, as the title suggests, is just for amusement. An electronic dice is one example of the circuits in this category.

The kits should prove effective for training and are also an interesting and amusing way for hobbyists to increase their understanding of electronics. The mention of ETI in the instruction manuals, as a source for further projects, must surely count in their favour! I can thoroughly recommend these kits.

Intro

This is a digital electronics introduction kit intended for schools. It contains a glossy covered book thirteen CMOS chips, a seven segment display, a phototransistor, a few passive components, and two different lengths of precut and stripped insulated wire links. It also includes a special PCB on which to carry out the experiments, populated with IC sockets and other useful components. Even the battery is included.

The board includes a four part DIL switch, six LEDs with a CMOS high current driver to run them, a pushbutton switch and debouncer described as 'a pulser', and 100k resistor networks wired as pull-ups on the connections to the IC sockets. There is a clock oscillator circuit, only requiring the addition of a capacitor to work.

The power connections to the four IC sockets are included in the tracking, so the experimenter only has to add the interconnections. These are made with the wire links, which plug into expensive looking flush-mounting connectors. In one corner of the board is a Molex connector, intended to connect signals to and from a Microprofessor microprocessor system.

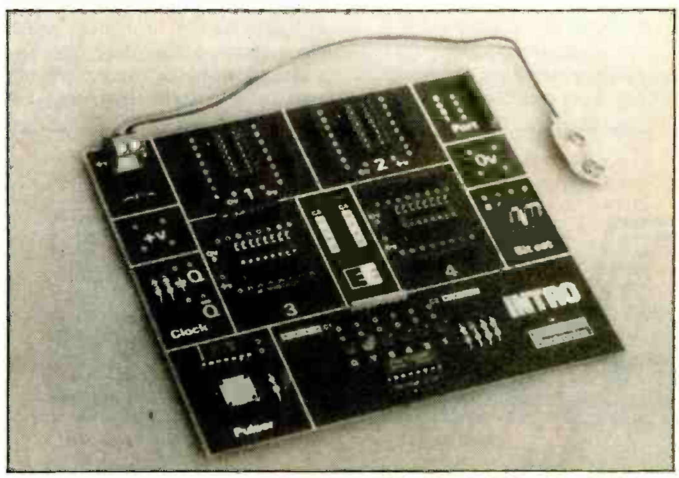
A battery connector is supplied connected to screw terminals on the board, and there is a diode connected in series with the battery input to protect the circuit. The top of the board is finished in matt black, with white lettering, and it looks very smart.

Each experiment is designed to illustrate a particular principle, and the principle is explained with the use of circuit diagrams and Boolean algebra expressions. A wiring layout for the board is also shown. What is missing is a circuit diagram of the actual experiment, though in some cases part of the circuit is shown. I realise that in a shcool, the teacher could draw the circuit diagram if it was considered important, but I still think this is a serious omission.

In addition, between some of the experiments, there are descriptions of sample applications of microelectronics. This may be helpful to hold the interest of schoolkids, but the applications shown are so far above the level of the experiment that it seemed to me to emphasize the difference between what you can achieve with a few custom LSIs or a chunky desk top computer, and with a couple of standard CMOS chips.

In short, I remain unconvinced about the book. It does not live up to the rest of the kit.

Andy Armstrong



ALF'S PUZZLE

Readers may be interested in Alf's method of generating free electricity. He begins with a 2μF capacitor charged up to 10V. From the formula $E=½CV^2$ he calculates that the energy stored is 100μJ. He then takes three uncharged 2μF capacitors and connects them in parallel with the charged one. As they are all equal in value, he reckons that each one will have 25μJ of energy stored. Finally, he takes the four charged capacitors, connects two in series to give the equivalent of a 1μF capacitor, connects the other two in series to give another 1μF capacitor, then connects the two pairs in parallel to give the equivalent of a 2μF capacitor.

From the formula above, he calculates that the voltage across each 'real' 2μF capacitor is 5V, so the voltage across the series/parallel 2μF capacitor will be 10V. He started with a 2μF capacitor charged to 10V and finished with a 2μF capacitor charged to 10V. Nothing remarkable about that, you may think.

The puzzling thing is that the charge stored by the original capacitor was 2μF x 10V = 20μC. The charge on each of the four 2μF capactirors at the end of his experiment is 2μF x 5V = 10μC. There are four of them, so the total final charge is 40μC. How did he manage to double the amount of charge?

The answer to last month's puzzle:

Yes, the circuit will work. The numbering of address and data lines on memory ICs is completely arbitrary and you can renumber them any way you like, as long as you are consistent about it.

ETI

OPEN CHANNEL

In Open Channel in the January issue of ETI, I reported on the attempt by British Telecom to acquire a controlling intetest in Mitel, and the fact that the Monopolies and Mergers Commission was looking into the deal. If you remember, I said that it looked as though the Commission was about to give the go ahead, much to the displeasure of companies such as Plessey and GEC who are in competition with BT.

Well, yes, the Commission did clear the attempt, but with recommendations that BT's marketing, sales, supply and maintenance organisations should be kept separate from those of Mitel. That, I feel, was going too far. There is no doubt (and I said this at the time) that BT will develop its own manufacturing organisation if it doesn't purchase one outright. Buying a controlling part of Mitel merely cuts out the start-up procedures of doing it from scratch. There is little wrong with either approach, and certainly nothing that the Monopolies and Mergers Commission should concern itself with. The best outcome of the affair should have been a recommendation (and I quote myself from the January issue) that "BT can buy Mitel if it wants, but that for a limited timespan it cannot increase its market share because of the manufacturing advantage". This approach would have meant that other concerned manufacturers had a chance to get their houses in order and compete effectively.

The Department of Trade and Industry apparently agrees with me (someone, somewhere, in the DTI must read Electronics Today International), and has overuled the Commission's recommendation, defining the purchase acceptable if the combined operations are kept to 1985 levels.

On the face of it, this seems reasonable, although no time limit was given for how long this situation must exist. It is unfair on BT and Mitel if the companies cannot eventually increase sales. Nevertheless, the definition appears to stand for 1985 products and services, so BT and Mitel can apparently increase their market share with other products and services, thereby sidestepping the strict sense of the definition. Whether this is so remains to be seen.

DBS Again

Yet another attempt is being made to finalise details of a British direct broadcasting by satellite (DBS) system. By the end of February (just a couple of weeks before this issue hits the streets, but too late to give details), the Home Office is expected to announce the latest go-ahead, so I should be able to report the outcome in May's ETI.

Rumours abound that some sort of tie-up with the Irish DBS system can be expected, as the British and Irish satellite orbital position allocations are the same, although different frequencies have been allocated. It makes sense to have such an involvement, technically at least, as it must surely help to keep costs (the main reason why previous attempts have floundered) as low as possible. But we all know that political and personal motives within Government tend to far outweigh commercial ones, so I can't say that I am convinced.

Perhaps we shall be pleasantly surprised.

Open Systems

The battle among the big computer and telecommunications companies to produce an open systems interconnect (OSI) system is building up. OSI is an International Standards Organisation (ISO) defined recommendation, which will allow any computer, anywhere in the world, to talk to any other computer on at least a basic level. This situation cannot occur, however, until a standard is defined for OSI, which all computer manufacturers stick to.

Eighteen major companies in the USA are getting together to fund the Corporation for Open Systems, a non-profit making organisation, for the purposes of defining the standard and testing manufacturers equipment for compliance.

Notably, IBM is not one of the eighteen. Its System Network Architecture (SNA) goes a long way to follow OSI but falls short in certain aspects. The Corporation for Open Systems is, in fact, being set up by IBM's main competitors with an eye to beating IBM's dominance in the computer/telecommunications world. I am a great believer in free competition (I am certain the customer benefits the most), so I wish them luck.

Keith Brindley

TRAINS OF THOUGHT

To an electronics buff a signal is an electrical pulse on a conductor — or an electromagnetic one in free space — which carries data. On railways and model railways a signal means something quite different — a lineside structure which offers the train driver data concerning the availability of the road in front of the train.

Most modern signalling installations use coloured lights, with red meaning danger (stop), green meaning clear (proceed) and yellow (in practice the colour is amber) meaning caution (proceed with care, be ready to stop at the next signal). Innumerable variations exist. For instance, on many main lines in Britain a double yellow indicates preliminary caution (be prepaed to stop at the next-but-one-signal). The addition of working signals to a model railway adds greatly to the effect, since it is no longer just the trains that 'do things'.

Old-fashioned semaphore (moving arm) signals pose what is primarily a mechanical challange, but colour-light signals can be modelled using exclusively electronic techniques since LEDs are available in all the right colours and all the right sizes. T1-size LEDs are almost exactly right for OO-scale (4mm/ft) and T1¾-size for O-scale (7mm/ft). Smaller LEDs may suit smaller scales.

PLAYBACK

Have you ever listened to an historic recording and wished it could have been made in the days of hi-fi? How sad that the golden tones of that famous singer or instrumentalist will never again be heard in their original glory, but be forever marred by hiss, crackles, and the tinney sound that was the best technology could offer at the time. And of course, all without the benefit of stereo.

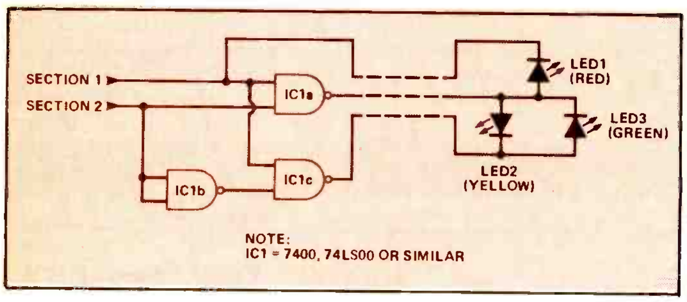
Some recent discoveries and developments raise hopes that some of these old recordings can be drastically improved. From California comes news of the work of a couple of recording and historic-record enthusiasts named Kay and Lasker. They made a rather significant discovery. During electric and acoustic recording sessions of the 1920s and '30s when recordings were made

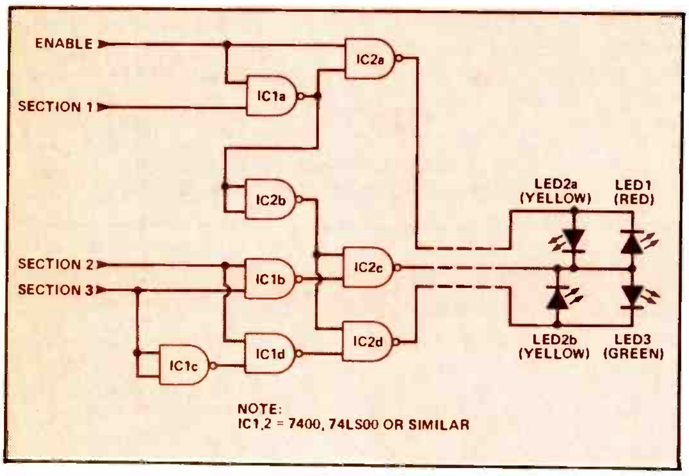
Water-clear LEDs provide most realism because their colour is not apparent until they are illuminated. On the real thing the outermost lens is colourless. Two types of signal — multi-lens and searchlight — can both be modelled using LEDs. In a searchlight signal all the colours ('aspects' as railwaymen call them) share one common lens, colour being changed mechanically by sliding a two- or three-colour filter between lamp and lens. These can be modelled most effectively using bicolour or multicolour LEDs. Multi-lens types use ordinary single-colour LEDs.

A great benefit of LED-based signalling systems is that they can reduce considerably the spaghetti-like festoons of wiring which hang beneath the baseboard of even the simplest model railway layouts. A two-aspect signal, for instance, can be run on two-wires only by connecting the two LEDs in reverse parallel (whereas three wires would be needed for two lamps). Even a four-aspect signal can be operated satisfactorily with a three-wire connection, as the second figure shows. Compare this with the conventional arrangement which demands five wires for four lamps.

Driving the signals is a simple but pleasing exercise in logic. Most modern signalling installations are automatic, operated by the trains themselves. The signal goes to danger as the train passes and returns to green automatically as the train clears the line. If you have track circuits or other train detectors as described earlier in this series it may be possible to arrange for them to drive two-aspect signals directly, but the more interesting three- or four-aspect types require logic circuits with inputs from two or three track sections. TTL (standard and LS) provides the ideal medium for these units since it can drive LEDs directly. The two figures show typical logic circuits for three- and four-aspect signals, assuming that an input taken low indicates a train in that section.

Roger Amos





directly on to disc, there was a high possibility of recording faults. To have to repeat a take was wasteful of the artiste's time, and could be frustrating to all concerned. So it made good sense to do two takes at the same time in case one turned out to be a dud. If both were good, there was the bonus of having an extra master. Thus many performances were recorded in duplicate.

Instead of splitting the output of the microphone to the two disc cutting machines, two separate mics were often used, no doubt because it was less trouble for the engineer to plug in a second one than fix a split. Having two also gave an extra back-up and could furthermore give a choice of balance. So although it was not realised at the time, the recordings were made in genuine stereo!

Where both takes were used for mastering, one was given the suffix A after the recording number. Kay and Lasker have discovered many old recordings which survive in both plain and A versions. Using a variable speed turntable and a lot of patience, they have managed to synchronise the pairs and produce genuine stereo tapes of these old performances.

At the other side of the world in Australia, recording engineer Robert Parker has been developing revolutionary sound processing techniques using the latest digital technology. The result with vintage jazz recordings is a complete absence of surface hiss, greatly reduced coloration, and simulated stereo for good measure. The stereo is very good, a far cry from some of the early efforts of pseudo-stereo and hardly distinguishable from the real thing. In fact many of these recordings sound as if they came from a modern studio. A series of them entitled "Jazz Classics" is now being broadcast on BBC Radio 2, Sunday afternoons.

Vivian Capel

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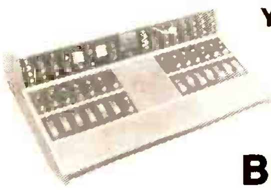

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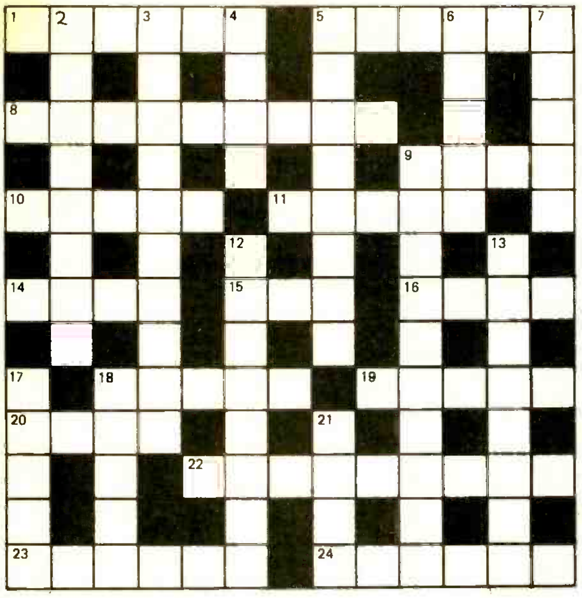
No. 3 Solution next month



ACROSS

1) Term used to describe one of a pair of connectors, having a hole to accept the plug of the other (6).
5) Common name for the 4mm plug and socket (6).
8) Audio transducer, often found on personal hi-fi systems (9).
9) Wound component (4).
10) Strong metal, sometimes used for instrument cases (5).
11) Holder of magnetic tape, solder, cable, etc (5).
14) Random HF background noise (4).
15) A type of plastic often used for moulded instrument cases (1,1,1).
16 No connection (4).
18) A radio receiver (5).
19) Non-volatile, non-eraseable memories (5).
20 Audio receptors (4).
22) Resistor construction used where high dissipation is required (9).
23) Random —— memories (6).
24) Old name for a stylus (6).

DOWN

2) Electron powered (8).
3) Typically, sixteen logic lines used as a pointer to a byte in memory (7,3).
4) Reflected audio or radio signal (4).
5) A filter whose response falls away above and below the selected frequency range (4, 4).
6) A high-level computer language (5).
7) One of the first desk-top microcomputers (5).
9) A means of marking components with their value, tolerance, etc (4,6).
12) Used to set the DC operating point of a bipolar tarnistor (4,4).
13) Another term for a VDU and keyboard (8).
17) Unit of measurement of magnetic induction, equivalent to 10^4 Gauss (5).
18) Gate controlled silicon switch (5).
21) Gas used in high voltage lamps (4).

Solution to Crossword No. 2

ACROSS

1) Schmitt
7) Pixel
8) One shot
9) Pick-up
11) Triac
13) Data
14) Corrode
15) Dish
16) Boost
17) Aspect
21) Panning
22) Joint
23) Licence

DOWN

1) Centronics
3) Mismatch
4) Tool
5) Hi-fi
6) Peek
9) PCDOS
10) Ultrasonic
12) Drift
13) Debounce
18) PROM
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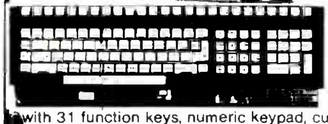

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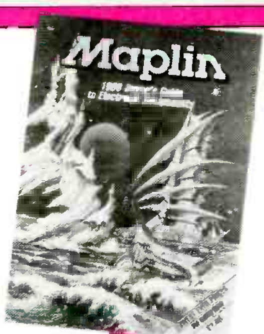

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