An Argus Specialist Publication

electronics today INTERNATIONAL

APRIL 1984 95p

DON'T HANG AROUND

Vertical speed indicator for hang-gliding – electronics leaves the workshop and takes to the air with ETI!

PLUS

Mains-borne remote control system – plug in and switch on from anywhere in your house!

Adding colour to computers – learn the techniques involved

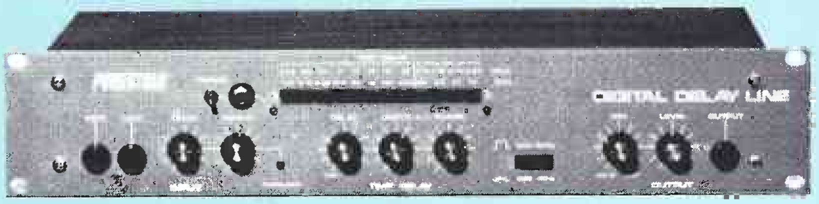
Bass for beginners – build your own loudspeakers and save £££s

BRITAIN'S LEADING ELECTRONICS MAGAZINE

.AUDIO....COMPUTING....MUSIC....RAD...TICS.

High performance, low price kits for today's musicians

DIGITAL DELAY LINE



Digital delay circuitry is an absolute necessity for high quality studio work, but usually comes with a four-figure price tag.

Powertran can now offer you digital quality for the price of a high analog unit. The unit gives delay times from 1.6mSecs to 1.6 secs with many powerful effects including phasing, flanging, A.D.T., chorus, echo and vibrato. The basic kit is extended in 400mSec steps up to 1.6 seconds simply by adding more parts to the PCB.

Complete kit (400mS delay) .... **£150** **Parts for extra 400mS delay (up to 3)** **£14.95**

MPA 200

100 watt mixer/amplifier

Here's a rugged, professionally finished mixer amp designed for adaptability, stability and easy assembly. Using new super-strength power transistors and a minimum of wiring, it offers a wide range of inputs (extra components are supplied for additional inputs), 3 tone controls, each with 15dB boost and 15dB cut, and a master volume control.

Complete kit **£58.00**

SP2-200

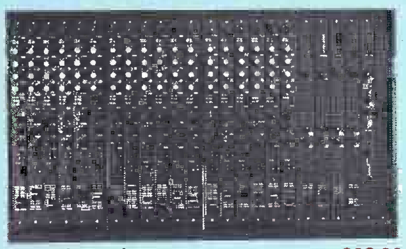
2-channel, 100-watt amplifer

The SP2-200 uses two of the power amplifier sections of the MPA 200 (above), each with its own power supply. A custom designed toroidal transformer enables both channels to simultaneously deliver over 100W rms into 8 ohms. Each channel has its own volume control, and a sensitivity of 0.775mV (OdBm) makes this amplifier suitable for virtually all pre-amps or mixers.

Complete kit **£75.00**

'DESTINY' MIXER

This versatile mixer offers a maximum of 24 inputs, 4 outputs, and an auxiliary channel. Input channels have Mic/Line, variable gain, bass/treble, and middle frequency equaliser. Output channels have PPM displays and record/studio outputs. There are send/return jacks, auxiliary, pan and fader controls, and output and group switching. There is also a headphone jack and built-in talk-back microphone.



Input channel	£23.00
Output channel	£23.00
Aux. channel	£26.00
Blank panel	£3.50
Base unit and front	£33.00
Pair of end cheeks	£25.00
Power supply and cabinet	£22.50

TRANSCENDENT 2000

ETI single board synthesizer.

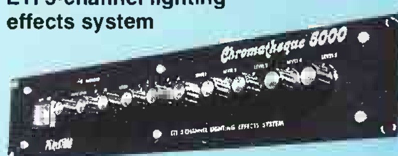
This professional quality 3-octave instrument is transposable 2 octaves up or down, giving an effective 7-octave range.

There is portemento pitch bending, VCO with shape and pitch modulation, VCF with high and low pass outputs and separate dynamic sweep control, noise generator and an ADSR envelope shaper. Other features include special circuitry with precision components to ensure tuning stability.

Complete kit **£150**

CHROMATHEQUE 5000

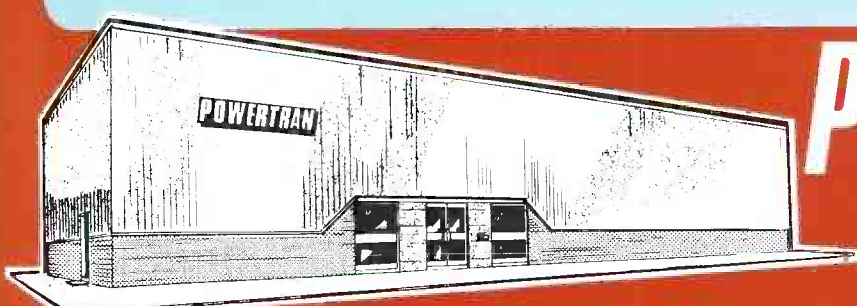
ETI 5-channel lighting effects system



Many lighting control units are now available. Some perform switching and others modulation of light output according to musical input. The Chromatheque combines both functions. It controls 5 banks of lamps up to 500W each in either analog or digital mode. And the 5 channels give more colours and more exciting linear and random sequencing than is possible with 3 or 4-channel systems. Versatile light level controls enable the lights to be partially on to suit the mood of the occasion. Wiring is minimal and construction straightforward.

Complete kit **£58.00**

Allow 21 days for delivery Access VISA



POWERTRAN cybernetics ltd.

POWERTRAN CYBERNETICS LTD, PORTWAY INDUSTRIAL ESTATE, ANDOVER, HANTS SP10 3ET. TEL: (0264) 64455

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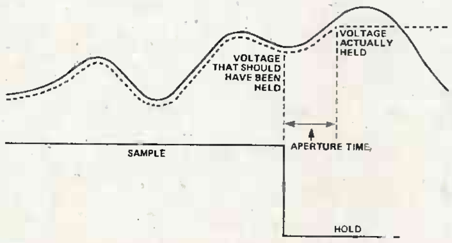
FEATURES



PROJECTS

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SWITCHES

TOGGLE 2A 250V SPST	35p
DPDT	48p

SUB-MIN TOGGLE

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

SLIDE 250V:

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

PUSHBUTTON 6A with 10mm Button

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

Mini Non Locking

Push to Make	15p
Push to Break	25p

DIGITAST Switch Assorted Colours 75p each

ETI PROJECTS We stock most of the parts

DIP SWITCHES

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

ROTARY SWITCHES

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

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

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

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

ROCKER SWITCHES

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

THUMBWHEEL Mini front mounting switches

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

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 6 inches	185p	205p	300p	465p
12 inches	198p	215p	315p	480p
24 inches	210p	235p	345p	540p
36 inches	290p	370p	480p	525p

IDC Female Header Socket Jumper Leads 36"

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

VEROBOARD

	0.1in
2½ x 3¾	95p
2½ x 5	110p
3¾ x 3¾	110p
3¾ x 5	125p
3¾ x 17	420p
4¾ x 17	590p
Pkt of 100 pins	55p
Spot face cutter	150p
Pin insertion tool	185p

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

PROTO DECs

Veroblock	405p
S-Dec	395p
Eurobreadboard	590p
Bimboard 1	575p
Superstrip SS2	1350p

VERO WIRING PEN

+ spool	340p
Spare spool	75p
Combs	8p

DALO ETCH RESIST PEN Plus spare tip 100p

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

ULTRASONIC TRANSDUCER 40KHz 350 pr

COPPER CLAD BOARDS

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

DILL SOCKETS

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

EDGE CONNECTORS

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

ANTEX Soldering IRONS
C15W 510p; CS17W 510p
C18W 525p; XS25W 530p
Spare Bits 85p; Elements 230p
Iron Stand 175p; Heat Shunt 30p

SIL SOCKET 0.1" pitch 20 way 65p

IDC CONNECTORS

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

EURO CONNECTORS

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

DIL PLUG (Header)

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

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	180p

ZIF DIL SOCKETS

24 pin	565p
28 pin	750p
40 pin	799p

'D' CONNECTORS

miniature

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

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

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

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

AMPHENOL PLUGS

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

PANEL METERS

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

CRYSTALS

32.768KHz	100
100KHz	235
200KHz	265
455KH	370
1MHz	275
1.008M	275
1.28MHz	390
1.6MHz	395
1.8NHz	395
1.8432M	200
2.0MHz	225
2.4576M	200
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.19430M	200
4.433619M	100
4.608MHz	200
4.80MHz	200
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.7328MHz	250
7.68MHz	200
8.0MHz	150
8.089333M	395
8.86723M	175
9.00MHz	200
10.0MHz	175
10.24MHz	200
10.5MHz	250
10.7MHz	150
12.0MHz	175
12.528M	300
14.31814M	170
16.0MHz	200
18.0MHz	180
18.432M	150
19.968MHz	150
20.0MHz	200
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	180
38.6667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	300

RELAYS

Miniature, enclosed, PCB mount.

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

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

ASTEC UHF MODULATORS

Standard 6MHz	325p
Wideband 8MHz	450p

BUZZERS

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

LOUDSPEAKERS

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

MONITORS

- ZENITH — 12" Green, Hi-Resulution Popular **£75**
- MICROVITEC 1431. 14" Colour RGB input. Connecting cable incl. **£205**
- KAGA 12". Med-res. RGB Colour. Has flicker-free characters. Ideal for BBC, Apple, VIC, etc **£210** (car £7)
- KAGA 12". As above but Hi-Resolution **£259** (car £7)
- Connecting Lead for KAGA **£5**

Carriage £7 Securicor

NEW LAUNCH Z80A 2nd PROCESSOR BOARD

Z80A 4MHz 2nd Processor Board with 64K memory, 4K Monitor EPROM, Parallel printer interface, CP/M handling, double density board will handle, 3½", 5¼" & 8" Floppy Disk Drives and many more facilities. All neatly housed in a twin slimline disc drive case.
Only: £350

TRANSFORMERS

3-0-3V, 6-0-6V, 9-0-9V, 12-0-12V, 15-0-15V @ 100mA 98p
pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.25A, 2x9V-0.15A, 2x12V-0.12A, 2x15V-0.1A 200p
6VA: 2x6V-0.5A, 2x9V-0.3A, 2x12V-0.25A, 2x15V-0.2A 270p
Standard Split Bobbin type:
6VA: 2x6V-0.5A, 2x9V-0.4A, 2x12V-0.3A, 2x15V-0.25A 250p
12VA: 2x4.5V-1.3A, 2x5V-1A, 2x9V-0.6A, 2x12V-0.5A, 2x15V-0.4A, 2x20V-0.3A 345p (35p p&p)
24VA: 2x6V-1.5A, 2x9V-1.2A, 2x12V-1A, 2x15V-0.8A, 2x20V-0.6A 385p (60p p&p)
50VA: 2x6V-4A, 2x9V-2.5A, 2x12V-2A, 2x15V-1.5A, 2x20V-1.2A, 2x25V-1A, 2x30V-0.8A 520p (60p p&p)
Specially wound for Multirail computer PSUs
50VA: Outputs +5V/5A, +12V, +25V, −5V, −12V at 1A 620p (60p p&p)
100VA: 2x12V-4A, 2x15V-3A, 2x20V-2.5A, 2x25V-2A, 2x30V-1.5A, 2x50V-1A 965p (75p)

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

VOLTAGE REGULATORS

1A TO220 Plastic Casing

	+ ve		− ve	
5V	7805	40p	7905	45p
12V	7812	40p	7908	60p
15V	7815	40p	7912	45p
18V	7818	40p	7915	45p
24V	7824	40p	7918	45p
			7924	45p

100mA TO92 Plastic package

5V	78L05	30p	79L05	50p
6V	78L06	30p	—	—
8V	78L08	30p	—	—
12V	78L12	30p	79L12	50p
15V	78L15	30p	79L15	60p

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

SOLDERCON PINS Ideal for making SIL or DIL Sockets

100 pins	75p
500 pins	350p

ALUM BOXES

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

CMOS

4000	14
4001	16
4002	16
4006	50
4007	16
4008	40
4009	24
4010	26
4011	16
4012	18
4013	40
4014	48
4015	45
4016	29
4017	42
4018	45
4019	30
4020	50
4021	40
4022	67
4023	22
4024	37
4025	22
4026	95
4027	43
4028	45
4029	47
4030	35
4031	130
4032	80
4033	130
4034	146
4035	46
4036	275
4037	115
4038	110
4039	280
4040	42
4041	57
4042	43
4043	42
4044	42
4045	110
4046	60
4047	60
4048	55
4049	30
4050	30
4051	45
4052	60
4053	50
4054	85
4055	85
4056	85
4057	1000
4059	435
4060	58
4061	500
4062	986
4063	85
4066	30
4067	245
4068	20
4069	22
4070	20
4071	22

4072	20
4073	22
4075	20
4076	55
4077	20
4078	20
4081	20
4082	20
4085	60
4086	60
4089	125
4093	37
4094	70
4095	95
4096	100
4097	275
4098	80
4099	110
4160	95
4161	96
4162	96
4163	96
4174	96
4175	105
4194	105
4408	850
4409	850
4410	725
4411	675
4412	775
4415	590
4419	280
4422	770
4435	850
4440	900
4450	360
4451	350
4490	450
4500	395
4501	28
4502	60
4503	40
4504	99
4505	385
4506	60
4507	32
4508	130
4510	48
4511	45
4512	45
4513	198
4514	115
4515	115
4516	55
4517	275
4518	53
4519	32
4520	53
4521	115
4522	125
4526	60
4527	65
4528	50
4529	150
4530	90
4531	130
4532	65
4534	400

4536	275
4538	80
4539	90
4541	95
4543	70
4544	150
4548	40
4549	400
4553	245
4554	160
4555	35
4556	55
4557	250
4558	120
4559	395
4560	180
4561	104
4562	350
4566	165
4568	250
4569	175
4572	45
4580	255
4581	125
4582	99
4583	100
4584	40
4585	70
4597	330
4599	155
40085	90
40097	45
40098	42
40100	215
40101	130
40102	140
40103	412
40104	120
40105	220
40106	38
40107	38
40108	198
40109	100
40110	175
40114	240
40161	194
40163	50
40174	45
40175	50
40181	220
40182	80
40192	75
40193	95
40194	70
40195	75
40244	196
40245	196
40257	196
40373	180
40374	180
45106	586

OPTO

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

OPTO ELECTRONICS

LEDs with clips

TIL209	10
TIL211 GRN	14
TIL212 Yel	14
TIL220 2" Red	12
2" Green, Yellow or Amber	14
0.2 Bi colour Red/Green	65
Green/Yellow	78
0.2 Tri colour Red/Green/Yellow	85
Hi-Brightness Red	58
High-Bri Green or Yel	68
Flashing red 0.2" red	55
Square LEDs, Red, Green, Yellow	30
Rectangle Stackable LEDs Red, Green or Yellow	18
Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	48
SFH205 Detector	118
TIL32 Infra Red	52
TIL78 Detector	55
TIL38	50
TIL100	75
BARGRAPH Red 10 segments	250

ISOLATORS

IL74	65
ILD74	115
ILQ74	220
TIL111/2/4	70
ILCT6 Darlington	135
4N33 Photo Darlington	136

7 Segment Displays

TIL312 .3" CA	105
TIL313 .3" CC	105
TIL321 .5" CA	120
TIL322 .5" CC	120
DL704 .3" CC	125
DL707 .3" CA	125
FND357 Red	120
FND500	130
.3" Green CA	150
.6" Green CA	215
3 ± 1 Red CA	150
3 ± 1 Green CA	150
LCD 3½ Digits	496
LCD 4 Digits	530
LCD 6 Digits	625
Reflective Switch	170
SLOTTED Optical Switch similar to RS Comp's	195

COMPUTER CORNER

- **EPSON RX80 PRINTER: 100 CPS,** 9 x9 matrix, dot addressable graphics, condensed & double width printing. Normal, Italics & Elite Char., Tractor Feed, Bidirectional, Logic seeking £235
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- **EPSON FX80 PRINTER** 10" Tractor & Friction Feed. 160 CPS, bi-directional Logic seeking, 9 x 11 matrix, hi-res bit image. Normal, Italic & Elite Char. Super & Subscript. Proportional spacing £349
- **SEIKOSHA GP100A.** 10" Tractor Feed, 80 Colmn. 30CPS, Normal and Double width Char. Dot Res Graphics £155
- **SEIKOSHA GP250X.** 10", 50 CPS. Normal and Double width and height Char RS232 and Centronix Intrf standard .... £199 (£7 car)
- Printer Cable for our printers and BBC MICRO £12
- **TEX EPROM ERASER.** Erases up to 32 ICs in 15-30 minutes £33
- **TEX EPROM ERASER** with a safety switch £35
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- **C12 COMPUTER GRADE CASSETTES** in library cases 40p
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Call in at our shop for demonstration. Be satisfied before you buy or write in for our descriptive Micro Peripherals Leaflet.

SPECTRUM 32K UPGRADE

Upgrade your 16K Spectrum to full 48K with our RAM Upgrade Kit. Very simple to fit. Fitting instructions supplied.
£22

BROTHER HR-15 DAISY-WHEEL PRINTER

An exceptionally high quality Daisy Wheel printer at the price of a Dot matrix printer. 18CPS; Bi-directional, has 3K of Buffer; has clear bufer facility. Carriage skip movement, Proportional spacing; underlining; Bold print and Shadow print. Prints in two colours: Super and subscript facility. Impact control facility to vary pressure on paper for making carbon copies. Has Centronics parallel or RS-232 interface. Connects directly to BBC Micro. A ribbon cassette plus a separate red ribbon. Optional extras. Single Sheet Feeder takes upto 150 A4 sheets; a Keyboard that transforms HR15 into a sophisticated electronics typewriter. Attractively finished in Beige.

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Only: **£375** (Carr. £7)

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(BBC Compatible)

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Model A .... **£299** Model B **£399** (incl VAT)

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NEXT MONTH

AN ARGUS SPECIALIST PUBLICATION

electronics today INTERNATIONAL

EPROM Programmer

The Universal EPROM Programmer published in August 1983 surprised us with its popularity, so we're doing it again! Well, not exactly — this project will be for the ZX81 and will allow programming and duplicating for the more common EPROMs — 2516s, 2716s, 2532s and 2732s.

ZX81s are so cheap — especially second-hand — that it should be less expensive to build this project and buy a ZX than to build a special-purpose stand-alone EPROM programmer. This cheapness opens new possibilities for the '81 as a component rather than a computer in its own right.

Because the Spectrum has dynamic RAM, this project can't be adapted to work on that machine. However, we have a Spectrum version on the drawing board . . .

The ZX81 — the shape of EPROM programmers to come.

Midi Drum Synth

Not a mini and not a full-sized drum synth, this is to whet your appetites for the full-sized synthesiser that is, as yet, a mere twinkle in the editor's eye . . . Actually, we're simple chaps here on ETI, keyboards being rather too difficult for us, which is why we're so keen on drum synths. Also, attaching them to the office walls means that we get a much more pleasant sound when a certain deputy editor on Hobby Electronics takes to 'head banging' (Status Quo are alive and, er, well . . .).

Microtanic Profile

Regular readers will have noticed that we have published a number of projects for the Microtan-65 computer, mainly because we consider this to be the best computer for the experimenter who is really committed to building his or her own hardware. To help complete the picture, Mike Bedford will be taking a look at the hardware you can buy as kits and as ready-made boards.

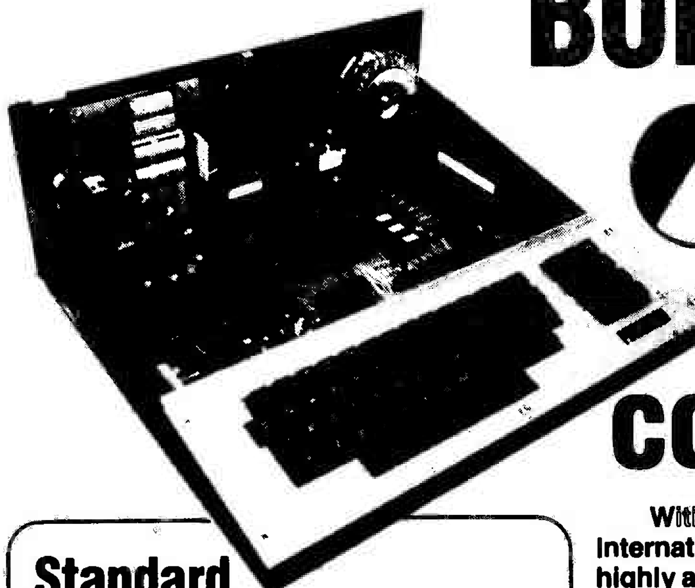
Also in the May issue . . .

Part 2s of the Mains-Borne Remote Controller and the Vertical Speed Indicator, Digest, Tech Tips, Machine Code Programming, and anything else we are able to cram in!

DON'T RISK MISSING OUT ON ALL THIS — PLACE YOUR ORDER NOW FOR THE MAY ISSUE, ON SALE APRIL THE 7th.

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

BUILD YOUR OWN cortex 16 bit, 64k RAM colour computer



Standard features –

- High speed 24K byte extended basic interpreter
- Powerful TMS9995 16 bit microcprocessor
- 48 bit floating point gives 11 digit accuracy
- High resolution (256 x 192) colour graphics
- Screen memory does not use up user memory space
- 16 colours available on the screen together in graphic mode
- Fast line drawing and point plotting basic commands
- High speed colour shape manipulation from basic
- Full textual error messages
- String and Array size limited only by memory size
- Real time clock included in basic
- Interval timing with 10mS resolution via TIC function
- Named load and save of basic or machine code programs
- Auto-run available for any program
- Powerful machine code monitor
- Assembler and Disassembler included as standard
- Auto line numbering facility
- Full renumber command
- Simple but powerful line editor
- Flexible CALL statement allows linkage to machine code routines with up to 12 parameters
- Basic programs may contain spaces between key words to make programs readable without using more memory
- Over 34K bytes available for basic programs
- Extended basic includes IF-THEN-ELSE
- Interfaces for screen and cassette included.
- Supports bit manipulation of variables from basic
- Error trapping to a basic routine included
- Basic supports Hexadecimal numbers
- Separate 16K video RAM for graphics

With this powerful machine (featured in Electronics Today International as a constructional project) you have access to highly advanced systems and software developed specially by MPE Ltd for the CORTEX. For business, education, R & D – or simply increasing your knowledge and understanding of computers – it beats comparably priced off-the-shelf machines hands down!

STATEMENTS	PRINT	TIME	RENUM	MAG	MWD	.	( )	INT	POS	= =
IF	;	WAIT	BOOT	TOF	BASE	@	[]	LOG	COL	=
ELSE	?	SAVE	GRAPH	TON	**COMMANDS**	#	**FUNCTIONS**	SQR	MOD	>
ON	*	LOAD	TEXT	DIM	RUN		FNA-FNZ	SYS	RND	>=
GOTO	1 UNIT	MOTOR	PLOT	LET	SIZE	:	ABS	TIC	KEY	<
GOSUB	BAUD	ESCAPE	UNPLOT	DEF	CONT	?	ADR	SGN	**OPERATORS**	<=
POP	CALL	NOESC	COLOUR	NEW	MON	%	ASC	BIT	OR	<>
REM	DATA	RANDOM	CHAR	END	**DELIMITERS**	$	ATN	CRB	LOR	−
FOR	READ	ENTER	SPRITE	BIT	TO	"	SIN	CRF	AND	+
NEXT	RESTOR	LIST	SHAPE	CRB	TAB	,	COS	MEM	LAND	/
ERROR	RETURN	PURGE	SPUT	CRF	STEP	!	EXP	MWD	NOT	*
INPUT	STOP	NUMBER	SGET	MEM	THEN	&	FRA	LEN	LNOT	∧
								MCH	LXOR	

Self assembly kit

£295

All prices exclusive of VAT. Carriage paid.

Optional Extras

Floppy disc interface electronics	£86.50
Hardware kit & connectors for disc drives	£49.50
RS232C interface kit	£9.20
Pair of 5¼" disc drives (SS)	£300.00
Pair of 5¼" disc drives (DS)	£590.00

Full assembly instructions and 216 page users manual.

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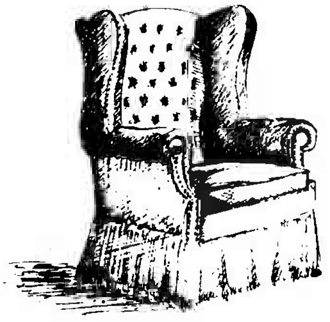
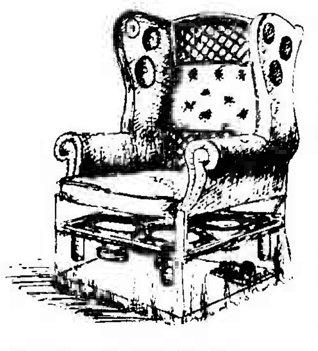
DIGEST

Not An April Fool



OK, we know it's our April issue and that you, being perceptive, are not unnaturally sceptical about odd-sounding things which appear in ETI this month, but believe us, this one's for real. It's a chair. That's right, a fine English hand-made chair. But this is a very unusual chair; carefully concealed within its sumptuous upholstery is a three way speaker system which can deliver sound levels in the region of 110 dB with an input of 8 watts. Carefully avoiding puns about electric chairs (although Barry Manilow at 110 dB should be the death of anybody), ETI has spared every effort to bring you full details. No one can accuse us of sitting down on the job!



The Acoustic Chair is, its manufacturers claim, designed specifically for the extended frequency response and wider dynamic range of modern digital and direct cut recordings. It will reproduce bass frequencies down to 15 Hz with explosive wavefronts that you can feel as well as hear and is capable of sound levels exceeding the threshold of pain. It enables you to listen to music unaffected by the acoustics of the listening room, with excellent stereo imaging and with little disturbance from ambient noise. Low frequencies are handled by powerful bass drivers, with acoustic vents below the midrange and high frequency units and additional vents below the pelvis and around the spine where conventional sounds are picked up by bone conduction. Low mid-range, midrange and high frequency drivers are mounted in the chair wings and are aligned for phase accuracy. The complete system can handle input powers up to 300 watts and has a nominal impedance of 8 ohms.

Quite what all this costs we do not know, but with an idea like this you can expect the price to fall sharply as the inevitable competition gets under way. Hobby Electronics are reliably reported to be working on a quadrophonic water bed and it can only be a matter of time before someone comes up with the holophonic loo-seat. Before crazed readers take an axe to the Tannoys and the Parker-Knoll, we should point out that further mind-and-posterior-numbing details can be had from the Acoustic Chair Company, 35 Britannia Row, London N1, tel 01-226 3377. Happy April!

Ambit Moves

Following their takeover by Circuit Holdings PLC, a division of Bulgin, Ambit International will shortly be moving to Broxbourne in Hertfordshire. The company say their business has expanded steadily to the point where the premises at Brentwood are no longer large enough for them.

The Broxbourne site is presently in use by Circuit Holdings, and all present Ambit staff will be given the opportunity to move to the new site.

Bill Poel, Ambit's founder and until very recently its managing director (and also some time editor of a magazine which attempted to compete with ETI — the gall of it!) has left Ambit and joined Amsoft, the software division of Amstrad Ltd.

Show Offs!

Time was when electronics exhibitions were few and far between, eagerly anticipated highspots of the enthusiasts' year. Now, anyone attempting to cover them all would need wings and the ability to be in several places at once. It's only two months since we last gave you a rundown on forthcoming events but already a large pile of new press releases has accumulated. So get out those well-thumbed diaries and make a note of some of these.

Human Factors in Manufacturing is a conference rather than an exhibition and is aimed at production managers and other industrial personnel. It takes as its starting point the proposition that, in spite of the current level of development and seeming sophistication of industrial robots, human beings are still industry's most important asset. Known as HUMAN-1 for short, the conference will take place at the Park Lane Hotel, London, from the third to the fifth of April, and details are available from The Conference Organisers (HUMAN-1), IFS (Conferences) Ltd, 35-59 High Street, Kempston, Bedford MK42 7BT, tel 0234 83605.

The second event is the ACC Micro-Robotics Conference which takes place on the 21st of April at the Central Hall, Westminster, London. It is run alongside the Association of London Computer Clubs' Easter Fair, and features talks and demonstrations by leading manufacturers and an opportunity for novice constructors to try their mice against the old hands on a micromouse maze. No details of opening times or admission prices are given in the press release so you will either have to turn up on the day and hope for the best or get in touch with the organisers in advance. The address is 69 Uplands Court, Greenview Avenue, Shirley, Surrey CRO 7QW, tel 01-777 9806.

The Electronic Production Efficiency Exposition (EPEE) will be held at the National Exhibition Centre, Birmingham, from the first to the third of May. It is mainly of interest to those working in the electronics industry and sets out to consider the factory of the future. Entrance tickets will cost £3.00 and car parking tickets £2.00 on the day but those who apply in advance will get both free. Contact Network Events Ltd, Printers Mews, Market Hill, Buckingham MK18 1JX, tel 0280 815226.

Communications '84 is one of several exhibitions organised by the Institution of Electrical Engineers and takes place in Birmingham on the 16th, 17th and 18th of May. The IEE do not give any details of the exhibition's coverage but we have had a number of press releases from companies in the microwave, satellite, cable, and military command and control communications fields saying that they will be exhibiting. For details of this and the other conferences, vacation schools and seminars organised by the IEE, contact them at their headquarters, Savoy Place, London WC2R 0BL, tel 01-240 1871.

Hard luck on those who are interested in both speech technology and machine control systems because conferences on those two topics take place at exactly the same time, the 23rd, 24th and 25th of October. However, since both take place in Brighton, real knowledge vultures may be able to commute rapidly between the two. The International Conference on Speech Technology is concerned with speech synthesis and speech recognition systems and aims to make available to British industrialists the benefits of a technology which is already widely used in Japan and the United States. The International Conference on Machine Control Systems is concerned with the intelligent control of individual production processes and the linking of such controllers to provide overall management. The organisers claim the conference will be a revelation to those who think they already know all there is to know about machine control systems. Details of both conferences can be obtained from IFS (Conferences) Ltd at the address given above for the HUMAN-1 conference.

The International Test and Measurement Exhibition and Conference (ITAME) takes place at Olympia 2, London, from the 30th of October to the 1st of November, and the organisers say it will cover all areas of electronic test and measurement. The same people are also organising Electronic Displays '84 at the Kensington Exhibition Centre, London on the 27th, 28th and 29th of November, an event which should not be confused with the Electronics Displays exhibition at Frankfurt which we mentioned in February News Digest. For details contact Network Events at the address given above for the EPEE event.

2 Inch Video Monitor

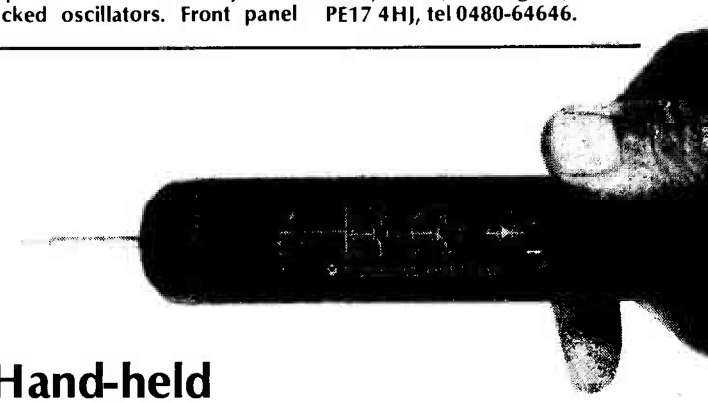
The TV2S from Thandar Electronics is a lightweight, low power miniature monochrome video monitor. It operates from a standard 1 volt composite video signal via a 75 ohm BNC connector and is designed to be used in applications where space is of prime importance. Desk-mounted security surveillance or closed circuit television camera viewfinders are typical examples.

The TV2S is self-contained in an attractive aluminium case measuring 150 x 105 x 49mm, and utilises a high resolution 50mm (2") diagonal CRT giving a usable viewing area of 40 x 30 mm. Stable picture lock is ensured by the use of phase locked line and injection locked oscillators. Front panel controls are provided for brightness and contrast in addition to on/off, and rear panel controls include 525/625 switch, 75Ω bridge facility, focus and line and field control. Fitted with internal re-chargeable Nickel Cadmium batteries, the monitor can also be powered from an external regulated 5 to 7 volts DC power supply or from an unregulated 12 volt DC source through the adaptor/charger supplied. Mains adaptor/chargers for 117,220 and 240 volt operation are available as optional accessories. The TV2S costs £135.00 plus VAT, and further information is available from Thandar Electronics Ltd, London Road, St Ives, Huntingdon, Cambs PE17 4HJ, tel 0480-64646.

5V RS232C Module

Newport components have introduced an RS232C interface module. The NM232C requires a single 5 volt supply only and provides one transmit and one receive channel. Both channels are fully EIA — RS232C compatible and the logic input and output are TTL/CMOS compatible. The package is low profile DIL style of 9 mm total height and a pin row spacing of 0.5 inch with a pitch of 0.1 inch. The no load current is typically 10 mA representing just 50 mW of quiescent power consumption.

Applications are anticipated in all areas of micro computing and peripheral design requiring data exchange rates up to 19.2 kbaud. The NM232C will also be useful in battery powered designs requiring RS232C capability with low power consumption. The device uses less board space than the standard integrated circuit solution and does not require ±12V supply rails. Indeed the internally generated positive and negative supplies are also made available for external use, although at limited current levels. Newport Components Ltd, 134 Tanners Drive, Blakelands North, Milton Keynes MK14 5BP, tel 0908-615232.

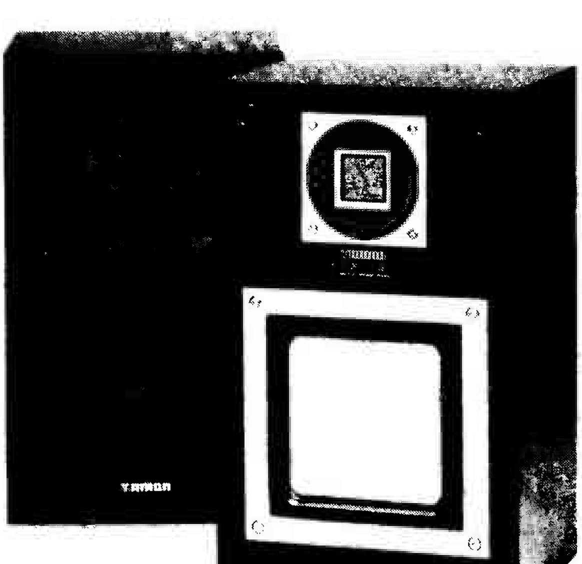


Hand-held Transistor Tester

A new addition to Osborne Electronics 4000 series of hand-held test units is the model 4500 transistor tester. Completely self contained, the unit simplifies and speeds the task of checking the PN junctions of discrete semi-conductors whether in or out of circuit.

The model 4500 measures just 32 x 22 x 100 mm and weighs 75 grams. It readily rests between thumb and forefinger and features an integral series of LED's which indicate the junction status. PNP or NPN transistors, diodes and open or short circuit junctions can be instantly indentified and operation remains reliable even when parallel circuit values approach 270 ohms or 33 microfads. In operation, the two test probes are connected across the junction to be checked and the junction state is immediately displayed. The unit's integrated circuitry ensures a very long battery life.

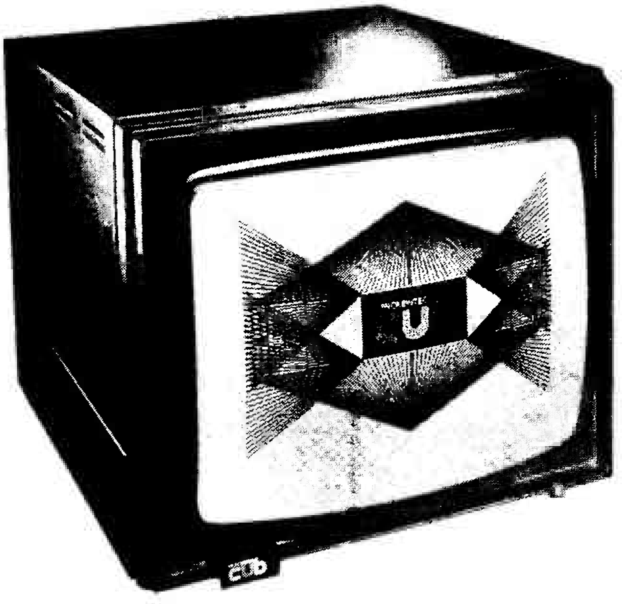
The model 4500 costs £16.00 plus VAT and is available from Osborne Electronics, Binstead Road, Ryde, Isle of Wight, tel 0983-63622.



Flat Response?

No, you haven't been watching too much TV, the cones in those loudspeakers really are square and flat. They're the new DX70 loudspeakers from Tamon of Japan, a two-way system using a 1½" tweeter and a 6" bass driver, both with flat cones. They are rated at 45W RMS, 90W peak and have a frequency response which is said to extend from 50Hz to 40kHz. The cabinet finish is dark mahogany, and they should be on sale by the time this issue appears at an anticipated price of £130 a pair.

Of course, flat cone loudspeakers are nothing new in themselves, and many will remember a novel piano shaped (or was it ear shaped?) design which appeared some years ago. A number of more conventionally packaged units have also appeared, but flat cone systems have yet to make any significant impact on the world's loudspeaker markets. It will be interesting, therefore, to see if Tamon have now got the formula right or if, as with their predecessors, the response from the 'speaker buying public is as flat as the cones themselves.

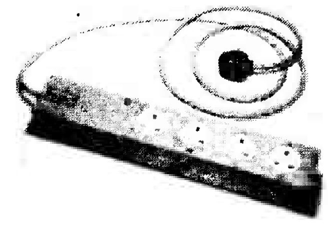


Spectrum-Compatible Colour Monitor

After a period of selling to the education market, Microvitec have launched their Sinclair Spectrum-compatible colour monitor onto the consumer market. They claim it is the only low-complexity colour display equipped to handle the output of the Spectrum, Britain's most popular home computer.

The 1431/MZ comes in a metal cabinet with die-cast frame surround finished in matt black to match the appearance of the Spectrum. Inside, the picture tube and control circuitry of the RGB/TTL input models is retained while an additional card carries the Spectrum interface which effectively converts to the RGB/TTL format the luminance ('U') and chrominance ('V' & 'Y') signals appearing at the output port of later Spectrum models. Since the interface can be switched in or out of the circuit, the monitor can also be driven by computers with conventional RGB/TTL outputs, such as the new Sinclair QL.

Over a million Spectrums have now been sold, many of them to first-time buyers who may now wish to up-grade to more recent machines. By designing the monitor to accept two input formats, Microvitec expect it to generate wide sales opportunities. The Microvitec 1431/MZ costs £249.00 plus VAT and is available from any of the growing number of Microvitec Dealers. Further details and a list of dealers are available from Microvitec Limited, Futures Way, Bolling Road, Bradford, West Yorkshire BD4 7TV, tel 0274 390011.



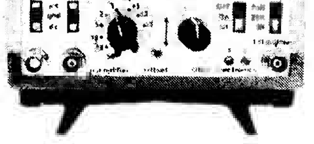
Multi-Output Portable Filter

New from Roxburgh Suppressors is a multi outlet portable mains filter. Rated at 13 amps total load, the unit is fitted with four 13 amp sockets and is constructed in a steel case with neon mains indicator.

The LF134 filter module incorporates an earth line choke and a large replaceable 'Varistor', providing a high degree of protection from mains transients and interference for micro computer systems and their peripherals. It comes complete with 2 metres of mains lead and a 13 amp plug, is ready for use, and costs £62.25 plus VAT and carriage. For details contact Roxburgh Suppressors Ltd, Eagle road, Rye, East Sussex, tel 0797 223725.

Oscilloscope Accessories

Otter Electronics is a recently formed British company whose staff includes the designer responsible for the Scopex range of analogue oscilloscopes. They intend to specialise in oscilloscope accessories and ancillary equipment and have just launched two new instruments, a μ amplifier and an isolation amplifier.



The μ amplifier enables signals as minute as 100μV from DC to 2MHz to be viewed and measured on most oscillosocpes. The amplifier offers sensitivities from 100μV/division to 50mV/division with AC or DC input coupling and maintains a constant output of 100mV/division. To make full use of the high sensitivity a differential input is provided so that common mode signals can be minimised, and to improve the display a bandwidth limiting switch is provided to reduce the upper frequency limit to 20KHz or 1KHz.

The amplifier will find many uses in audio and video work, enabling monitoring of signals direct from playback heads and measuring ripple. Even physiological signals come within its performance. Battery operation from PP3 batteries means that the amplifier can quickly convert an oscillosocpe for very low level signal observation.

The isolation amplifier offers a safe way of making measurements on floating circuits up to 1,500V from ground. the input amplifier offers sensitivities from 10mV/division to 5V/division (50V with probe set to X10) AC or DC coupled. Signals from the input amplifier are coupled to the output amplifier by a pair of differentially connected opto-couplers, thus ensuring good linearity and high common mode rejection. The output remains constant at 100mV/division giving a useful gain boost for older, less ensititive oscilloscopes. The amplifier will find great acceptance in diverse fields from power engineering, examining SCR and triac gate firing pulses, switch mode power supplies, and eliminating ground loops to medical research, where complete isolation between subject and measuring instrument is essential. Battery operation from PP3 batteries means that the amplifier can quickly and easily extend an oscilloscope's performance at any time.

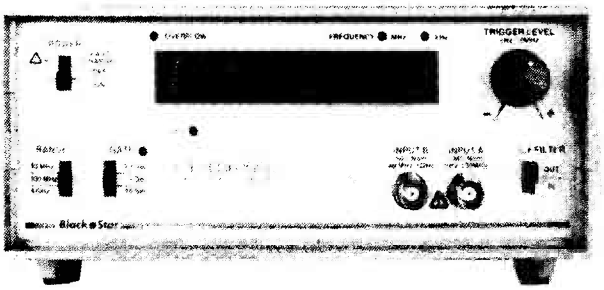
The μ amplifier costs £144.00 plus VAT and the isolation amplifier costs £157.00 plus VAT. Both prices include packing and delivery. Otter say they are developing further new instruments, some of which will be unveiled later this year. Otter Electronics Ltd, Otter House, Weston Underwood, Olney, Buckinghamshire MK46 5JS, tel 0234 - 712445.

New Chip Cuts Z80 Component Count

A new high speed Z80 peripheral chip designed to replace several discrete ICs has just been introduced by Verospeed. Called the Mostek Serial Timer Interface, this powerful new chip incorporates a USART (Universal Synchronous/Asynchronous Receiver/Transmitter), two binary timers, two full function timers, and eight bi-Directional I/O lines with individually programmable interrupts.

The Z80 STI is designed to operate at 4MHz and is therefore compatible with the higher speed members of the Z80A Peripheral Family. Selection and control of the on-chip function is made by means of 24 internal registers which are accessed via the system bus. It is packaged in a standard 40-pin DIL, allowing peripheral functions perviously requiring the use of several components to be realised in a minimum of printed circuit board area.

For further details, or a complete 400-page catalogue listing over 7500 components, contact Verospeed, Stansted Road, Boyatt Wood Industrial Estate, Eastleigh, Hants, tel 0703 641111.



GHz Frequency Counters

The Meteor Series of Frequency Counters, designed and manufactured in Britain by Black Star, is now available fitted with a Temperature Compensated Crystal Oscillator (TCXO) for extra accuracy and temperature stability.

The Meteor 1000X measures typically from 2Hz to 1.2GHz with <50mV sensitivity at 1GHz, features a temperature stability of ±0.5ppm from −10 C to +40 C, and an ageing rate of <±1ppm per year, and setability of <±0.2ppm. The other models in the range, the Meteor 100X (2Hz-100 MHz) and the Meteor 600X (2Hz-600 MHz) are available with the same TCXO. All models are battery or mains powered and are fitted with a trigger level control, a low pass vilter and offer three gate times (0.1 sec, 1 sec and 10 sec).

The Meteor 'X' series of Counters come complete with mains adaptor/charger, a comprehensive instruction manual, and a year's guarantee, and a wide range of optional accessories is available. The Meteor 100X costs £225 plus VAT and postage and packing, and further details are available from Black Star Limited, 9A Crown Street, St Ives, Huntingdon, Cambs PE17 4EB, tel 0480 62440.

400V Transistor Optocouplers

Motorola has introduced a new series of optocouplers utilizing gallium arsenide infrared emitting diodes optically coupled to phototransistor detectors with 400 volt breakdown ratings. This is a significant increase over the previous industry maximum of 300 volts, and permits these devices to be used in applications such as high-voltage solid-state relays, copy machines, etc, without the need for voltage divider circuits or other compensating designs.

The MOC8204 has a current transfer ratio of 20, the MOC8205 a current transfer ratio of 10, and the MOC8206 a current transfer ratio of 5.0. All devices are currently available in the standard 6-in DIP package. In addition to the high breakdown voltage, the devices feature a very high peak isolation voltage of 7500 V AC (min), and are UL recognized (file number E54915). For further information contact Motorola Ltd, European Literature Centre, 88 Tanners Drive, Blakelands, Milton Keynes MK14 5BP, tel 0908-614614.

TUG Of War

The Tangerine Users Group has been in the battles a bit recently and some members may be a bit worried as to what is going on. The simple answer is that the original TUG has now suspended operation, but a new users group is fast rising from the remains of the old and should be in operation within a month or two.

The new users group will be run by Colin Nowell, a member of TUG from its inception and a contributor to its newsletter. He takes over from Bob Green who has moved on to do other things. Colin was unable to tell us too much about the problems with TUG when we spoke to him, but he assured us that they are now being dealt with and that the new users group will be run by him personally in an effort to avoid any recurrence. He says he is in contact with the computers' manufacturers and that, as a bit of a carrot to tempt back any wavering members, he has a full CP/M implementation using a Z80 control card ready to run on the Microtan. So hang in there, TUG members, and wait and see what happens.

SHORTS

● Greenweld's 1984/85 electronic components catalogue has 84 pages and lists audio modules, books, cases, kits and test equipment as well as semiconductors and the more mundane components. VAT inclusive prices are quoted on the page, credit card orders can be taken by telephone, and the catalogue complete with bargain lists costs £1 including postage from Greenweld, 443 Millbrook Road, Southampton SO1 0HX, tel 0703-772501.

● Greenpar Connectors have issued a short form catalogue of their range of RF connectors. Each series is extensively illustrated and there is a useful guide to the principal differences between the various series and their respective applications. Greenpar Connectors, P.O Box 15, Harlow, Essex CM20 2ER, tel 0279-27192.

● Thorn EMI has published an 8-page brochure entitled "A Comparison of the Performance of Photomultiplier Tubes and Silcon Photodiodes". The paper is intended as an aid to equipment designers and scientists engaged in all fields of light measurement and is available free of charge from the Sales Office, Thorn EMI Electron Tubes Ltd, Bury Street, Ruislip, Middlesex HA4 7TA, tel 08956-30771.

● Following the demise of Scopex Instruments Ltd and the subsequent acquisition of their assets by Bridage Scientific Instruments, a new company has been formed called Scopex Electronics Ltd. They report that production of the Scopex 14D15 dual beam oscilloscope and the 14D10 video model is now in full swing again and that the first samples are ready for despatch to customers. Bridage Scientific Instruments, 63-65 High Street, Skipton, North Yorkshire BD23 1EF, tel 0756-69511.

● A new MIL Standard covering electrical, physical and environmental test methods for microelectronic devices has been published by the United States Department of Defence. MIL-STD 883C, Test Methods and Procedures for Microelectroncis, supercedes MIL-STD 883B, contains 488 pages, and costs £39.05 from London Information (Rowse Muir) Ltd, Index House, Ascot, Berkshire SL5 7EU, tel 0990-23377.

● Marshall's 1984 electronic component catalogue has 56 pages and lists over 8000 items. They will accept orders over the telephone from credit card holders and the catalogue costs 75p to callers or £1 post paid to UK addresses and comes with a price list valid until June. A. Marshall (London) Ltd, 85 West Regent Street, Glasgow G2 2AW, tel 041-322 4133/5.

● Sircal Instruments are introducing a 2716 and 2732 EPROM programmer for use with the ZX81. It requires four 9V batteries, operates using simple POKE statements, and has an extension bus for further peripherals. SAE for details to Sircal Instruments (UK) Ltd, Southfields Court, Sutton Common Road, Sutton, Surrey SM1 3JE, tel 01-644 0981.

● The Scots really are brave — at least where high technology is concerned. A recent poll carried out by the market research company Taylor Nelson & Associates found that only 22% of people in Scotland suffer from what they call 'technofear', an aversion to high technology products. The figure was 35% in the North of England and the midlands and 44% in the South.

● The Independent Broadcasting Authority have produced a 48-page illustrated book entitled "Compatible Higher-Definition Television" which disucsses the problems associated with providing higher-definition domestic television which remains compatible with existing systems and receivers. Copies are available free to educational centres and technical libraries and to firms, engineers and students directly involved in Broadcasting. The IBA Engineering Information Service, Crawley Court, Winchester SO21 2QA, tel 0962-822444.

● B&R Electrical products of Harlow, probably best known for their range of relays, have produced a nine-minute video film on electrical safety. The professionally produced film is entitled "Because it's not worth the risk" and uses commentary and animated graphics to illustrate the dangers of electricity and the value of Residual Current Circuit Breakers (RCCBs) in minimising those dangers. It is available for hire by schools, colleges, etc for £3.00 a day or can be purchased for £29.95 from The Education Department, B & R Electrical Products Ltd, Temple Fields, Harlow, Essex CM20 2BG.

ETI

VERTICAL SPEED INDICATOR

Of special interest to hang gliding enthusiasts but unusual enough to inspire flights of fantasy in even the most vertigo ridden of armchair adventurers; Lindsay Ruddock describes a vertical speed indicator using a silicon piezo-resistive pressure sensor.

The vario and the altimeter, in that order, are the hang glider pilot's first and most important instruments. The altimeter measures height, but it is the vario which helps the pilot get high.

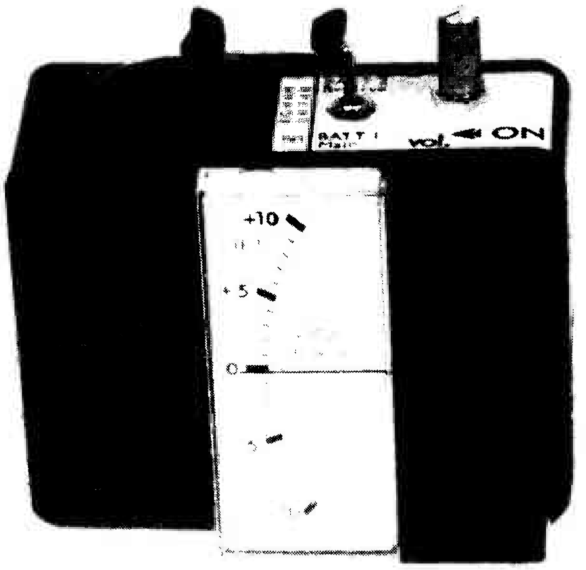
Vario is short for variometer, which means a VSI or vertical speed indicator to the gliding fraternity. In order to stay airborne, the glider pilot seeks out areas of rising air, the most important of which are called thermals — bubbles of warm air rising from the ground on sunny days (visualise a pan of water boiling on a stove). Using a vario to read the rate of climb or sink, the pilot flies to centre on the core of the rising air.

Essential as the vario readout may be, hang glider pilots do not want to spend their flying time staring at a panel meter. Also, flying sites can get very crowded. A light NNW wind on Devils Dyke in Sussex will see as many as fifty hang gliders airborne at one time. Accordingly, as well as a visual readout usually on a panel meter, hang gliding varios must have an audio tone which sounds when the glider is climbing. What is being measured, of course, is the net effect of the glider's sink rate and the lifting air. However the audio must do much more than simply distinguish between lift and sink, so the pitch of the tone is made to vary according to the strength of the lift.

The circuit described generates interrupted tone audio, the type recognised as being the easiest to follow. It sounds as a series of friendly encouraging beeps, the pitch rising steadily through an octave from zero lift to full scale. The rate of interruption is optimally chosen to begin at 2Hz at zero lift and progresses steadily to 4Hz at full scale. The visual readout is still necessary as the audio only gives relative information.

There are two viable types of vario for hang gliding, the flask type and the pressure derivative type. Both work by detecting the change in atmospheric pressure with height, but do it in different ways.

The flask uses a reservoir flask vented to the atmosphere via a narrow passageway or constriction. As atmospheric pressure changes, air flows into or out of the flask and it is this airflow which is measured to indicate vertical speed. A pair of closely matched resistance wires are placed one in front of the other in the constriction in the flask vent. The wires are connected as two arms of a Wheatstone bridge, and are directly heated by passing a current through them. The one in front gets cooled more than the other by air flowing into the flask and vice versa. This temperature difference causes the bridge to unbalance and the resulting signal is amplified to drive a display and an audio tone generator.



The vario described in this article is of the pressure derivative type. The difference between this type and the flask type is that here the absolute value of atmospheric pressure is measured directly using a silicon chip pressure transducer. The resulting signal, which represents altitude, is then differentiated to obtain a rate of climb signal, hence the name 'pressure derivative vario'. Figure 1 is a block diagram of the instrument.

A very big advantage can immediately be seen; since we are only concerned with rates of change, the instrument is inherently self-zeroing. Much of the very high gain required can be placed before the differentiator, and in this way, long term drift in the transducer and first amplifier is ignored by the differentiator circuit and does not show in the output.

Although the idea is simple, a successful vario of this type needs very careful design. The overall circuit amplification is very high and the circuit impedance in the differentiator stage is very high. The problems are those of noise, drift and stability.

Noise and drift are dealt with by choosing suitable low noise, low drift components and, most importantly, by the elimination of PCB surface conduction. In the bandwidth we are concerned with

(0 to 1 Hz), surface conduction (surface leakage) is an extremely noisy process, easily swamping noise originating elsewhere in the circuit and also showing up as output drift. Fortunately, guard tracks around the sensitive circuit points prevent PCB surface leakage and consequently elminate the accompanying noise.

Figure 2 is a graph of atmospheric pressure against altitude plotted for the International Standard Atmosphere. Clearly the gradient or derivative of such a curve is not a constant. Plotting the gradient of the pressure curve in fact gives us Fig. 3. For our purposes we would like Fig. 3 to be a horizontal straight line, ie, uniform rate of change of atmospheric pressure with altitude. However, Fig. 3 shows that atmospheric pressure falls off more slowly the higher one goes, with the result that an uncompensated pressure derivative vario will under-read by a factor which can be read off from Fig. 3.

Although an awareness of the under-reading characteristic is useful, the extra complexity of compensation has not been included in the circuit presented here. We said earlier that a vario is primarily an indicator in gliding and providing the zero is stable, the absolute accuracy at all altitudes is of lesser importance. With a cloudbase at a typical 4000 feet on the better days of an English summer, the error can be completely ignored, and in other parts of the world, where hang gliders are regularly flown to 18,000 feet, it is sufficient that the pilot remembers the general trend of Fig. 3.

The design requirements for a vario are:

1. Reasonably small weight and size.
2. Long battery life and dual batteries.
3. Scale ±1000 feet per minute (or ±10 Knots).
4. Accuracy 10% at sea level, with a known calibration error with height.
5. Resolution 20 fpm (=4" per second).
6. Nicely responsive (fairly light damping).
7. Stable zero.

The first requirement goes without saying. The second, dual batteries, means a reserve is always available. A battery, no matter how long it lasts, must go flat sometime. Low battery indicators are now reliable enough especially with Ni-Cads but are too easily ignored.

A scale of ±1000 fpm was chosen as it caters for the vast majority of flying conditions. An alternative could be ±1500 fpm but this makes the scale a little cramped. Other possibilities are switched scales (±1000 and 2000 fpm) or compression of the upper part of the scale, both of which introduce greater complexity.

Absolute accuracy is not an important feature. For gliding purposes, the vario is used in a relative mode as an indicator — hence the name VSI. Calibration to 10% at SL is more than adequate, and provided the zero position is stable, the absolute accuracy at all altitudes is of lesser importance.

The limit to resolution is set by circuit noise. Full scale deflection (±1000fpm) at the output is ±1.25V, which corresponds to ±18μV at the transducer output.

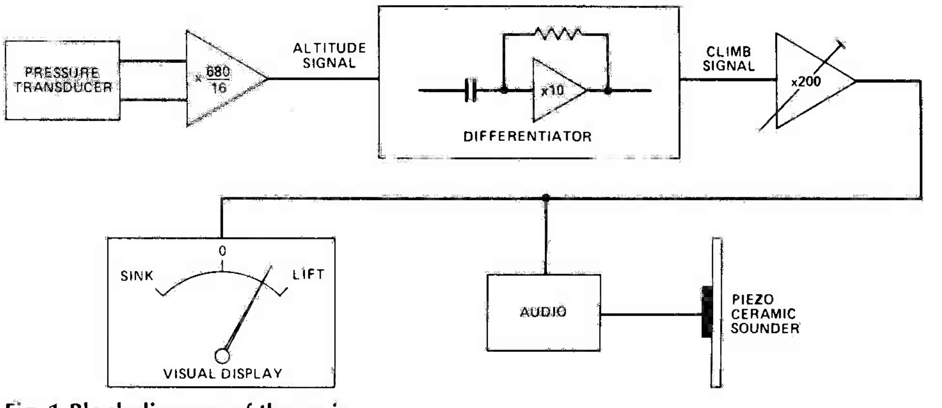


Fig. 1 Block diagram of the vario.

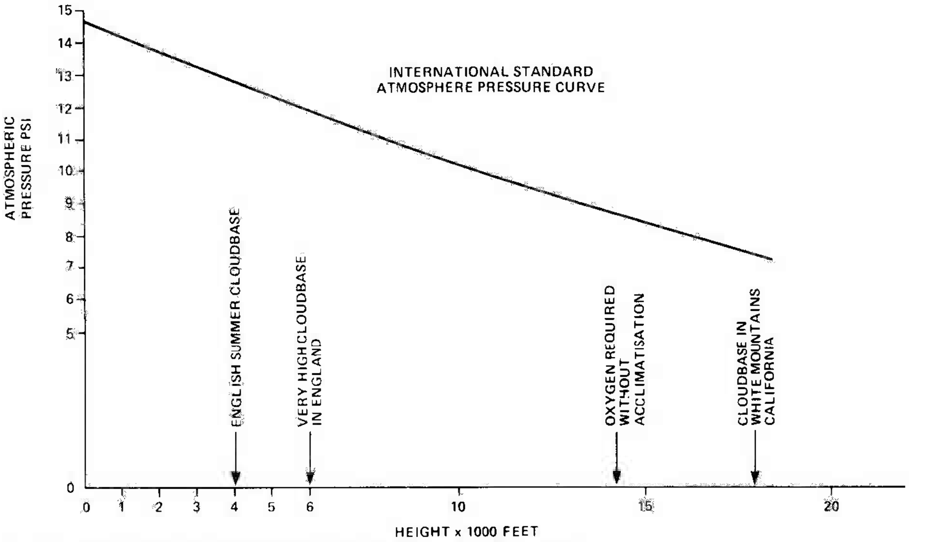


Fig. 2 International Standard Atmosphere (ISA) curve.

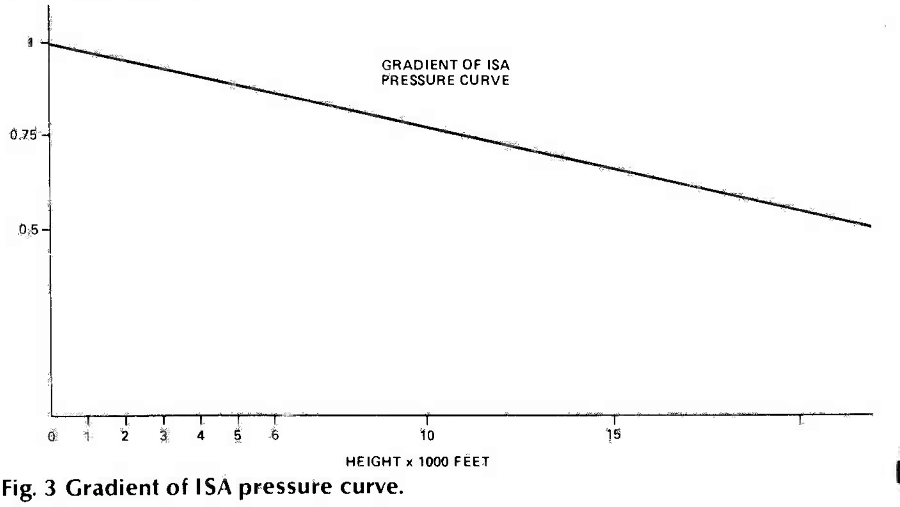


Fig. 3 Gradient of ISA pressure curve.

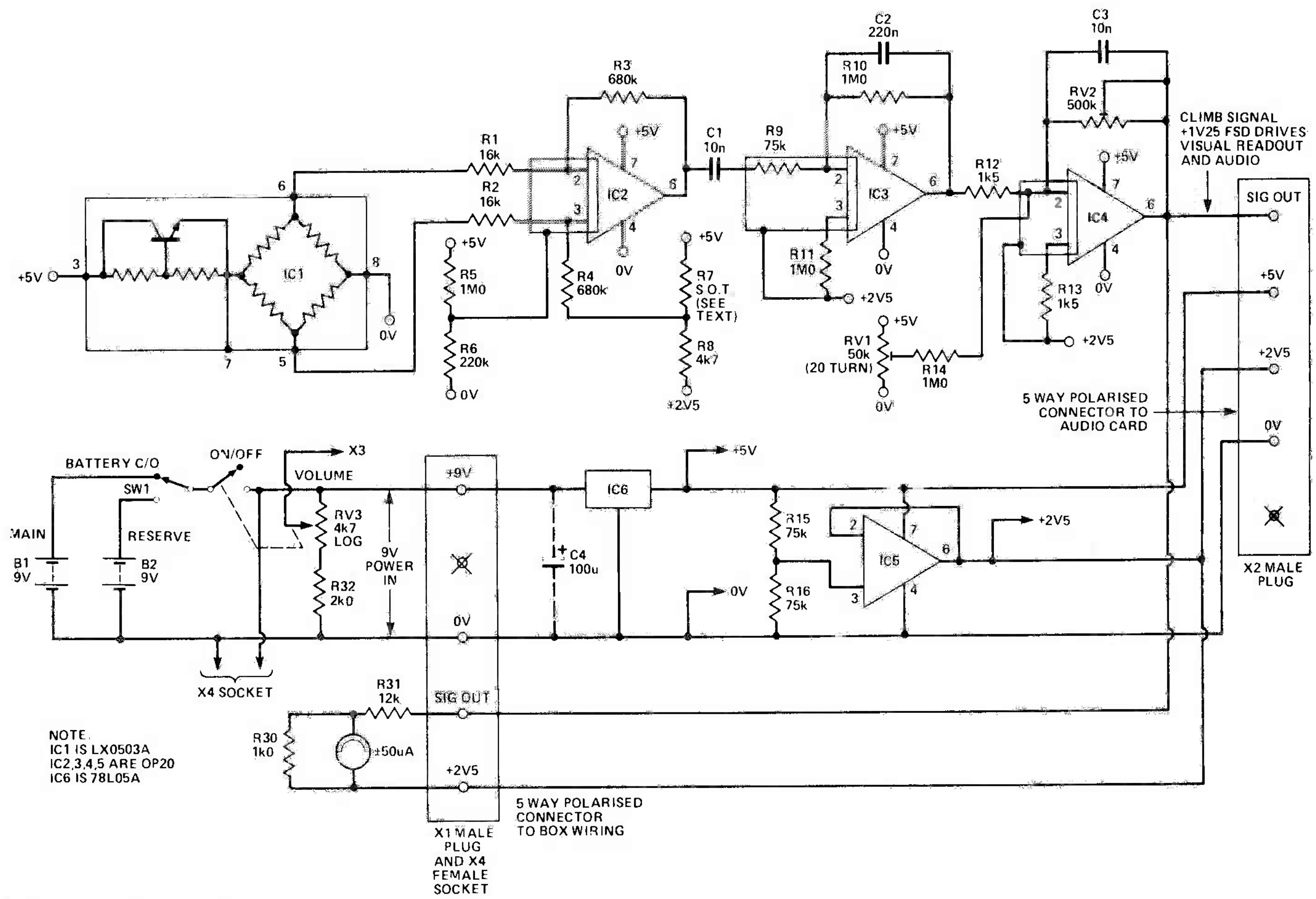


Fig. 4 Circuit diagram of the vario.

HOW IT

The LX0503A is a semiconductor piezo-resistive strain gauge manufactured using integrated circuit technology. A hollow is etched in a single crystalline (and therefore perfectly elastic) silicon chip about 2mm square, forming a diaphragm. This chip is then bonded to another chip acting as a backing plate, the pair forming a closed vacuum cell. Four strain gauge resistors making up a Wheatstone bridge are diffused into the diaphragm, two in areas of compression and two in areas of tension. Since the resistors are diffused in, the bonding to the diaphragm is perfect. The semiconductor material of which the bridge resistors are made has an enormous temperature coefficient. The gauge factor (sensitivity to stress) also changes with temperature. To compensate for this the LX0503A has an internal V_{be} multiplier.

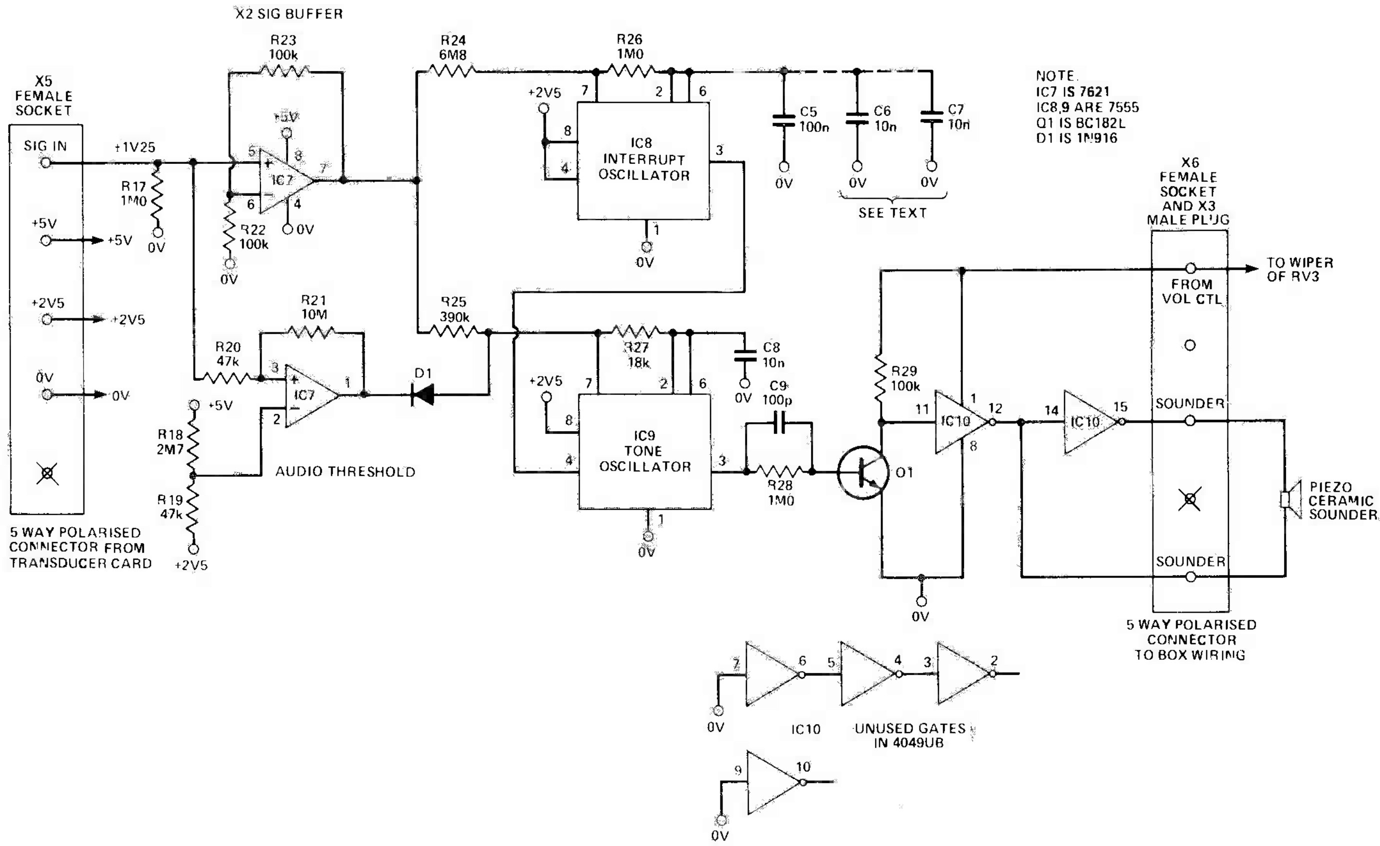
In this application, the bridge and the compensation network are wired in series and connected across 5V. Wired this way, pins5 and6 of the transducer sit at about a volt above the negative supply and the swing between sea level (SL) and 20,000 feet (14.7 psi to 6.75 psi) is typically 16 to 20mV.

The first op-amp (IC2), converts the transducer differential output to a single ended output, with a gain of 680/16. The resistor marked SOT (Select On Test) is adjusted to bring the op-amp output to 0.25V below the +2.5V signal ground rail (assuming the altitude of your workshop is SL ±1000'). Not only does this procedure make sure that the op-amp does not saturate at the positive end at altitudes up to 20,000 feet, it also makes certain that the voltage across the 10uF capacitor, C1, is never more than ±0.25V at switch on. Too large a voltage across this capacitor at switch on would cause too much dielectric absorbtion and hence too long a warm up time. The resistors in this stage are all best quality metal film in keeping with the low flicker noise requirement.

A crude guard track is used around the input pins of the op-amp. The principle of a guard track is that sensitive high impedance points or tracks in a circuit can be surrounded by a low impedance guard track at the same potential. Because there is no potential difference across the PCB surface, no leakage takes place and hence noise caused by leakage is reduced. Here, the potential on the guard track is set by the divider chain R5, R6 at about 1V, approximately the same potential as that on the inputs.

IC3 is configured as a differentiator. The effective gain of the stage is set by the product of C1 and R10, which is why both are as large as practicable. Both C1 and C2 must have polyester dielectric or better. A guard track is run around IC3 inputs and also around R9, and since the voltage at the inputs never exceeds a few millivolts, a track connected to signal ground is very effective. The 75k resistor R9 and the 0.22uF integrating capacitor C2 fix the response time of the vario. This is also referred to as damping. Using the values given the response is quite fast.

The final amplifier, IC4, is an inverting amplifier providing a gain of typically X200 to bring the climb signal up to the ±1.25V output. RV2 adjusts the gain between X100 and X330 to enable scale calibration to be set. RV1 sets the zero, nulling the offsets from both IC3 and IC4, and also has sufficient adjustment range to swing the output plus or minus full scale when testing the audio section. A guard track connected to the signal



WORKS

ground is run around IC4 inputs. C3 quietens any noise picked up after the differentiator which would otherwise cause a ragged turn on of the audio.

The output of IC4 drives a ±50uA panel meter as well as the audio. The 1k resistance in parallel with the meter coil (which also has a resistance of 1k) is necessary to add damping to the meter movement itself. A gain of X2 is provided by the first half of IC7, an Intersil 7621 CMOS op-amp whose output will swing all the way between its supply rails. The other half of IC7 is wired as a non inverting Schmitt trigger switching at a threshold equivalent to 33 feet per minute, which is set by R18 and R19. R20 and R21 provide positive feedback to implement the Schmitt trigger action with a small amount of hysteresis. The output, again switching fully between the supply rails, is routed via D1 to inhibit the tone oscillator unless the climb signal is above the threshold.

Two CMOS 555s configured as VCOs are used, one for the interrupt running at 2 to 4Hz and the other for the tone running at 330 to 660Hz. Both are voltage controlled over an octave. C5 charges through R24 and R26 and C8 through R25 and R27 until pins 2 and 6 reach two thirds of the 555 supply voltage (2.5V). Pin 7 then discharges C5 through R26 and C8 through R27 until pins 2 and 6 drop to one third of the 555 supply, when the IC removes the discharge through pin 7 and alllows the capacitor voltages to rise again, continuing the cycle. The VCO action arises because the higher the voltage to which R24 and R25 are returned, the faster will be the charging rate on the long cycle.

The output of the interrupt oscillator IC8 drives into the RESET pin of the tone oscillator IC9. More tone than interrupt is allowed through by making the interrupt oscillator mark/space ratio uneven. Provision has been made for padding the interrupt oscillator VCO capacitor C5 with C6 and C7. This is important as the interrupt frequency must be 2Hz or a little less to sound right to the ear.

Q1 acts as a level changer to bring the signal level up to 9V. Because the base drive resistance is high, a small capacitor (C9) helps Q1 turn off more quickly by dumping a charge into the base when the drive switches from a high to a low state. Reasonably fast rise and fall times remove the risk of oscillation in the CMOS 4049 buffer. The risk is further reduced by specifying a suffix UB part. Volume control is provided by supplying both the buffer IC10 and Q1 from a 4k7 log pot across the 9V supply.

The very efficient piezoceramic sounder used gives maximum volume at around a few kHz. To get the loudest sound, IC9, the tone oscillator, generates a very uneven mark/space ratio signal running at a fairly low frequency, but which is very rich in harmonics. Although the oscillator runs from 330 to 660Hz, its output consists of pulses only 250uS wide. The sounder is connected between the input and the output of the second inverter in IC10. It is thus driven in a complementary mode which effectively doubles the battery supply voltage and significantly increases the sound power.

Alkaline PP3 sized 9V batteries are used in the Vario giving about 40 hours of life. The 9V is regulated to 5V with a 78L05A regulator IC6, while IC5 provides a split rail to act as signal ground. A 100uF capacitor (C4) decouples the 9V input lead if necessary.

We want to resolve to ±20fpm or ±2% of FSD. In other words, the random flicker observable on the pointer due to noise should be hardly noticeable. Bearing in mind the bandwidth of DC to 1 Hz, total noise referred to the transducer output must be kept to a fraction of a microvolt. If the working frequency band was in the audio or RF spectrum, this would be quite easy. There we would only have thermal and shot noise to deal with and over a 1 Hz bandwidth these would be insignificant. However, down at the bottom end of the spectrum, below a few Hz, the lesser known phenomenon of flicker or 1/f noise dominates. '1/f noise' is so called because its amplitude is inversely proportional to frequency; it seems to be caused by discrete jumps in conductivity but very little information is available. Experiments showed that PCB surface leakage contributed very large pulses of this noise but at intervals of one or two minutes.

Noise in the vario originates from the regulator, the transducer, the first op-amp, the resistors in the first amplifier, and from PCB surface leakage around the differentiator. Attention must be paid to all of these as noise from any one can be sufficient to swamp the others. A number of different parts from various manufacturers have been tried in the circuit and the regulator, transducer and op-amps specified in the parts list have been found to give the best noise performance. Similarly, several different types of resistor were tried but metal film proved the most appropriate, offering less noise in this band than the supposedly less noisy thick film types, for example. Finally, the problem of noise caused by PCB leakage has been tackled by placing guard tracks around sensitive points on the PCB.

Damping (or what is often mistakenly called 'sensitivity') is a damping down of the speed of response by limiting the circuit bandwidth. Sailplane pilots seem content with quite heavy damping and consequent sluggish response. Hang glider pilots like a fairly light damping, but again, too little damping can be very annoying. Every little bump of lift and bit of turbulence in the air causes the vario response to be all over the place and the reading is very difficult to interpret. Accordingly, the damping used in this design has been set at a value as light as is consistent with a reasonably satisfactory integration of the irrelevant bumps and turbulence. Or, to put it another way, damping is added until the point just before a lag becomes noticeable in the vario response. As it happens, this coincides quite neatly with the bandwidth constraint imposed by circuit noise.

The last requirement, for a stable zero, is probably the most important. It does not matter so much if one is climbing at an indicated 400 fpm when the real climb rate is 600 fpm. The 200 fpm difference could be due to a calibration scaling error of 30%, a zero shift of plus 200 fpm. If the former, then a true 100 fpm sink will show as 60 fpm sink on the vario. Again, not too bad. But if the error is due to a shift in the zero, then a true 100 fpm sink will show as 100 fpm lift on the vario for the same 200fpm difference — a totally different and unacceptable situation. Drift of the zero can be considered in two parts — drift originating before the differentiator and drift originating after the differentiator. Clearly drift originating before the differentiator only shows through to the output while the drifting is actually taking place. Therefore an advantage is gained by placing as much gain as possible before the differentiator, the limit being set by the allowable swing at the transducer buffer op-amp output. Further, since the differentiator op-amp gain is X1 so far as offset drift is concerned, regardless of the effective gain in the differentiator circuit, a further advantage is gained by making the differentiator gain as large as is practicable. The limit is set by the maximum physical size of polyester dielectric capacitor which can be accommodated and the maximum differentiator feedback resistor which is considered acceptable. The gain of the last stage is then the figure by which the offset drifts in both the differentiator and final amplifier op-amps should be multiplied. In this circuit, the final stage gain is 250. The sources of drift before the differentiator are the op-amp and the transducer. The op-amps used have been chosen for their low offset drift as well as their low noise performance, and the transducer specified has an internal V_{be} multiplier which provides at least coarse nullification of the temperature drift in the measuring bridge. This still leaves some non-linear drift in the transducer, but correcting this would require far more complex circuitry and a lengthy setting-up procedure, and in practice the level of drift remaining is quite acceptable.

Device	Manufacturer	Comments
LX0503A	Sensym	Cheapest 0-15 psi transducer available. Used to be manufactured by National Semiconductor
MPX100A	Motorola	
134PC15A1	Honeywell	Very variable quality
1800-01-33-00B-0	Foxboro	
PTQ-H-360 A	Kulite	
PAA-2-1	H.W. Keller-Druck	Top quality, very expensive.

Table 1 Basic 0-15 psi pressure transducers available in this country.

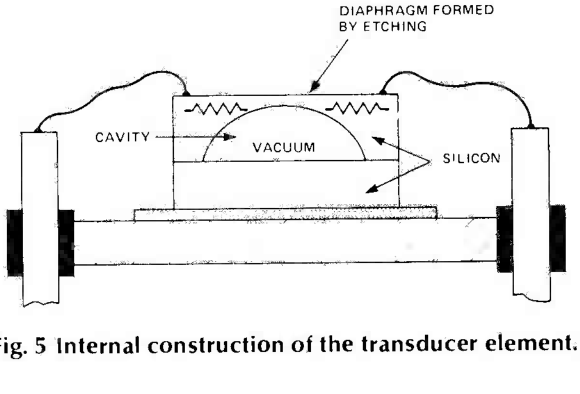


Fig. 5 Internal construction of the transducer element.

Next month's concluding article will contain full constructional details and an extended Buylines giving advice on where to purchase the components.

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DESIGNER'S NOTEBOOK

Signals come and go, but sometimes you want to hang on to them for a while. Joe Pritchard shows how it can be done.

Let us start this article with a definition: a sample and hold circuit is used to obtain a discrete value that represents an analogue signal at a particular instant in time. It samples the signal, and then, on a given command, holds the value that the signal posessed at the instant of interest. These circuits have found use in many different areas of electronics where it is necessary to take a "snapshot" of a signal at a particular instant.

We'll first look at these circuits from a theoretical point of view, examining an ideal circuit. At its simplest, a sample and hold circuit consists of some means of holding the voltage, and some means of connecting this storage element to the signal of interest when we want to sample the signal. Figure 1 shows us an ideal sample and hold circuit, in which we have an electronically-controlled switch to connect the capacitor, our storage element, to the input signal when we wish to sample the input. On opening the switch, the capacitor holds the voltage that was present at the input the instant the switched was opened. We shall call the input voltage V_{in}, and the impedance of the souce R_{out}. The **sample period** is the length of time for which the switch is closed and the **hold period** is the length of time the switch is open.

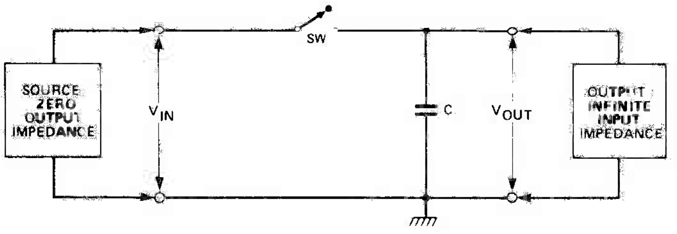

Fig. 1 Ideal sample and hold.

When we initiate a sampling period by closing the switch, the following happens. After the switch is closed, ignoring the on resistance of the switch, the circuit approximates to that in Fig. 2. As you can see, we now have a simple RC circuit in which the capacitor is charged up via the source impedance R_{out}. The output voltage, V_o will rise as an exponential with a time constant of $R_{out}C$; mathematically, this is:

$$V_o = V_{in}(1 - \exp(-t/R_{out}C)) \quad \ldots\ldots\ldots \text{Eq. 1}$$

where t is the time between the start of sampling and the instant at which we are measuring V_o. The practical significance of this is that we allow the sampling period to get longer and longer, then V_o becomes closer and closer in value to the input voltage.

If we allow the sampling period to carry on for five time constants, V_o attains a value that is within 1% of the value of V_{in}: this is shown in Fig. 3. Obviously, extending the sampling period leads to the value of V_o becoming even closer to V_{in}, and after nine time constants the output voltage is within 0.01% of the input voltage.

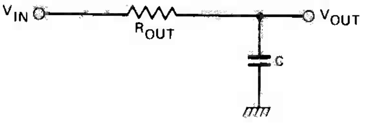

Fig. 2 The effect of the source impedance.

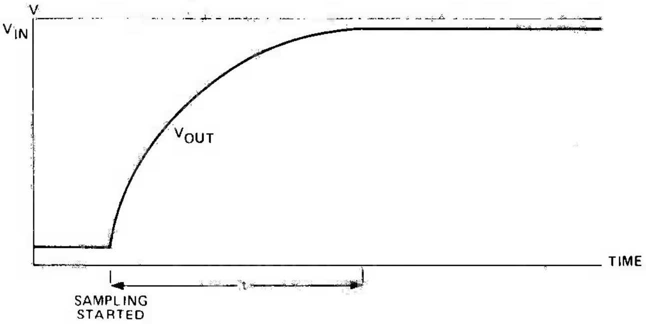

Fig. 3 The effect of the source impedance.

The time required for the output to approximate to the input to within a given percentage accuracy is called the **acquisition time** for that particular accuracy and that particular sample and hold circuit. In the above example, the acquisition time for 1% accuracy is five time constants, and nine time constants for 0.01% accuracy.

So, to recap on the sampling state. While the switch is closed and sampling is occurring, V_o will follow V_{in} to a certain degree of accuracy after the acquisition time has expired: this state of affairs is shown in Fig. 4. We'll now go on to examine what happens when the switch is opened and the circuit performs the hold function.

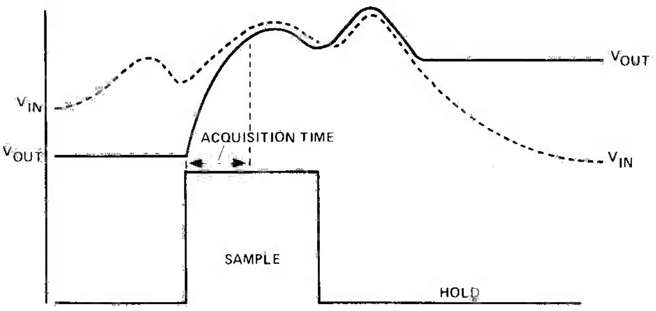

Fig. 4 The acquisition time.

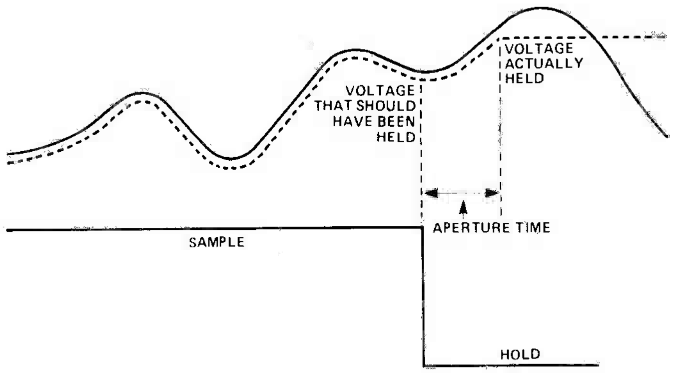

Fig. 5 Aperture time.

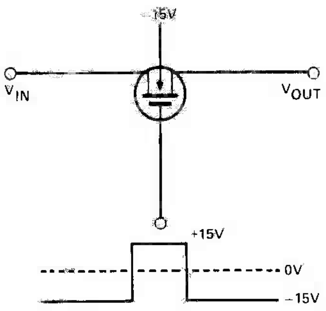

Fig. 6 (left) N-channel MOSFET as a switch.

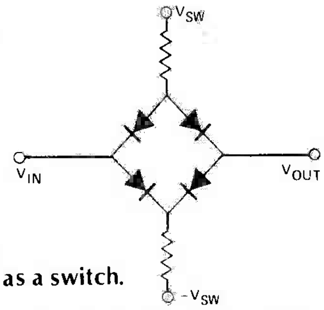

Fig. 7 (right) Diode switch.

Holding On

The first thing to note is that the input voltage, and its impedance, in theory no longer have any effect on the capacitor, due to the switch being open. In reality there is a slight delay in between the hold condition being initiated and the switch actually opening. This time is called the **aperture time** and during the output voltage will still follow the input: this is shown in Fig. 5. The aperture time is a function of the circuitry used to perform the switching and we'll look at it in greater detail when we go on to look at the practical implementations of these circuits.

In addition to the aperture time there is the **settling time,** which is the time taken for the output to attain a value approximating the input voltage at the instant that the hold was initiated. The settling time also depends upon the the degree of accuracy needed.

Once the hold state has been set up, with the capacitor isolated from the input voltage, then in the ideal situation with a perfect capacitor, the capacitor would retain the charge indefinitely. However, as nothing is truly perfect, the charge stored on the capacitor gradually leaks away and the held voltage falls. This decay is prosaically known as the **droop rate** and depends upon the capacitor value and the current that leaks through it. Mathematically,

$$\frac{dV_o}{dt} = \frac{I}{C} \quad \ldots\ldots\ldots\ldots\ldots \text{Eq. 2}$$

where I is the leakage current, C is the capacitor value and dV_o/dt is the rate of change of the output voltage.

The leakage current in the circuit under consideration would be purely due to the leakage through the capacitor itself. However, in practical circuits, this current can leak away through other circuit elements. So, the output voltage will be constantly falling, at the droop rate, during the hold period.

Building Blocks

Let's now look at some of the basic building blocks that we'll use to build a sample and hold circuit out of discrete components. The first circuit element that we'll consider is fundamental to the whole operation — the electronically controlled switch.

FET Switches: field effect transistors are obvious candidates for the job of an electronic switch due to their high resistance when they are not turned on, and their low on resistance of between 30 and 200 ohms. MOSFET's are also used in this role (Fig. 6). However, these devices have drawbacks at high frequencies due to the capacitance that is inherent in them due to their construction. This stray capacitance, which is often between 20 and 50pF, reacts with the on resistance of the switch to give a low pass filter, thus limiting the input frequency that the switch can handle. If we do the sums, it turns out that the top limit of these FET switches is around 20 MHz. This is ample for most cases, however. The aperture time of these switches is about 100 ns.

Diode array switches: diode arrays can be employed to give fast switching combined with short aperture times. The capacitance of these arrangements tends to be lower than that for the FET switches. A typical diode array switch is shown in Fig. 7. A voltage applied across the V_{SW} terminals will lead to the diode array switching.

CMOS switches: these use the sort of switches found in the 4016 package. They have a low on resistance of between 30 and 50 Ω and have the advantage that they can be driven directly from CMOS chips used to implement the control logic of the sample and hold circuit. Other switching devices, such as relays, have been used in this role, but their obvious limitation is their low speed and high aperture time. Both of these parameters are due to the fact that these devices are mechanical.

We'll now go on to look at how we might implement sample and hold functions, firstly by using 'standard' devices, such as operational amplifiers, and then by using integrated circuit packages designed specifically for the purpose. Figure 8 shows what is almost a classical design for a sample and hold circuit utilising op-amps. This circuit still has the essential components of the ideal system but we now introduce the additional components to do some signal conditioning on the input voltage and some isolation of the capacitor from the circuitry connected to the output.

The amplifier IC1 is connected as a unity gain amplifier, and it serves to take the input signal and provide a copy at the input to the switch that is identical but with a lower impedance. This impedance is the parameter R_{out} in the first system we considered and we saw there how it is desirable to minimise this value. The switch in this circuit could be one of those found in a 4016 package.

The capacitor used here is a compromise value, as there are conflicting design factors. From the equation describing the droop rate, Eq. 2, a large value capacitor will minimise droop. However, if the capacitor is too large, it will reduce the maximum frequency at which the sample and hold circuit can operate, by acting as a low-

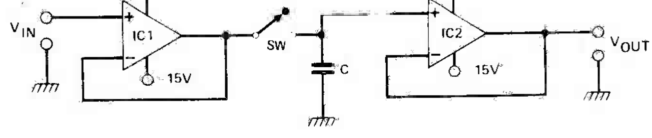

Fig. 8 A basic sample and hold circuit.

pass filter in conjunction with R_{out} and the on resistance of the switch, and a large capacitor here will increase the acquisition time for a given percentage accuracy by increasing the value of the time constant of $R_{out}C$. Thus for the circuit to be able to follow high frequency signals it is necessary that the capacitor should be fairly small.

An alternative to a large value of capacitance to minimise droop is to use some means of reducing the leakage current, I. It is best to stay clear of using aluminium electrolytic units in this role, as they have a very poor performance due to their relatively high leakage. Polyester, polypropylene and tantalum units can be employed here, depending upon the value of capacitance chosen.

Another source of leakage across the capacitor comes from whatever circuit element the capacitor 'looks into' when the switch is open. In this case, it is the input of an operational amplifier in a configuration that offers a high input impedance and so a low leakage. By putting this amplifier in the circuit, we give the capacitor a standard output to which any circuitry may be connected without increasing the droop rate. The op-amp used for IC2 should thus have a low input bias current, and this parameter is always given in the data sheets for such a device. The input bias current is the minimum required by the operational amplifier for correct operation. If the figure quoted is large, then the droop rate will increase. Thus we must have a good quality amplifier at this point in the circuit and operational amplifiers with JFET inputs are often used here due to their low input bias currents. This makes it possible to chose the value of the capacitor to suit the frequency requirements of the circuit rather than the droop rate requirements.

A final consideration that we must make is the amplifier IC1. It must be able to follow the input signal that is applied to it, and supply a copy of this input to the switch. The frequency characteristics of the circuit are thus dependant upon the characteristics of IC1 as well as the capacitor. The first parameter of the operational amplifier that we must look at here is the slew rate of the amplifier, a value that determines the frequency response of the device. This is best described in Fig. 9, which shows what happens when an input of sufficient magnitude to drive the output of the amplifier in to saturation is applied very suddenly. Note how the output takes a finite time to assume the final output voltage level. The slew rate is rate at which the output rises, usually quoted in volts per microsecond.

Obviously, if this parameter is fairly small, the output voltage will take a longer time to stabilise than if it were quite large. High speed amplifiers have high slew rates, such as 100 V/μs. The unit we choose for IC1 should have a slew rate that is appropriate for the signals under consideration.

Another parameter of IC1 that is important for satisfactory operation of the circuit is the ability of the output to provide current. In charging the capacitor during the sampling period, the amplifier will have to provide a charging current of

$$I = C_1 \frac{dV}{dt} \qquad \text{Eq. 3}$$

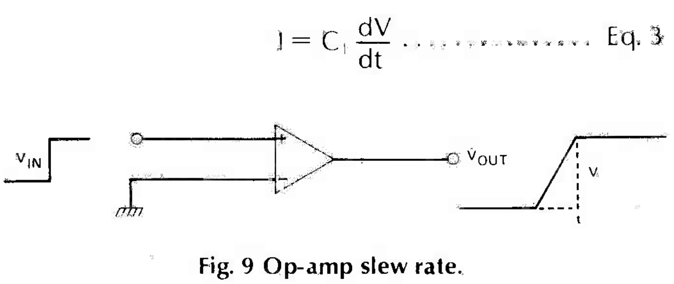

Fig. 9 Op-amp slew rate.

If the rate of change of voltage is quite large, a state of affairs that is not rare when we have a rapid sampling rate or a rapidly changing input signal, the current required can be considerable. Amplifiers used in this position in the circuit can suffer a rise in temperature.

It is often the current sourcing ability that limits the slew rate of the system as a whole. Consider an amplifier driving a signal changing a 10 V/μs into a 100 nF/ capacitor; the current it must supply is 10mA.

It is the lower of the two slew rate parameters (op-amp slew rate and current supply capability) that limits the frequency operation of the circuit. The maximum current that an operational amplifier can source can be found in data sheets for the device in question.

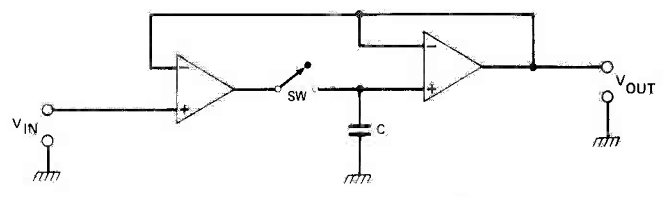

Fig. 10 Alternative sample and hold circuit.

Figure 10 shows an alternative connection of the operational amplifiers, but the principles outlined above still hold; however, this alternative connection minimises the effects of the op-amp's offset voltages.

Before we go on to see some general rules of thumb about op-amp based sample and hold circuits, a few words about the rate of and length of sampling. The first point to make is that the sampling period should be longer than the acquisition time of the system, so that when sampling takes place, for most of the sampling period the output voltage into the capacitor follows the input voltage with reasonable accuracy. If the sample period is shorter than the acquisition time then the output at hold will not be an accurate representation of the input. With regard to the rate of sampling, if the aperture time is longer than the time interval between separate samples being taken, then again inaccurate results will be obtained. To be quite safe, you should allow a good deal longer than the aperture time between samples.

Choosing Devices

First of all, which amplifiers should we use? For IC1 in the circuit we have considered, the main requirements, as we've seen, are high slew rate and good current sourcing ability. The LM318 and the LF351 are both possible choices here. The ubiquitous 741 is not usually useful in this role as it has a low slew rate. The equally popular LM324 suffers from the same problem, but both of these devices can be used in low frequency applications as they have good current sourcing ability.

With regard to the switch used, this really depends on the speed of sampling that is to be used. For many applications, CMOS switches are quite adequate. The rate of sampling and the sample period can both be controlled by suitable astable and bistable circuits, or via signals from a microprocessor.

The value of the capacitor used should be chosen for the acquisition time required, as we can minimise droop effects by careful choice of the final op-amp. If a small acquisition time is needed, which would be the case if we were sampling a rapidly changing signal, then the capacitor should be small.

The main requirement of the final op-amp is that it should have a low input bias current. Devices that come into this category are the LF356 and the LM308. The more common op-amps such as the 741 could be disappointing due to their relatively high bias current.

Some Practicalities

Figures 11 and 12 show practical versions of Figs. 8 and 10 due to Texas Instruments which is why they both use TI devices. Figure 11 uses two P-channel enhancement FETs to produce a very high degree of isolation between the capacitor and the input buffer IC1. Obviously, PCB lay-out can enhance the isolation still further, and conversely poor lay-out can degrade it. If the value of C1 is chosen to be 1μ0, then the maximum drift should be around 0.2 mV per second.

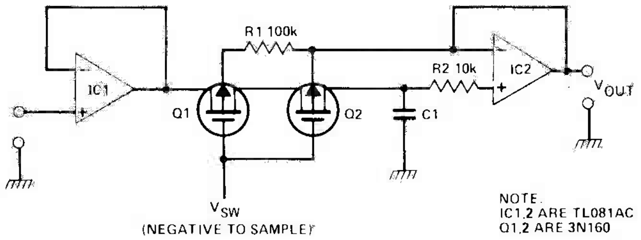

Fig. 11 (above) Practical sample and hold circuit.
Fig. 12 (below) Low offset sample and hold circuit.

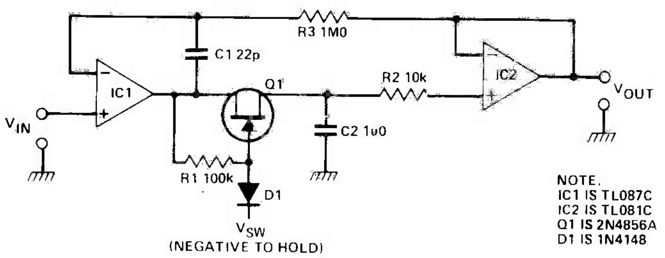

Fig. 12 is a high-accuracy sample and hold; since IC2 is within a closed loop, the effect of its offset voltage is negligible. IC1 is chosen to be a type with a very low offset voltage, maximum 0.5 mV at 25 degrees centigrade. Components C1 and R3 are to improve loop gain in the sampling mode. The one problem with this circuit is that during hold, DC feedback to IC1 is removed and it will saturate. It is therefore important to chose Q1 to withstand this possibility. Alternatively, a second FET could be put in parallel with C1 so as to provide feedback when Q1 is off.

The LM398 is a ready-made unit and its internal circuitry is very similar to the configuration that we have looked at in this article, with the difference that the capacitor is an external component to the chip. This device makes the construction of a simple sample and hold circuit much more straight forward. A typical configuration is shown in Fig. 13. The signal that is being sampled is put in to pin 3 of the device, and the output is taken from pin 5. C_h is the capacitor that stores the voltage at hold, and the value of this capacitor is best

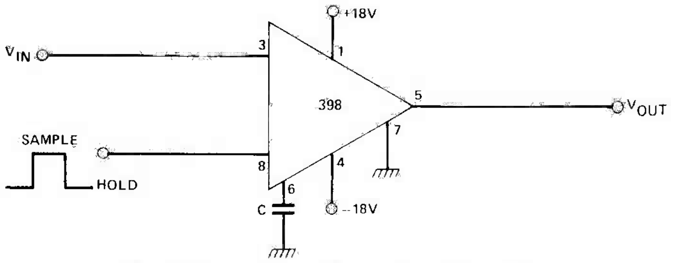

Fig. 13 A ready-made unit, the LM398.

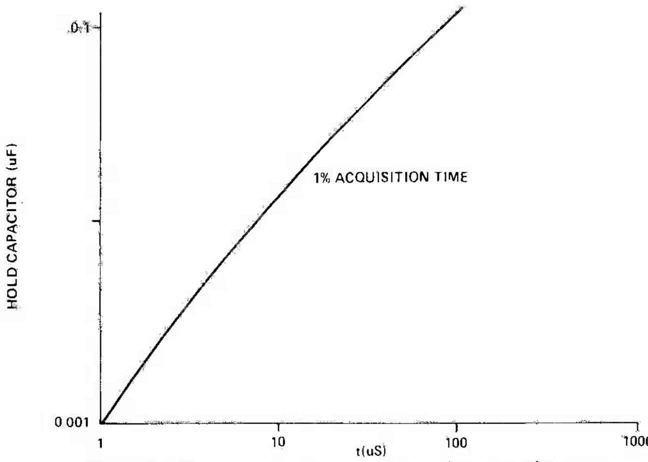

Fig. 14 Choosing the capacitor value for Fig. 13.

estimated from the graph in Fig. 14. Taking pin 8 to a logic 1, say 5 volts, will cause sampling to take place, and restoring it to a logic 0 will cause a hold state to ensue.

A capacitor of a value of 1n0 will give a settling time of around 5μS, indicating that after this time after sampling has started a voltage will be available at the output. Thus after this time you can hold and get an accurate result. This device has found use in analogue to digital conversion systems where it is used to hold a typical value of a rapidly varying analogue signal long enough for digitisation to occur to the desired degree of accuracy.

Uses

With regards to applications, the field of computer interfacing is the most obvious. In an analogue to digital conversion system, the circuit would sample the input and then hold it until conversion had occurred. Obviously, the device used would need to be fast enough to follow the input, but would also require a droop rate which was low enough to allow the conversion to occur before the voltage held on the capacitor had decayed substantially. In this type of application we would be using the sample and hold circuit to make it possible for a relatively slow analogue to digital converter provide values of a fast moving waveform at regular intervals. Without the sample and hold circuit, the input waveform would have changed before conversion was complete, thus giving an inaccurate reading.

Digital instrumentation is a similar field of application. Electronic synthesisers also utilise them, enabling complex electrical signals to be used to control voltage controlled amplifiers, filters and oscillators.

Slightly modified sample and hold circuits are also used in circuits known as "peak pickers". These circuits continuously sample the input signal but have as their output a value representing the highest signal that they've experienced within a given time. The output voltage shows droop, but these circuits find use in estimating rapid transients that have occurred in circuits. Figure 15 shows one peak picker, due to TI.

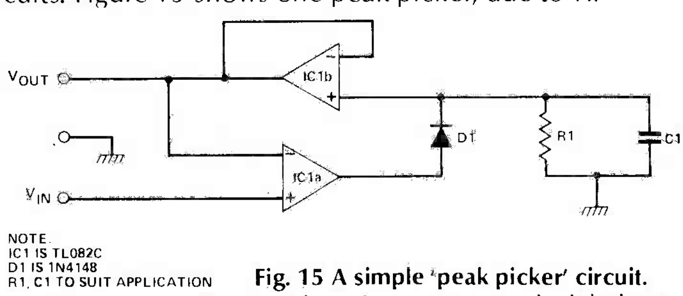

Fig. 15 A simple 'peak picker' circuit.

I hope that this article has given you some insight into the sample and hold circuit — a circuit that is finding new applications in the field of data conversion. **ETI**

UNIVERSAL EPROM PROGRAMMER

THE SEQUEL TO THE SEQUEL

Some projects just won't lie down — and the EPROM programmer published last year was one of them!

One inevitable fact about projects published in electronics magazines is that although they are believed to be 100% functional at the time they are printed, it is obviously not possible to test them as extensively as if they were developed in a true commercial environment. This fact explains how a particular device may often be built as an ETI project for a faction of the cost of a similar commercial product. For this reason, we very much appreciate feedback from readers about any difficulties they are experiencing with published projects.

In particular we would like to express our gratitude to Graham Davies for the helpful comments he has made with regard to some problems he was having with the EPROM programmer. As a result of this correspondance we are now able to publish the following amendment to the assembler routine which appeared in January 84.

The 50mS programming pulse required to program EPROMs is initiated by lines 138 to 142 of the assembler routine and the code on lines 122 to 130 is relied upon to turn it off by re-setting up the initial conditions after executing the delay loops and jumping back to LOOPP.

The problem with this method is that part of the initialisation code resets IC1PIA to zero on lines 125,126. Since this register contains some high order address bits as well as control lines and on some EPROM types this zeroing takes place before turning off the pulse there is a short time when the programming condition still exists and yet the address has been modified to a value in the range 00 to FFH. Although the duration of this condition is nowhere near the 50mS required to program a location it has been found that the cumulative effect of this happening a number of times can be to overwrite the first 255 bytes of the device.

Although this could probably be cured by changing the order of some of the instructions in lines 122-130, it was considered that a 'play it safe' approach of ensuring that the programming pulse is turned off before jumping back to LOOPP should be adopted. This is done by duplicating lines 138-142 between lines 148 and 149. The modified section of assembler program is shown below together with a new hex dump.

A different problem has been mentioned in connection with using the programmer on machines other than the Microtan. The BBC machine and some others, especially those with disc operating systems, generate

1C00	4C	4C	1C	00	00	00	00	00	00	00	00	00	00	3C	3C	3C
1C10	3C	3C	3C	34	34	34	18	18	18	10	10	18	12	10	12	3C
1C20	3C	3C	34	34	3C	3C	3C	3C	08	08	08	05	25	08	22	00
1C30	22	01	01	01	01	01	08	02	08	02	06	06	06	06	06	05
1C40	06	05	06	01	01	01	01	01	00	01	00	01	20	96	1D	AD
1C50	0B	1C	C9	02	D0	03	4C	BC	1C	A9	30	8D	25	BC	A9	00
1C60	8D	24	BC	A9	34	8D	25	BC	AE	0C	1C	BD	0D	1C	8D	23
1C70	BC	A9	00	8D	20	BC	A9	3C	8D	25	BC	BD	16	1C	8D	26
1C80	BC	20	AB	1D	20	71	1D	D0	03	4C	22	1D	20	26	1D	AD
1C90	25	BC	49	08	8D	25	BC	20	AB	1D	AD	24	BC	8D	0A	1C
1CA0	A2	00	AC	0B	1C	F0	10	30	07	C9	FF	F0	BB	4C	22	1D
1CB0	C1	35	F0	B4	4C	22	1D	81	35	4C	68	1C	A9	30	8D	25
1CC0	BC	A9	FF	8D	24	BC	A9	34	8D	25	BC	AE	0C	1C	BD	0D
1CD0	1C	8D	23	BC	A9	00	8D	20	BC	BD	1F	1C	8D	25	BC	BD
1CE0	28	1C	8D	26	BC	20	AB	1D	20	71	1D	F0	35	20	26	1D
1CF0	A2	00	A1	35	8D	24	BC	AE	0C	1C	BC	3A	1C	B9	20	BC
1D00	5D	31	1C	99	20	BC	A0	1D	A2	FF	CA	D0	FD	88	D0	FA
1D10	AE	0C	1C	BC	3A	1C	B9	20	BC	5D	31	1C	99	20	BC	4C
1D20	CB	1C	20	96	1D	60	AD	05	1C	8D	22	BC	BD	43	1C	F0
1D30	09	AD	06	1C	8D	20	BC	4C	61	1D	AD	20	BC	0D	09	1C
1D40	8D	20	BC	AD	06	1C	29	10	F0	08	AD	20	BC	09	08	8D
1D50	20	BC	AD	06	1C	29	08	F0	08	AD	26	BC	09	01	8D	26
1D60	BC	AD	06	1C	29	20	F0	08	AD	23	BC	09	08	8D	23	BC
1D70	60	E6	35	D0	02	E6	36	EE	05	1C	D0	03	EE	06	1C	AD
1D80	06	1C	29	E7	8D	09	1C	AD	05	1C	CD	07	1C	D0	06	AD
1D90	06	1C	CD	08	1C	60	A6	35	A4	36	AD	03	1C	85	35	AD
1DA0	04	1C	85	36	8E	03	1C	8C	04	1C	60	A0	80	88	D0	FD
1DB0	60															

Fig. 1 The modified hex dump.

regular interrupts in which zero page locations may be overwritten. Since the software presented for use with the programmer uses two zero page locations, 35H and 36H, if either of these were to be accessed in an interrupt routine, then things will obviously go wrong.

The solution here is to re-write portions of the assembler routine to access the data RAM area by some addressing mode which does not require zero page locations. One possible method is to use self-modifying code, or in other words, arrange for the reads and writes to the data RAM area to be made by absolute addressing, altering the op-codes of the instructions to access the next location each time the INCADD routine is executed.

In practice this would involve the following:

1. Remove all references to ZPLOAD, ZPHIAD and the ZPSWAP routine.
2. Change line 108 to VV: CPM VV
   111 to RR: STA RR
   136 to PP: LDA PP
3. Insert the following code at the start of the routine i.e. line 66.

```
LDA     LOADR
STA     VV+1
STA     RR+1
STA     PP+1
LDA     HIADR
STA     VV+22
STA     RR+22
STA     PP+22
```

4. Change the start of the INCADD routine to the following:

```
INCADD:  INC  VV+1
         INC  RR+1
         INC  PP+1
         INC  RR+1
         BNE  INCROM
         INC  VV+2
         INC  RR+2
         INC  PP+2
INCROM: (as before...)
```

As a final point, although this doesn't affect the operation of the program, two comments are incorrect in the assembler listing published in January 1984. The following are the correct versions of the comments:

line 44 : ;0-R, 80H-V, 1-T, 2-P

line 105 : ;MUST BE TEST – FF ?

```
138   1CF7  AE0C1C         LDX   TYPE        ;EPROM TYPE
139   1CFA  BC3A1C         LDY   PTBYTE,X    ;BYTE TO TOGGLE
140   1CFD  B920BC         LDA   ICIPIA,Y    ;LOAD IT
141   1D00  5D311C         EOR   PTBIT,X     ;TOGGLE BIT
142   1D03  9920BC         STA   ICIPIA,Y    ;PUT IT BACK AGAIN
143   1D06  A01D           LDY   £1DH        ;CARRY
144   1D08  A2FF           LDX   £0FFH       ;OUT
145   1D0A  CA       DEL:  DEX               ;50 MS
146   1D0B  D0FD           BNE   DEL         ;DELAY
147   1D0D  88             DEY               ;FOR
148   1D0E  D0FA           BNE   DEL         ;PROGRAMME
149   1D10  AE0C1C         LDX   TYPE        ;TOGGLE BIT BACK
150   1D13  BC3A1C         LDY   PTBYTE,X    ;
151   1D16  B920BC         LDA   ICIPIA,Y    ;
152   1D19  5D311C         EOR   PTBIT,X     ;
153   1D1C  9920BC         STA   ICIPIA,Y    ;
154   1D1F  4CCB1C         JMP   LOOPP       ;ROUND AGAIN
155
```

Fig. 2 The modified section of the assembler program.

ETI

BASS FOR BEGINNERS

Looking for a way to save money on hi-fi? One way that is still open to the home constructor is to build your own loudspeakers. But what if you haven't seen a design you like? Simple, design it yourself! Barry Porter tells us how to get the bass right.

When it comes to bass loading, most loudspeakers fall into one or two categories — reflex or closed box (often referred to as 'infinite baffle' by optimists, and 'acoustic suspension' by Americans). Although these configurations have been in use for many years, the design processes involved have become clouded with an air of mystery and black magic (no, not the fattening type!) so that many DIY speaker builders believe that they cannot compete with commercial designs unless they have a 10,000 ft^3 anechoic chamber at their disposal, and, B&K equipment sprouting from every cupboard.

This need not be the case, and by devoting a modest amount of brain power to the following procedures, anyone with access to a scientific calculator will be able to produce speakers of all shapes and sizes which, as far as bass response goes, will equal similar, manufactured items. Whereas it is not possible to design a complete speaker system without taking frequency response measurements, the intelligent application of manufacturers' information can often lead to a perfectly acceptable result, especially if due allowance is made for it being all your own work (which is good for at least a 6dB error to go unheard!). As this article is purely about bass loading, the whole subject of crossover networks will be left until another time, and preferably another author.

Reflex Or Closed Box?

You will probably have noticed that some loudspeakers have a hole in their front panels while others do not. One theory says that reflex speakers are produced by those who know how to work out how big the hole should be, whereas those who don't know use closed boxes. While this may have been true a few years ago, some of the most capable, present-day manufacturers base their designs on closed boxes, and some of the most awful speakers available are wrongly aligned reflex systems. So, what are the advantages of one method over the other?

In simple terms, for a given cabinet size and drive unit, reflex loading will give extended bass response with a roll-off slope that is steeper than that obtained with a closed box. Figure 1 shows superimposed low-frequency response curves for reflex and closed box loading of the same bass driver. At first sight, the reflex response appears to be the more attractive, and this would be the case if the normal listening environment were an anechoic chamber or a ten acre field — arguably not the ideal places for soft lights, sweet music and whatever else is appropriate to the occasion.

Average sized living rooms tend to be ideally proportioned to reflect a considerable percentage of the low frequency output of a loudspeaker, which interacts in a rather haphazard way with the direct output of the bass unit. As most of this interaction is additive, the effect is to increase the perceived low frequency level, often leading to complaints about larger speakers having LF colouration when used in rooms that are too small for them. In practise, the rather unattractive response of a closed box system may well be modified by the listening room to have a very flat effective output, which is part of the reason that such diminutive speakers as the Celestion SL6 can appear to have a bass output that is out of all proportion to their size.

An important factor in low frequency reproduction is phase shift, which needs to be minimized in order to maintain a good, tight bass sound. The response plots show that a reflex speaker rolls off at 24dB per octave — twice the rate of a closed box. This higher order of attenuation is accompanied by increased phase shift and its associated transient overshoot and ringing.

A combination of these factors often means that a relatively small closed box unit will exhibit a much better

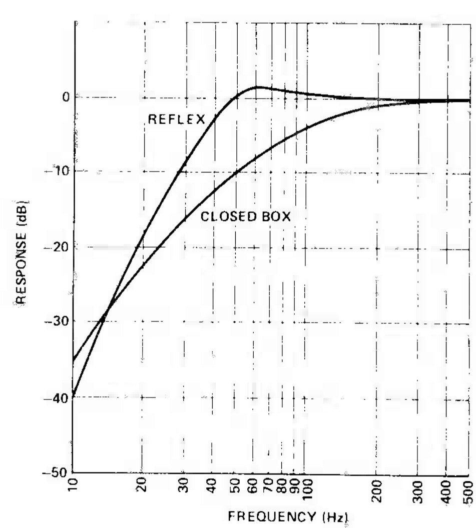

Fig. 1 Comparison of reflex and closed box responses for similar sized speakers.

bass sound than a much larger reflex design. Of course, this does not mean that reflex speakers should be condemned out of hand, as many superb examples do exist, but those that have proved successful under normal, domestic conditions, have usually been of moderate size — the Spendor BC1 being a classic specimen.

So, it really is a case of "suck it and see", but as a 'do-it-yourselfer', you have the advantage that you can tailor your speakers to meet your individual requirements, even to the point of introducing a reflex vent to a closed box, or of filling one in, with no infringement of anyone's guarantee. As a guide, the best sized units for a typical 1500-2000 ft^3 living room appear to be based on a 200 mm bass driver in a 20-40 litre closed box. Larger rooms or a liking for music with plenty of bass content is when 300 mm drivers in 100 litre reflex cabinets come into their own.

There are several directions from which speaker design can be approached. A manufacturer can decide upon a cabinet size then design a bass unit to meet the system requirements. This is obviously out for the home constructor unless he has taken up unit construction so the design process has been based on the drive unit parameters being fixed while the enclosure dimensions are variable.

Choosing A Drive Unit

Having decided upon a bass driver size, the main factors governing the actual units to use are likely to be:

1 price;
2 availability;
3 continuity of supply (in case you damage a unit in 1987);
4 availability of technical information;
5 electrical & mechanical parameters, cone material, etc;
6 manufacturer's reputation;
7 maximum power handling;
8 appearance;
9 performance of available systems using the unit.

Most of these points are self-explanatory, and most drive units supplied by reputable manufacturers should be worthy of consideration. Whether you settle on a particular unit or decide to produce theoretical designs for a number of contenders, the following parameters must be obtained from the manufacturer:

f_S : Free air resonance of driver (Hz)
Q_{TS} : Total Q of driver at f_S
V_{AS} : Suspension compliance of driver (litres)

With this information at hand, you can claim your rightful ownership of the ZX81 (remind your offspring who paid for it) and design either a reflex or closed box enclosure, calculating the frequency response to an accuracy of about 1dB, by following the simple procedures detailed here. In order to help you check your calculations, examples based on a typical 200 mm bass unit will be given at each stage. This unit will be assumed to have the following specification:

f_S = 27 Hz
Q_{TS} = 0.37
V_{AS} = 90 litres

Reflex Design

Each drive unit has an optimum reflex cabinet internal volume given by:

$$V_B = 20\ V_{AS}\ Q_{TS}^{3.3} = 67.66 \text{ litres.}$$

Just to make life more interesting, we will assume that threat of the introduction of speakers of this size into your love nest leads to the instant purchase of a one-way ticket back to mother, to you compromise on something smaller — say 40 litres. This will have a −3dB point of:

$$f_3 = f_S \left(\frac{V_{AS}}{V_B}\right)^{0.44} = 38.6 \text{ Hz.}$$

which will be obtained by tuning the box to:

$$f_S \left(\frac{V_{AS}}{V_B}\right)^{0.31} = 34.7 \text{ Hz.}$$

It is now possible to plot the frequency response of this unit-box combination. First of all, calculate the following parameters:

$$A = \left(\frac{f_B}{f_S}\right)^2 = 1.6517$$

$$B = \frac{A}{Q_{TS}} + \frac{f_B}{7f_S} = 4.6477$$

$$C = 1 + A + \frac{V_{AS}}{V_B} + \frac{f_B}{7f_SQ_{TS}} = 5.3979$$

$$D = \frac{1}{Q_{TS}} + \frac{f_B}{7f_S} = 2.8863$$

For each frequency of interest, define "normalised" frequency, f_N as $\frac{f}{f_S}$ (in our example at 20 Hz f_N= 0.7407 and at 50 Hz f_N= 1.8519). The relative response may now be calculated from:

$$R(dB) = 20 \log \left(\frac{f_N^4}{\sqrt{(f_N^4 - Cf_N^2 + A)^2 + f_N^2(Df_N^2 - B)^2}}\right)$$

Our example gives the following response:

Hz	dB	Hz	dB
20	−18.33	60	+1.15
25	−12.25	70	+1.13
30	− 7.68	100	+0.70
40	− 1.81	200	+0.19
50	+ 0.60	300	+0.09

With a programmable calculator or home computer, the above steps may be repeated for different combinations of drive unit and cabinet volume until one is found that has the required response.

Having settled on a final design, the vent size required to tune the cabinet to f_B may be worked out. In case you haven't yet discovered it, plastic rainwater, or 'down' pipe is an ideal material for making tuning vents, as it is available in several sizes, and is easily cut and glued into place. It should be obtainable from your friendly local hardware store, but don't arrive on your bicycle and expect to buy a foot of it, as it is normally sold in 6 or 8 foot lengths. (A colleague discovered this, and the accident that ensued when the string holding a length to his crossbar decided to part company with itself was a fair imitation of the morning after at Pearl Harbour.) Tubing with an internal diameter of 75mm is usually the most useful.

For a given internal diameter (D_V= 75 mm) the length (L_V) is given by:

$$L_V = \frac{2340}{f_B^2\ V_B} \cdot D_V^2 - 0.731\ D_V = 218.5 \text{ mm}$$

This is a realistic length, but if the result calls for a vent that is less than 50 mm or longer than, say, 250mm, it will be necessary to change the tube diameter to obtain a more convenient length. For example, if D_V had been 100 mm, L_V would be 412.7 mm, which could just cause embarrassment at the cabinet back panel.

This is not the place to go into the details of cabinet construction, but as a general rule, choose three dimensions that differ by at least 20%, keep the width as narrow as possible to minimise diffraction problems and mount the drive units in line vertically and as close together as is reasonably possible. Our 40 litre example could have internal dimensions of: 250mm wide, 550 mm high and 320mm deep, giving a total volume of 44 litres. This will be reduced to approximately 40 litres by the internal filling, bracing pieces, etc.

Closed Box Design

For any bass unit, the closed box volume primarily controls the Q of the system, one of 0.707 giving the flattest response without a peak prior to the low frequency roll-off. Some designers tend to aim for a system Q (Q_{TC}) of about 0.5, as this gives improved transient response and a better phase characteristic. For our example, a Q_{TC} of 0.55 will be the objective.

The total enclosure volume is given by:

$$V_B = \frac{V_{AS}}{\left(\dfrac{1}{\left(\dfrac{1}{Q_{TC}} - 0.2\right)} \cdot \dfrac{1}{Q_{TS}}\right)^2 - 1} = 50.3 \text{ litres}$$

We now hit a slight problem. The resonant frequency (f_S) of the drive unit is considerably altered by the existence of a cabinet, so until you have built a unit and carried out some measurements, it is not possible to predict its performance. Luckily, speaker design is not a particularly precise art, so a certain amount of guesswork is likely to pass unnoticed. As a starting point, assume that a cabinet giving a Q_{TC} of 0.5 to 0.7 will double the free air resonance (f_S) of your drive unit ($f_{SB} = 2f_S$). The unit used as an example had an f_{SB} of 48Hz in a 46 litre enclosure, which is close enough to the assumed 54 Hz for the purpose.

Using this approximation, it is possible to calculate a provisional response curve which will have sufficient accuracy to indicate whether or not the unit-box combination meets your requirements. Once the cabinets are built, it is possible to measure f_{SB} and Q_{TC}, which will enable more accurate results to be plotted.

The necessary test set-up is shown in Fig. 2. The drive unit impedance is calculated from:

$$Z = \frac{R}{\left(\dfrac{V_{IN}}{V_L}\right) - 1}$$

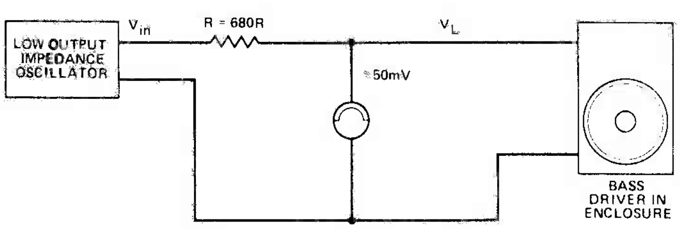

Fig. 2 Test set up for f_{SB} and Q_{TC} measurements.

and should be plotted over a range of frequencies to produce a curve similar to the one shown in Fig. 3, which was obtained from the driver being used as an example mounted in a 40 litre enclosure. One point to note is that the surround material of many units is very temperature sensitive, so make sure that your unit is at 20 degrees centigrade or slightly above before making any measurements. The resonant frequency may be read directly from the graph, or more accurately calculated as:

$$f_{SB} = \sqrt{f_1 f_2} = 47.6 \text{ Hz}$$

(f_1 and f_2 are shown in Fig. 3). The system Q is given by:

$$Q_{TC} = \sqrt{\frac{R_{DC}}{R_{MAX}} \cdot \frac{f_{SB}}{f_2 - f_1}} = 0.505$$

which is quite close to the original calculated value, but was probably influenced by the measurements being made at 25 degrees centigrade.

It is now possible to estimate the −3dB frequency from:

$$f_3 = f_{SB} \left(\frac{1}{\dfrac{1}{Q_{TC}} - 0.2}\right) \cdot \frac{1}{Q_{TS}} \sqrt{\frac{K + \sqrt{K^2 + 4}}{2}}$$

$$= 110.7 \text{ Hz.}$$

$$\text{where } K = \frac{1}{Q_{TC}^2} - 2 = 1.9212$$

Now for the frequency response plot, calculated by:

$$R = 10 \log \left(\frac{f_N^4}{f_N^4 + K f_N^2 + 1}\right)$$

where f_N is defined as:

(see over page)

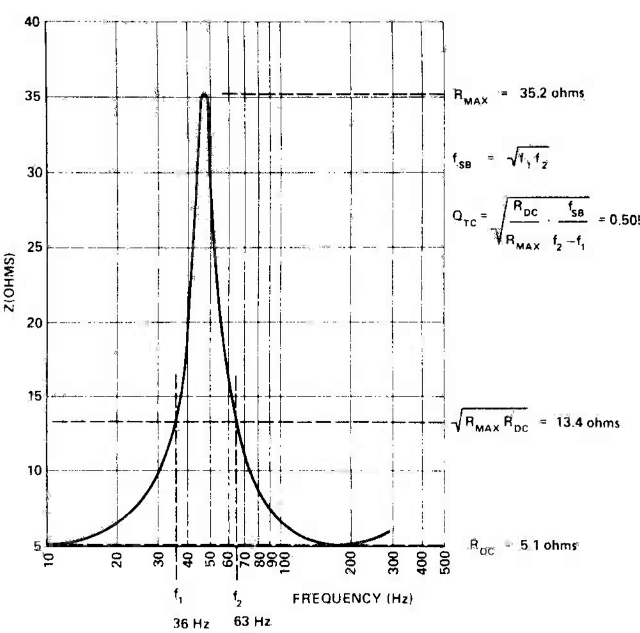

Fig. 3 Impedance curve used to measure f_{SB} and Q_{TC}.

$$\frac{fQ_{TS}}{f_{SB}Q_{TC}}(1 - 0.2Q_{TC})$$

e.g. 20Hz — 0.277
50Hz — 0.692

our example gives the following response, which should be compared to the reflex response calculated earlier.

Hz	dB	Hz	dB
20	— 22.9	60	— 7.7
25	— 19.4	70	— 6.2
30	— 16.6	100	— 3.6
40	— 12.5	200	— 1.0
50	— 9.7	300	— 0.5

Similar rules apply to closed box construction as to reflex enclosures. Needless to say, all joints must be made airtight by a copious application of glue, and internal standing waves should be reduced by loosely packing the cabinet with suitable wadding or foam. Bracing shelves or battens should be fitted to limit panel resonances, which may also be reduced by sticking bitumenous pads to all the inside surfaces.

Finally, for those who are still wondering which drive unit has been used as the example, your suspense is over — it was the KEF B200G, a fine 200 mm unit with high power handling and a smooth response characteristic that makes it useable up to 3 kHz in a two unit design — but that's another story that will unfold shortly . . . **ETI**

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SUPER-SELECTIVE MUSIC FILTER

Paul Wollover explains how it is possible to electronically preselect what you listen to on the radio.

Most people have distinct preferences as to what sort of music they wish to listen to and probably more so about what they wish to avoid. With this in mind the designer of this project has set out to assist us to be much more selective about our auditory intake with little or no extra effort. In this first part we shall cover the principles of operation and their application to the task in hand.

The main task of this unit is to detect, by some means, when the input signal contains a certain class of sound, in this case a certain type of music. If and when this is found and verified, the module must then take appropriate action, ie, switch over to the alternate source if the input is not desirable or switch from the alternate source to the main channel if it is desired. How quickly this should happen is a matter for personal chice but the timing inherent in this design should be suited to most needs.

The circuit as shown in the block diagram Fig. 1 illustrates the dual detection units available and how they intereact to get the desired results. The first detection path examines the input signal for multiple glissandos which occur at regular intervals in certain types of 'popular' music. The circuit basically examines the input and triggers when an instrument slides from note to note over an extended period. When triggered, this initiates two gated timed pulse generators and some logic to switch the audio pathways. At the same time this signal also starts a starts a time out circuit which eventually activates the permanent muting trigger circuit solenoid.

The second detection path examines the input signal for repeated sequences of sub-phrases in which minimal information changes occur. This is performed by a phase-locked loop, to extract the duo-decimal frame reference, and a synchronised digital pitch extractor. The resulting data is stored in a small memory and is compared is obtained, indicating the minimal information syndrome of this type of programme material, then the following coincidence timer will activate the programme switch via the mode switch and gate.

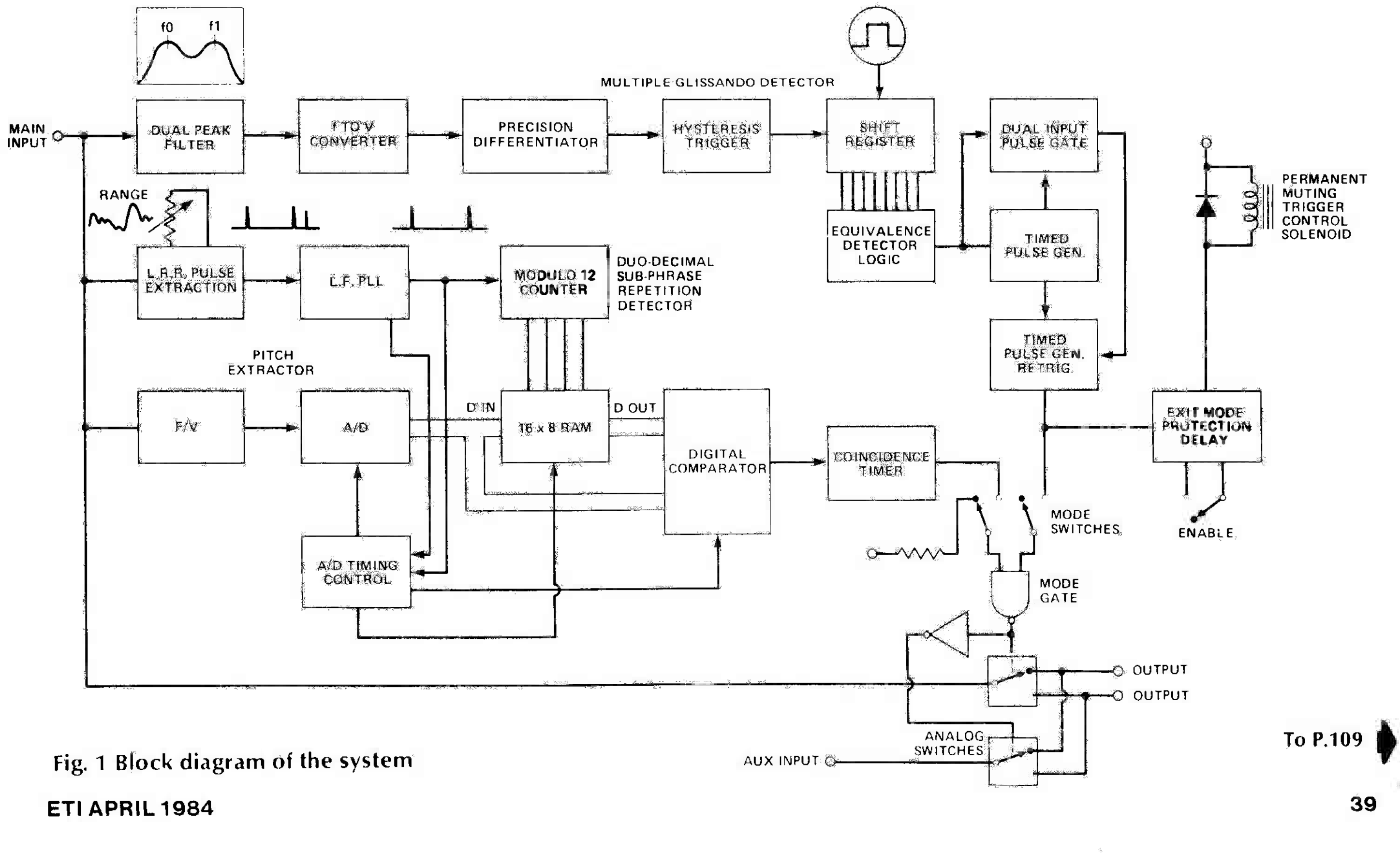


Fig. 1 Block diagram of the system

To P.109

ADDING COLOUR TO THE ACE

Black and white is boring, so add a little colour (or a lot, if you want) to your computer's life with this project from John Wike. Additional material by Phil Walker.

The two facilities that really enhance the output of a microcomputer are sound and colour. The Jupiter Ace already has sound of sorts and this project provides a means of adding colour to its monochrome display. Eight colours including white and black are available, any of which may be selected as foreground (ink) or background (paper). The circuit is active from switch-on and requires no special software for monochrome operation. Thus programs may be listed, edited and run without the need to keep swapping over aerial leads or operating systems. The board uses the smaller edge connector and contains a RAM (addressed in parallel with the Ace video RAM) to hold the colour information for each of the 768 locations on the screen.

EDITORIAL COMMENT

It may seem a little strange to publish a project for the Jupiter Ace several months after the manufacturer has gone into liquidation. However, there will be a number of readers around who have Aces, and, moreover, we think that there is a lot to be learned from the techniques and systems described here. We think you will agree with us once you've read this article.

Attributes

Each character written on the screen will have associated with it the current attribute describing its ink and paper colours. To print anything with different colours the current attribute must first be updated. This is easy to implement and software for doing so is given later. The default colours at switch-on are green ink and black paper. The attribute number is obtained by adding the ink value to the paper value and adding 128 (80h).

Colour	Ink	Paper
Black	0	0
Blue	1	16 (10h)
Red	2	32 (20h)
Purple	3	48 (30h)
Green	4	64 (40h)
Cyan	5	80 (50h)
Yellow	6	96 (60h)
White	7	112 (70h)

About The Ace

The Jupiter Ace video display consists of 24 rows of 32 characters, each of which is selected by storing the required code at the appropriate location in the video RAM. There are 128 character shapes (plus their inverses) available and these are re-definable by the user.

At the rear of the computer

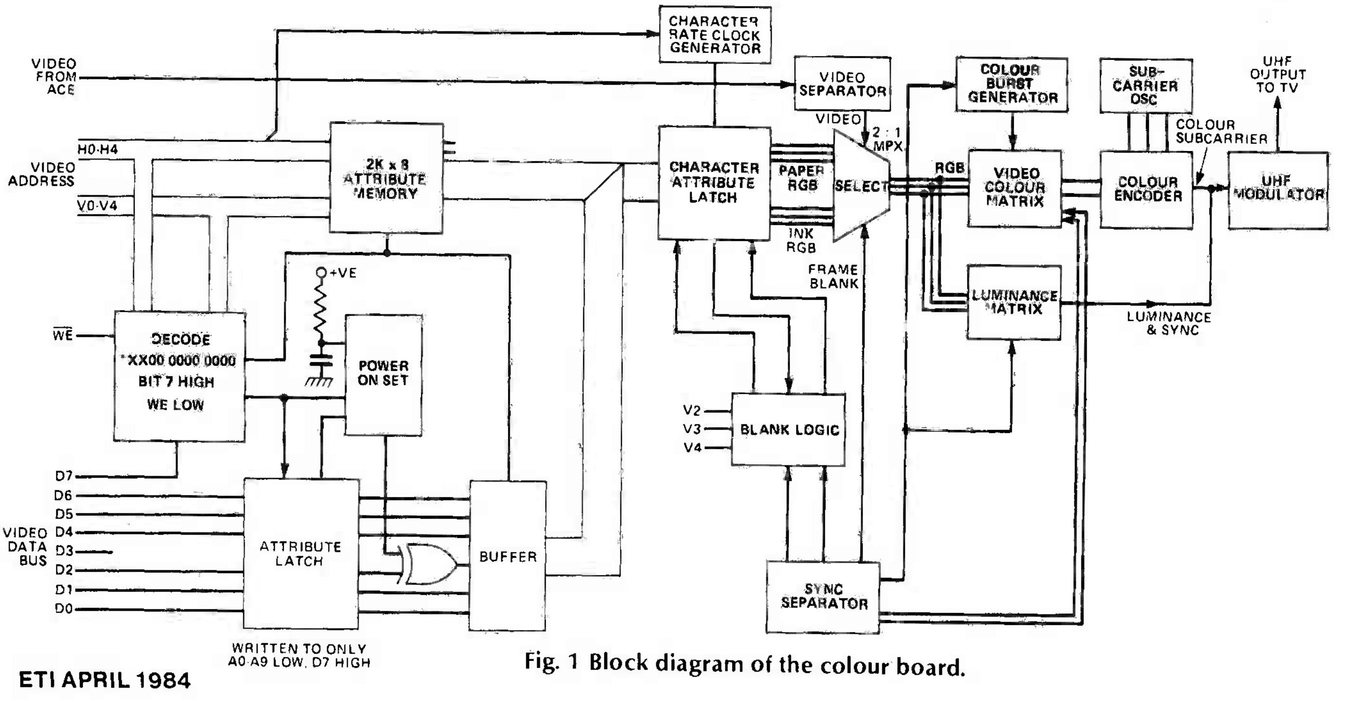


Fig. 1 Block diagram of the colour board.

Painting In Colours

To produce on a suitable TV set while still being able to get a good black and white picture from the same input signal, the broadcast authorities have adopted the PAL system for use in the UK. This system operates by retaining a simple amplitude modulated brightness (or luminance) signal which can be used by both colour and monochrome receivers. The colour information is added on to this in a rather complex manner such that it produces a minimum amount of interaction on the screen.

As far as our eyes are concerned, the colour information can be represented by the sum of three 'primary' colours — red, green and blue — in various mixtures. The total brightness effect of the combination is the luminance signal and this is transmitted as such.

The colour information is coded differently. The luminance signal is the weighted sum of all the colour signals and the colour information can be sent in two further difference signals obtained by subtracting the luminance signal from the red and the blue colour signals. In order to combine these signals with the luminance signal, they are modulated onto sub-carrier signals. The frequency of the two sub-carriers is the same and has a carefully chosen relationship to the line frequency. The difference between the sub-carriers is that they are 90° out of phase with each other. This phase difference is +90° on one line and −90° on the next to reduce the visible effects of phase distortion during transmission. These modulated sub-carriers are then combined with the luminance signal to form the composite video signal. This, together with a separate frequency-modulated sound sub-carrier, is then used to modulate the UHF transmitter.

This, then, is what the colour board project is doing (with the exception of the sound part). Incidentally, there are a few other such as synchronising and blanking signals which have not been mentioned but are necessary and are provided by the circuitry on the PCB.

A Typical Video System

For those of our readers not yet thoroughly steeped in the inner workings of micros from the hardware side, we present a short description of a typical black and white TV style video display.

As far as we can tell from a surreptitious peek inside the case of a Jupiter Ace borrowed for the occasion, there is nothing unusual about the video system used. Fig. 3 shows in block diagram form the main components of such a system.

The first major part to consider is the 1K of RAM which stores one 8-bit byte for each character location on the screen. This memory can be written into and read by the processor. By this means information can be updated as necessary.

The next part to consider is the video address generator. This normally consists of a crystal controlled clock oscillator driving a counter chain. The frequency of the oscillator and the division ratio of the counter chain are matched together such that they also provide information at the correct time for line and frame synchronising pulses and for the blanking signals necessary to prevent us seeing the line and frame fly-back traces.

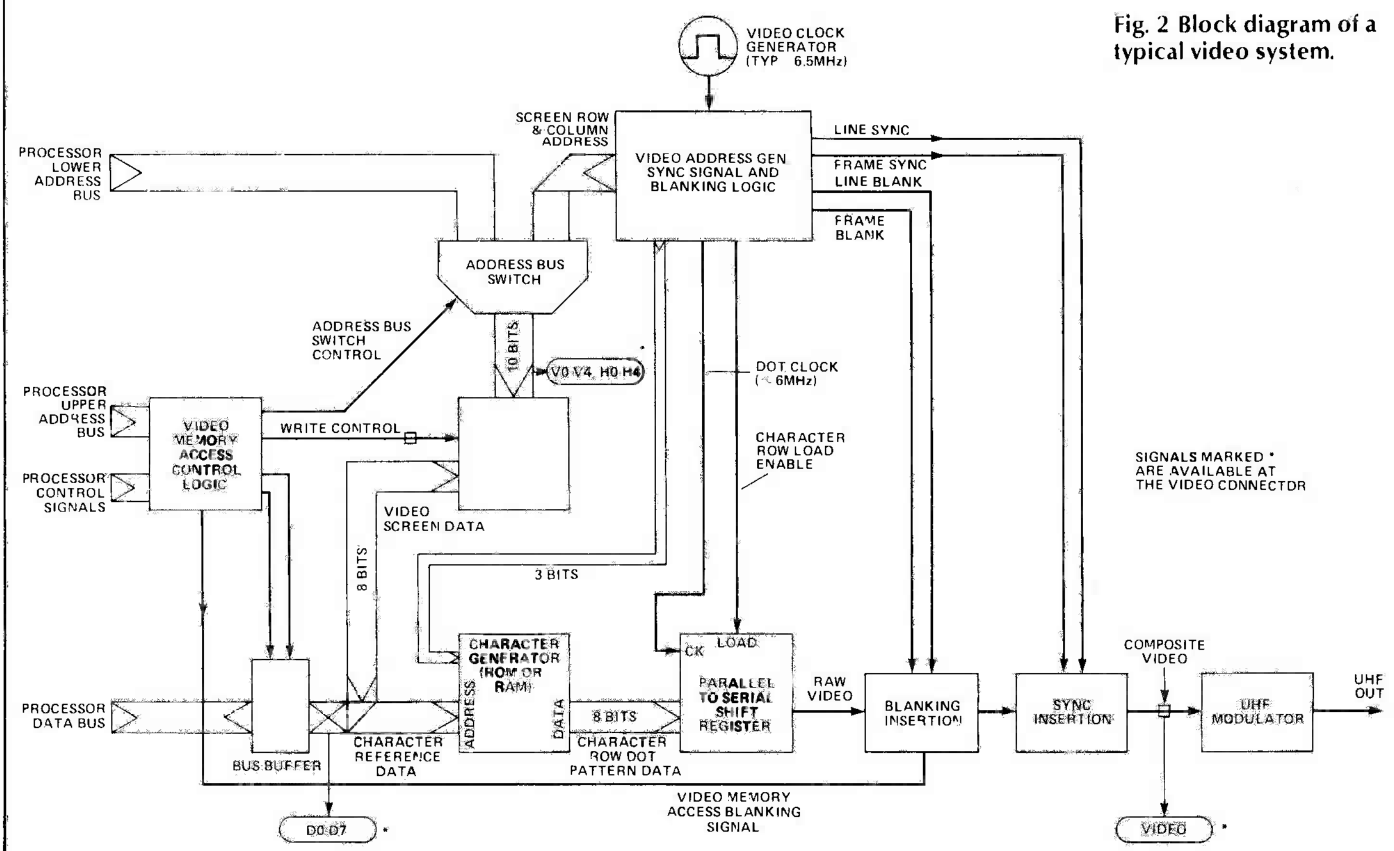


Fig. 2 Block diagram of a typical video system.

For operation in the UK and several European countries, the line period is 64μs (15.625kHz) while the frame period is 20ms (50 Hz). The line blanking period is nominally 12μs while the frame blanking lasts about 4ms.

The video address generator in the Ace provides 5 address lines in the horizontal direction and 5 more for the vertical direction. This gives a possible 32 x 32 screen of which only 32 x 24 are actually used. In addition to these 10 address lines there are three more (sometimes four in other machines) which go directly to the character generator — of which more later.

When the video system is displaying the data in the video RAM at any time the address generator supplies 10 address bits to the RAM which then supplies its eight data bits on its output pins. These are taken to the character generator device. The character generator can be either ROM or RAM and in the case of the Ace it is RAM.

In the Ace, seven of the data bits from the video RAM are used as address bits for the character generator and point to a group of eight locations in it. These locations store the dot pattern for each horizontal line of the character specified by the seven bits from the video RAM. The actual line to be displayed is selected by the three extra address lines coming from the video address generator.

The dot pattern for the line of the character to be displayed passes from the output of the character generator to a parallel input shift register. At a suitable time the data is loaded into this device and then shifted out one bit at a time to give the raw video signal. In the Ace there is an extra bit available from the video RAM which is used to invert the polarity of the raw video when it is set.

The raw video signal from the shift register is combined with the blanking signals and then the sync. signals to form the composite video signal which drives the UHF modulator.

If, as in the Ace, the character generator is not a ROM, then there must be a way for the processor to load it with the correct dot patterns when the machine is first switched on. Note that this is not shown on the block diagram.

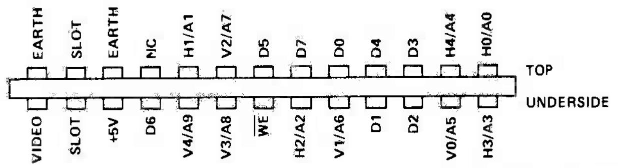


Fig. 3 Edge connector details that aren't in the manual!

there are two edge connectors, the larger of which is documented in the manual and brings out the processor busses for memory and peripheral expansion. The smaller connector is not documented, but it is intended for expansion of the video circuits and carries the video RAM address, data and $\overline{WE}$ lines as well as the composite video signal from the input to the UHF modulator.

The 1K video RAM appears twice in the Ace memory map, at 2000h-23FFh and at 2400h-27FFh. When addressed in the lower range the processor has priority over the video circuits and accesses can occur during the display period. In the higher range the video circuits have priority and processor accesses are confined to the blanking periods. The latter is the preferred situation so only the range 2400h-27FFh will be considered here.

Of this space the 768 bytes at 2400h-26FFh hold the screen data and the 255 bytes at 2701h-27FFh are used as a scratchpad by the system. According to the ACE manual, the one remaining byte at 2700h should always be zero, but this is in fact used only by the input command interpreter to mark the end of the input buffer on the screen. Therefore when a program is running, the byte can be any value provided it returns to zero before the next operation of the command interpreter. Thus the current colour attribute is held in a latch at 2700h. As a zero written to this address must not affect the contents of the latch, the most significant data bit D7 is set to 1 (by adding 128) to indicate that an attribute is to be stored.

The Circuit

The circuit consists of a six-bit current attribute latch, a 1K by 6 screen attributable RAM, a blanking section, ink/paper selector, colour encoder and UHF modulator. Both the latch and RAM are write only so it will be necessary to maintain separate variables or arrays to keep a check on their contents. In most situations, however, the value required in a particular RAM location can be derived from either its address or the contents of the video RAM at that location.

As there is no blanking signal from the edge connector, it must be re-constituted from the RAM address counters. This can be done provided processor accesses are confined to the blanking periods by using addresses 2400h-27FFh as described earlier.

The selection of ink or paper is determined by the Ace video signal. Areas of the display that are normally white are taken to be ink and black areas to be paper.

The colour encoder is based on a National Semiconductor LM1889 colour modulator chip. Although designed to work at the American colour subcarrier frequency of 3.58MHz, it will work at the UK's 4.4336MHz with suitable changes of component values. This IC requires a supply voltage of 10 to 15 volts, for which the author used a spare computer power pack which actually came with a Sinclair printer. Obviously any alternative voltage source could be used. The 5 volt supply for the UHF modulator was derived from the 12 volt line to avoid problems with noise on the logic supply.

Construction

Construction of this project is straightforward but we recommend that you do it in the following order using a fine tipped soldering iron.

Firstly, since this is a double sided PCB and is not plated through, some links must be inserted and soldered on **both** sides of the board; note especially the ten underneath IC8. Also, some component leads must be soldered on both sides.

Next fit the recommended IC sockets for IC8 and IC4. Now fit the other ICs and remember to solder the leads on the top, bottom or both sides of the board as necessary. Check this part carefully as mistakes here will be very difficult to locate. Make very sure you put ICs in the right way round as well.

Now fit the resistors, capacitors, variable resistors, variable capacitor, diodes, transistors, crystal, edge connector and UHF modulator in this order. Don't forget

The address inputs of RAM IC8, the colour attribute store, are connected to the address inputs of the Ace video RAM, H0 to H4 and V0 to V4. These lines normally carry the display horizontal and vertical character position counters, but during a processor access to the video RAM (2400h — 27FFh) they are equal to the processor address lines A0 to A9.

If the access is a write operation then the decoded write enable signal $\overline{WE}$ will go low and data from latch IC4 (via tri-state buffer IC1) will be written into IC8. The $\overline{WE}$ signal is further decoded by gates IC2 and IC3 so that data written to address 2700h will be latched in IC4 if the most significant bit D7 is high. At switch on, IC4 is cleared by R3/C5, but as this would give a colour attribute of black on black, gate IC6a (controlled by latch IC5b) inverts the green ink signal to give the default condition of green on black. Latch IC5b will be cleared when IC4 is written to, and the green ink signal will then be passed normally by IC6a.

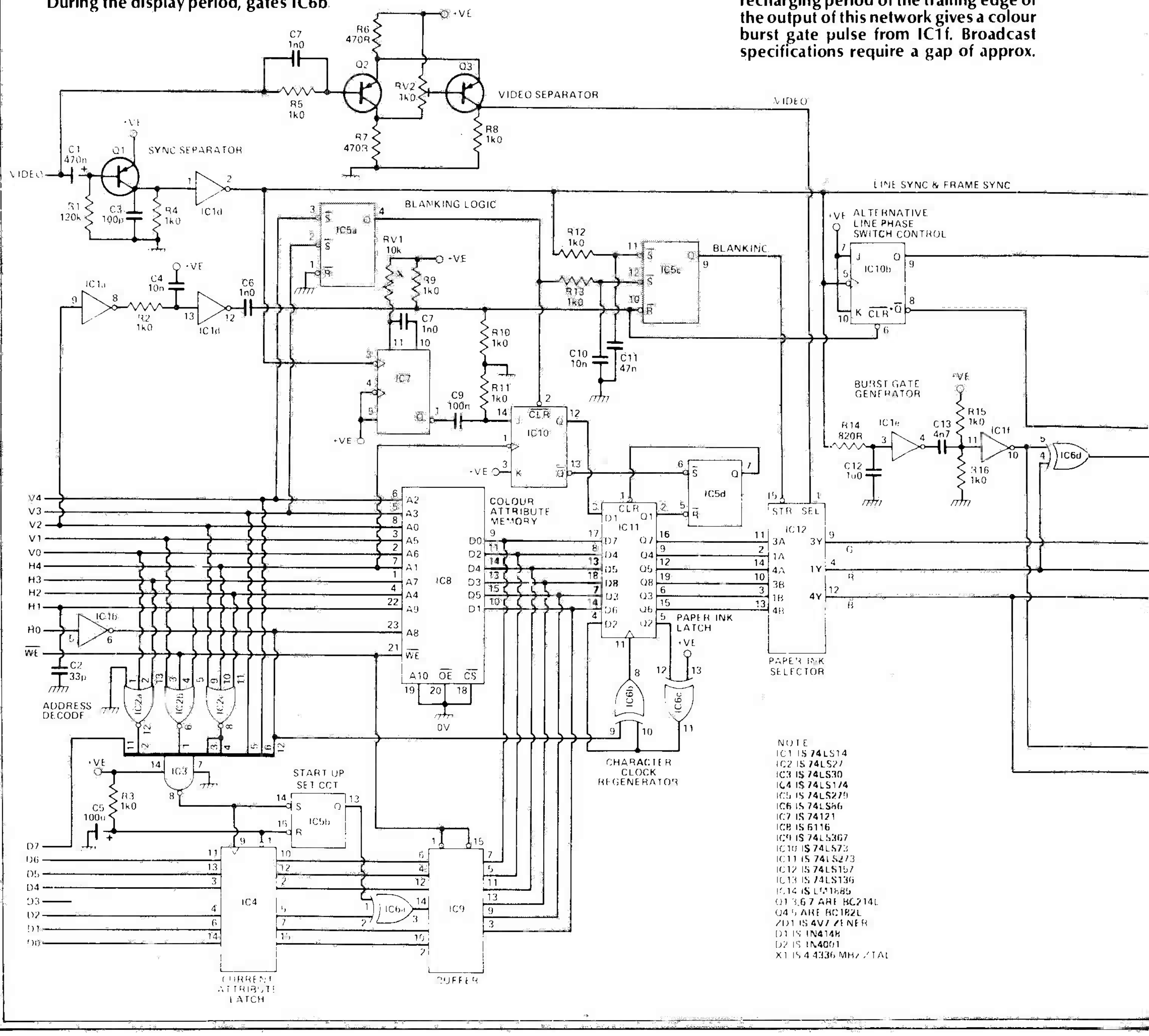
During the display period, gates IC6b and c in conjunction with output Q2 of latch IC11 produce a short clock pulse for IC11 every time address line H0 changes. As the RAM outputs change very quickly, timings here are critical so H0 is buffered by IC1b and H1 is delayed slightly by C2.

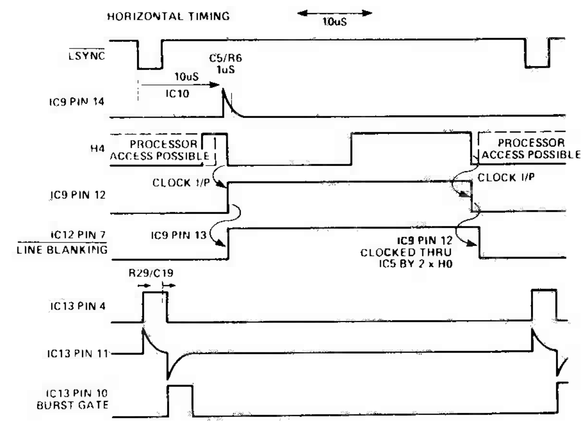
The outputs of IC11 consist of three ink bits and three paper bits for the character currently being displayed by the Ace character generator. Selection of ink or paper bits in data selector IC12 is controlled by Schmidt trigger Q2/3 from the Ace composite video signal. White areas select ink colours and black areas select paper colours. The outputs of IC12 are the red, green and blue video signals.

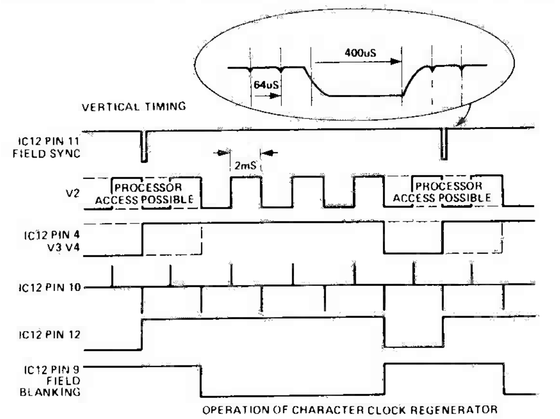
The most significant horizontal address line H4 clocks bistable IC10a on and off to provide line blanking. To ensure that any processor accesses of the video RAM during the blanking period do not lead to incorrect triggering of IC10a, monostable IC7 and differentiator R11/C9 give a short window for triggering to occur. Latch IC5d and output Q1 of IC11 serve to delay the blanking signal for the same period that the data from the RAM is delayed.

Sync. separator Q1/IC1d provides the line sync for the board from the Ace composite video signal. The sync is integrated by R12/C11 to give a field sync input to set latch IC5c, the field blanking generator. The latch is reset by a short pulse produced by differentiator C9/R9/R10 at the end of one cycle of address line V2. This allows the field display period, which ends when address lines V3 and V4 (combined in IC5a wired as a NAND gate) are both high and sets IC5c again. Integrating networks R13/C10 and R2/C4 prevent their respective signals responding to changes caused by processor accesses, as these last only about 1μs.

The line sync pulse is applied via R1d to differentiator C13/R15/R16. The recharging period of the trailing edge of the output of this network gives a colour burst gate pulse from IC1f. Broadcast specifications require a gap of approx.







OPERATION OF CHARACTER CLOCK REGENERATOR

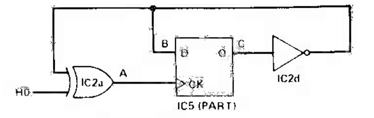
800ns between line sync and burst. This is provided by delay network R14/C12.

Bistable IC10b is clocked by the line sync to give the PAL alternating phase control. This was found to require phase locking to the field period in order to work with the author's TV so the short differentiated V2 signal at C6/R15/R10 was available to clear the bistable.

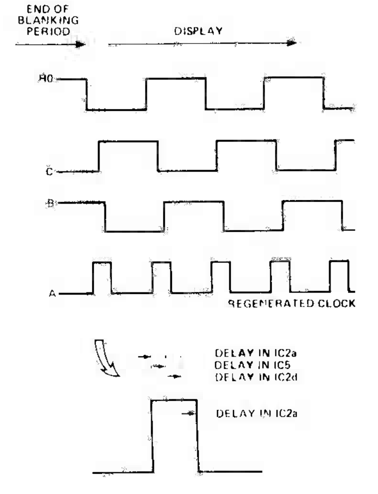
The red, green, blue and sync signals are combined in R21,30,31,36,37,38, 39 and D1 to give the composite grey-scale luminance signal. This is applied via output stage Q6 and Q7 to the UHF modulator. A relatively clean 5 volt supply for the output stages is derived from the 12 volt supply by R41/ZD1.

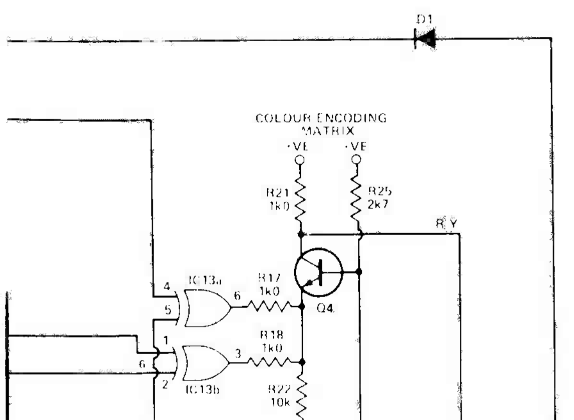
The colour subcarrier is generated by colour modulator IC13 at a frequency determined by the feedback network around pins 18 and 17, set by crystal X1 at 4.433 MHz. The phase shifting networks R33/C17 and C16/R17 ensure that the inputs at pins 1 and 18 have a phase difference of 90 to form the quadrature components of the sub-carrier. These are modulated respectively by the R-Y and B-Y colour difference signals at pins 2 and 4. For the limited range of colours to be displayed, the difference signals can be produced by algebraically subtracting the red and green and the blue and green colour signals. This is achieved by the open collector gates of IC13 switching current into the emitters of Q4 and Q5. The values of bias resistors R27/R28 and R25/R26 ensure that the zero level of the difference signals is equal to the chrome bias voltage at IC14 pin 3.

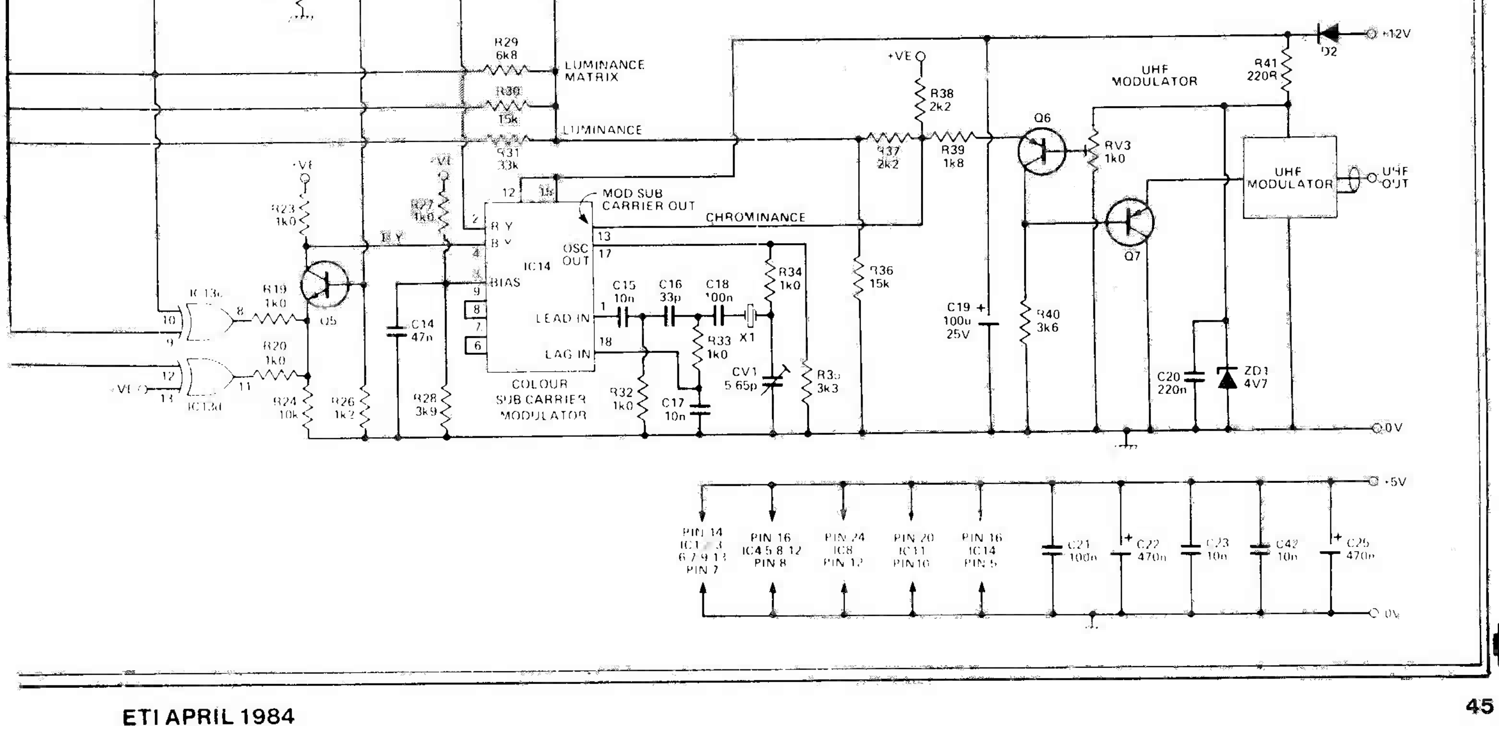
The colour burst is produced in the correct phase by mixing the burst gate pulse from IC1f with the R-Y signal in IC6d and the B-Y signal in IC13c. The phase alternation of the R-Y signal occurs in IC13b and IC13a under the control of IC10b.



REGENERATED CLOCK SIGNAL







the flying leads for the 12 volt supply.

Lastly, insert IC8 and IC14 in their sockets and all should be ready.

At this stage, **check again** carefully for shorted tracks, etc, before setting up.

If you do not get a polarising key with your piece of edge connector, either bend the contacts at the slot position in towards each other or alternatively, break the pins off very close to the rear of the connector at the correct position and pull the contact part out of the front.

Cut a small piece of PCB material or similar board and having made sure that it fits the slot in the Ace connector, glue it, preferably with a fast-acting cyanoacrylate adhesive, into the front of the edge connector. This will allow positive location of the connector into the Ace.

Setting Up

After checking the board (again!) very carefully for shorted tracks, etc plug it into the Ace, connect it to a 12 volt supply (that is switched off!), connect the TV aerial to the board and switch on all supplies. Tune in the television and a blank flickering raster should be present.

Now proceed as follows:
Turn RV1 fully clockwise.
Adjust RV3 so that the blank raster is locked.
Adjust RV2 until the whole display area brights up and set it at the mid point of its bright-up range. It may be necessary to adjust RV3 to keep the display steady. The central area of the screen should now be green. If not try re-tuning the TV.
Adjust RV1 until the cursor is visible at the bottom left.
Enter VLIST and adjust RV1 to give the boldest lettering with no streaking. Any colour dot crawl can be tuned out with CV1.
Produce colour bars by entering and running the following:

```
16 base c!
: colourbars
  2700 2400
  do
    i 4 / 8 mod
    10 * 80 or
    2700 c! 20 i c!
  loop
  87 2700 c!
  0 2700 c!
```

Adjust RV3 to give the best range of colours.

PARTS LIST

RESISTORS (all ¼W 5% unless stated)	
R1	120k
R2-5, 8-13, 15-21	
23, 27, 32-34	1k0 (22 off)
R6, 7	470
R14	820
R22, 24	10k
R25	2k7
R26	1k2
R28	3k9
R29	6k8
R30, 36	15k
R31	33k
R35	3k3
R37, 38	2k2
R39	1k8
R40	3k6
R41	220, ½W
RV1	10k 10-turn preset
RV2, 3	1k0 preset
CAPACITORS	
C1, 22, 25	470n 35V tant
C2, 16	33p
C3	100p
C4,10,15,17,23,24	10n
C5	100µ 6V3 electrolytic
C6, 7, 12	1n0
C8, 11, 14	47n
C9, 18, 21	100n
C13	4n7
C19	100µ 25V electrolytic
C20	220n
CV1	5-65p
SEMICONDUCTORS	
IC1	74LS14
IC2	74LS27
IC3	74LS30
IC4	74LS174
IC5	74LS279
IC6	74LS86
IC7	74121
IC8	6116
IC9	74LS367
IC10	74LS73
IC11	74LS273
IC12	74LS157
IC13	74LS136
IC14	LM1889
Q1-3,6,7	BC214L
Q4,5	BC182L
ZD1	4V7 zener, 500 mW
D1	1N4148
D2	1N4001
MISCELLANEOUS	
X1	4.4336 MHz crystal

UM1233 UHF modulator;13-way 0.1" double-sided edge connector; 24-pin DIL socket; 18-pin DIL socket; PCB; pins for link-throughs (if preferred); wire, etc

Software

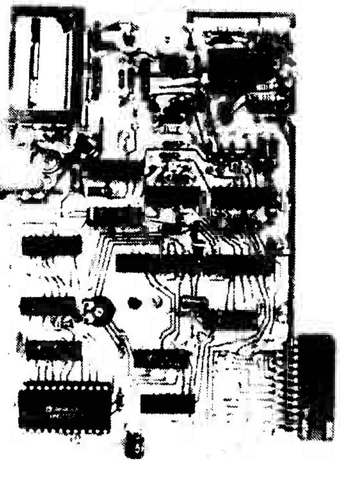
In order to use the colour facilities within FORTH programs, it is necessary to define the following words:

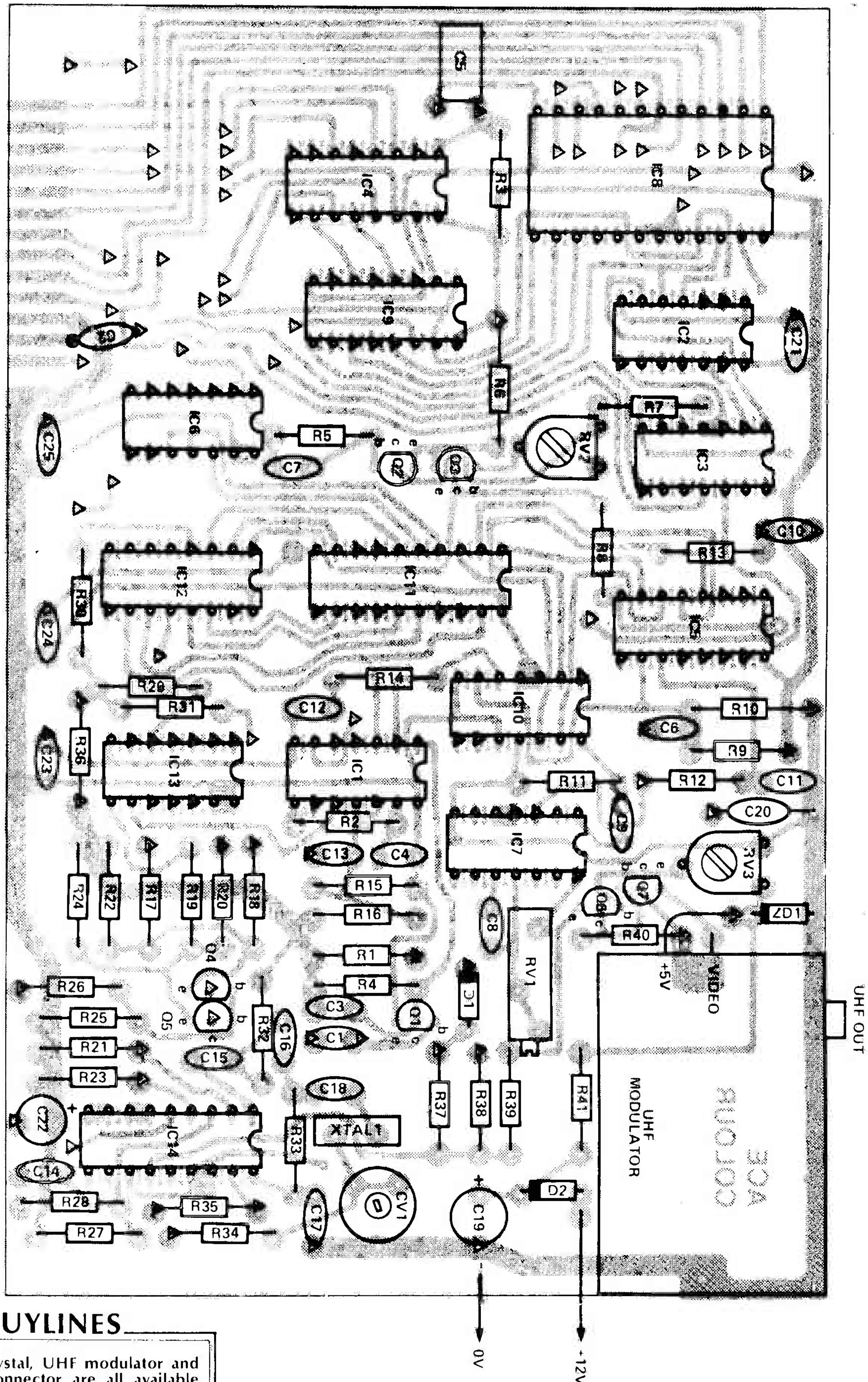
```
decimal 16 base c!
2700 constant attriblatch
0 constant black
1 constant blue
2 constant red
3 constant purple
4 constant green
5 constant cyan
6 constant yellow
7 constant white
87 variable attrib
: combine
  attrib c@ and or dup
  attrib c! attriblatch c!
  0 attriblatch c!
;
: ink
  £0 combine
;
: paper
  10 * 87 combine
;
```

By way of explanation, INK and PAPER both expect a colour number on the stack. They pass this and a mask value to COMBINE which masks out the old colour and adds the new one. This is stored in the variable ATTRIB and also in the latch. Zero is then written to the latch for the reasons given earlier.

These words can now be used directly by entering for example white paper blue ink, or they can be liberally sprinkled at the required points in applications programs.

If when you first turn on the screen is full of random colour blocks, do a CLS. This will write the current attribute (green on black) over the whole screen. Beware when you cause or allow a scroll operation to take place as this will also cause the current attribute to be written over the whole screen, wiping out all the pretty colours and giving a uniform foreground and background.





△ = SOLDERED ON BOTH SIDES (COMPONENTS AND LINKS)

● = SOLDERED TO TOP FOIL ONLY, WITH NO LEAD THROUGH

BUYLINES

The IC's, crystal, UHF modulator and the edge connector are all available from advertisers in ETI. The PCB is available from the author at 9 Lon y Garwa, Caerphilly, Mid-Glamorgan for £12 including postage.

MACHINE CODE PROGRAMMING

So you've bought this wonderful, marvelous heap of computer electronics: now how do you talk to it? I/O, I/O, it's off to work Bob Bennett goes . . . (The staff of the magazine wish to dissociate themselves from that pun.)

Every computer, no matter what its predigree, is just a handful of electronic components connected together. This constitutes the world of that particular computer and anything else belongs to the outside world. And every computer, to justify its existence, has to be able to communicate with the outside world — how else would you get information to a screen, or some other display, or to a printer, or from a keyboard?, not to mention the program going out to, or coming in from your tape recorder.

Although the method of this two-way communication may differ according to which CPU the computer has, the principle is essentially the same for every computer. An I/O port is just another name for an I/O address, and the principle is to use a register as an intermediary between the computer and the peripheral via an address. In some computer systems the method is to reserve a few addresses for I/O ports and, by using load or move instructions, transfer either the contents of the register to the port or vice versa.

In both cases the contents of the register is known as a data byte, and the above method is usually called memory-mapped I/O.

Because the Z80 set has quite a number of I/O instructions, and because the method used is slightly different, I will give examples from the Z80 set, and for the Spectrum in particular. To illustrate input port usage, let's pretend that we have just written a machine code game which places a graphics character on the screen. Whatever the object of this game is doesn't matter, but we do require to move the character about the screen using the keyboard to control the movements up, down, left and right. Page 160 of the Spectrum BASIC handbook gives a list of the eight addresses which are concerned with the keyboard input. These addresses range from 65278 to 32766, which is not surprising, because, in theory, 65,536 addresses could be used as I/O ports in the Z80 system.

The ideal keys to use for movement of our character would be the cursor control keys, but reference to page 160 shows that keys 6, 7, and 8 are input at address 61438 and key 5 is at address 63486. It would make for easier programming if all four keys were accessed at the same address so I'm going to plump for keys Y, U, I and O for up, down, left and right respectively, as these are all at address 57342. There is a misprint in the handbook which gives this address as keys P to 7, but should read P to Y. Figure 1 gives a listing in hex for the program to read the keys from input port address 57342 but I will explain what is happening. I would urge those of you who are fairly new to machine code programming to write the instructions down the side of a large ruled note pad (A4 size), with the addresses, and use appendix A of the Spectrum handbook to convert the hex to the Z80 assembler mnemonic.

The program I have given is only a small portion of our mythical program; it can be at any address, even in the printer buffer, and is called from the first address as RANDOMISE USR address. The object of this small routine is to 'capture' one of four keypresses and move the character on the screen in the direction that the key represents. However, all this program will do at present is print onto the screen the character of the key pressed.

CODE	EFFECT
3E	Load A
02	with 2
CD	Call address in ROM
01	to open stream to
16	upper 22 lines of screen
3E	Load A with high byte
DF	of port address
DB	IN A,(nn)
FE	nn = low byte of port address
CB	use instruction after CB
67	Bit 4 A, if reset then Y has been pressed
28	if Y pressed zero flag set so jump
18	forwards to print Y
CB	
5F	Bit 3,A then if Y not pressed
28	if U pressed then jump
10	to print U
CB	
57	Bit 2,A then if U not pressed
28	if I pressed then jump
08	to print I
CB	
4F	Bit 1,A then if I not pressed
20	0 has not been pressed so jump
EC	backwards to load A with high byte again
3E	Load A with code for letter 0
4F	because 0 must have been pressed to get here
D7	Print 0
C9	Return
93E	Load A with code for letter I
49	because I must have pressed to get here
D7	Print it
C9	return
3E	Load A with code for
55	letter U
D7	Print it
C9	Return
3E	Load A with code for
59	letter Y
D7	Print it
C9	
end of program	

Fig. 1 A routine to read certain keys.

Earlier I said that the data coming in, or going out, was a data byte, and we are going to test certain bits of the data. There are five keys at this particular port and bits D0 to D4 represent five keys with bit D0 for key P and working inwards on the keyboard to bit D4 for key Y (the D stands for data), so the bits we want are D4 to D1.

The first five bytes of the program open the stream to print to the first 22 line of the screen; if you want to print to the bottom two lines then load A with 1 instead of 2. Next the high byte of the port address is loaded into register A, then the instruction DB FE — IN A,(nn) where nn is the low byte of the port address, which in this case is FEh. Now the computer has the information — the port address is 57342 (keys P to Y) — and the data byte has to come into register A.

The next two bytes are CB67 — BIT 4,A. These together mean that we are going to test the current status of bit 4 in the A register and put the result into the zero flag bit of the status register. (Z flag = 1 if bit 4 of A register = 0). The following instruction 28 18 — JR Z,e, will cause a jump forward by the displacement 18h if the Z flag is set (ie. if bit 4 of the A register was 0 indicating that the 'Y' key was pressed) and print the letter 'Y'. If, however, the 'Y' key was not pressed, the jump will not take place and the next instruction executed wll be CB 5F — BIT 3,A and so on until BIT 1,A.

Note well the last conditional jump instruction, 20h — JR NZ,e, which jumps back to 3E DF to start again; this means that if none of the 4 keys are pressed the computer will wait until one is.

This program is not the most elegant of programs, and is certainly not the only way to 'read' the keyboard. The instruction DBh nn — IN A,(nn) is the first of 8 simple IN instructions, but the other seven have a slightly different form, and there are also eight simple OUT instructions which follow the same pattern of the IN instructions.

Covering the rest of the IN instructions first, they take the form IN register,(register). This means that the first register will receive the data byte, and the port address is formed from the low byte in the register in brackets, and the high byte in the other register of the register pair. To explain that, the instruction ED 78 — IN A,(C) could have been used in my program, with C loaded with FE, and B register loaded with DF, and the A register still tested for bits D4 to D1.

The first of the simple OUT instructions is D3 nn — OUT (nn),A; the other seven are of the form OUT (register), register with the register in brackets again holding the low byte, and the other one of the pair holding the high byte, the other register in the instruction being used for the data byte.

There are four fully automatic I/O instructions, two IN and two OUT, and all four are of similar pattern. The instruction ED B2h — INIR means IN (C) from address (HL) with register B holding the number of times the instruction is repeated; the address is then incremented, and B decremented, and repeated until B reaches zero. The second IN automatic instruction ED BAh — INDR which uses the same register format but with (HL) being decremented, which is what the D stands for.

Automatic OUT instructions are the same except that register C holds the data to go out to address (HL). There are two non automatic IN instructions, and two non automatic OUT instructions which follow the same pattern as the automatic instructions but the increment, or decrement (HL) is only done once, that is, the R, for Repeat, is left off, as in ED A2h — INI.

By the way, for those of you who have never met the instruction D7h — RST 10h used in the example program, it is an instruction to print the contents of the A register to the next PRINT position on the screen. ETI

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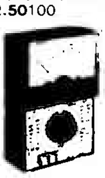

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1N4007	**7p**	78M/05/08/12/15	**50p**
1N4148	**4p**	78/05/08/12/15/18/24	**55p**
1N5401	**15p**		
1N5408	**20p**	79/12/15/18/24	**65p**

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AD149	**96p**	BC160	**30p**	BC238	**12p**	TIP3055	**60p**
AF239	**68p**	BC170	**14p**	BC300	**30p**	2N3055	**45p**
BA148	**16p**	BC182	**9p**	BC337	**12p**	2SC1306	**93p**
BC107	**10p**	BC183	**9p**	BD131/2	**34p**	2SC1909	**£1.20**
BC108	**10p**	BC184	**9p**	BFY51	**21p**	2SC1969	**£2.88**
BC109	**10p**	BC212	**9p**	BFY90	**90p**	3SK88K	**66p**

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555	**25p** 5/**£1**	TDA2030	**£2.78**	UPC1182	**£2.80**
LM324N	**55p**	TL072	**98p**	UPC1185H2	**£3.75**
LM346N	**90p**	UPC575C2	**£3.20**	UPC1212C	**£1.30**
LM380	**80p**	UPC1025H	**£2.90**	UPC1230H	**£3.90**
NE556	**80p**	UPC1158H	**76p**	UPC1373H	**£1.01**
ML231B	**£2.10**				

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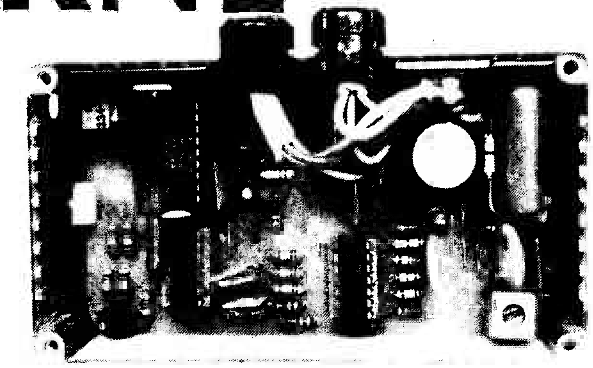
MAINS BORNE REMOTE CONTROL



Sit back and let your micro take the strain. ETI's MainsCom gives your micro remote control of any number of mains-powered devices in sixteen independent groups, and what's more, needs no extra wiring. Design by John Bawden.

Microcomputers offer some fascinating possibilities to the experimenter when used as intelligent controllers, for example, the careful control of heating, lighting, and other services in a house, which can result in enormous savings in energy and labour. The use of this type of controller is increasing both in the home and in the factory, but a major source of expense and inconvenience is the apparent need for wiring between the controller and the various devices scattered throughout a building. It has been realised for some time, that nearly every home, office and factory has a ready installed 'data bus' in the form of the mains wiring. To prove that nothing is new, the first patent suggesting this possibility was taken out in 1897. However, it is only in the last few years that the electronic devices needed to reliably and economically send and receive control signals over the mains wiring have become available.

The ETI MainsCom offers an inexpensive but reliable remote control facility, allowing a central microcomputer controller to switch mains-powered equipment on and off using only the mains wiring itself as a communications medium. The system comprises two distinct units, the transmitter and the receiver. The transmitter is interfaced to the controlling microcomputer, from which it also draws its power, and the output plugs directly into a 13A mains socket. The receiver also plugs into a 13A socket, is mains-powered, and has a 13A output socket which can be switched on and off by appropriate commands from the controlling microcomputer.

This first article discusses the operation of the system and describes the construction of the receiver unit only. Next month's concluding article will describe the transmitter, the procedure for interfacing with a microcomputer, and the alignment and operation of the completed system.

As with cordless intercoms, which also rely on the mains wiring for their interconnections, the MainsCom uses a frequency modulated carrier to convey the controlling data stream. The well known tolerance of FM signalling to noise and to signal level variation comes in useful in this application. The control data is generated and decoded by standard remote control ICs, manufactured by Plessey, which incorporate error detection logic to minimise the possibility of spurious switching occuring as a result of noise.

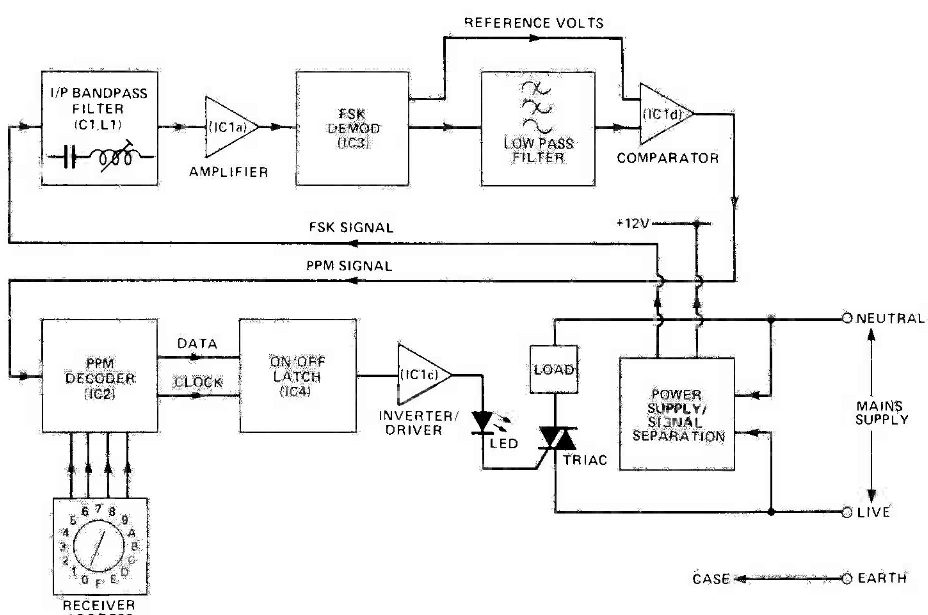


Fig. 1 Block diagram of the receiver unit.

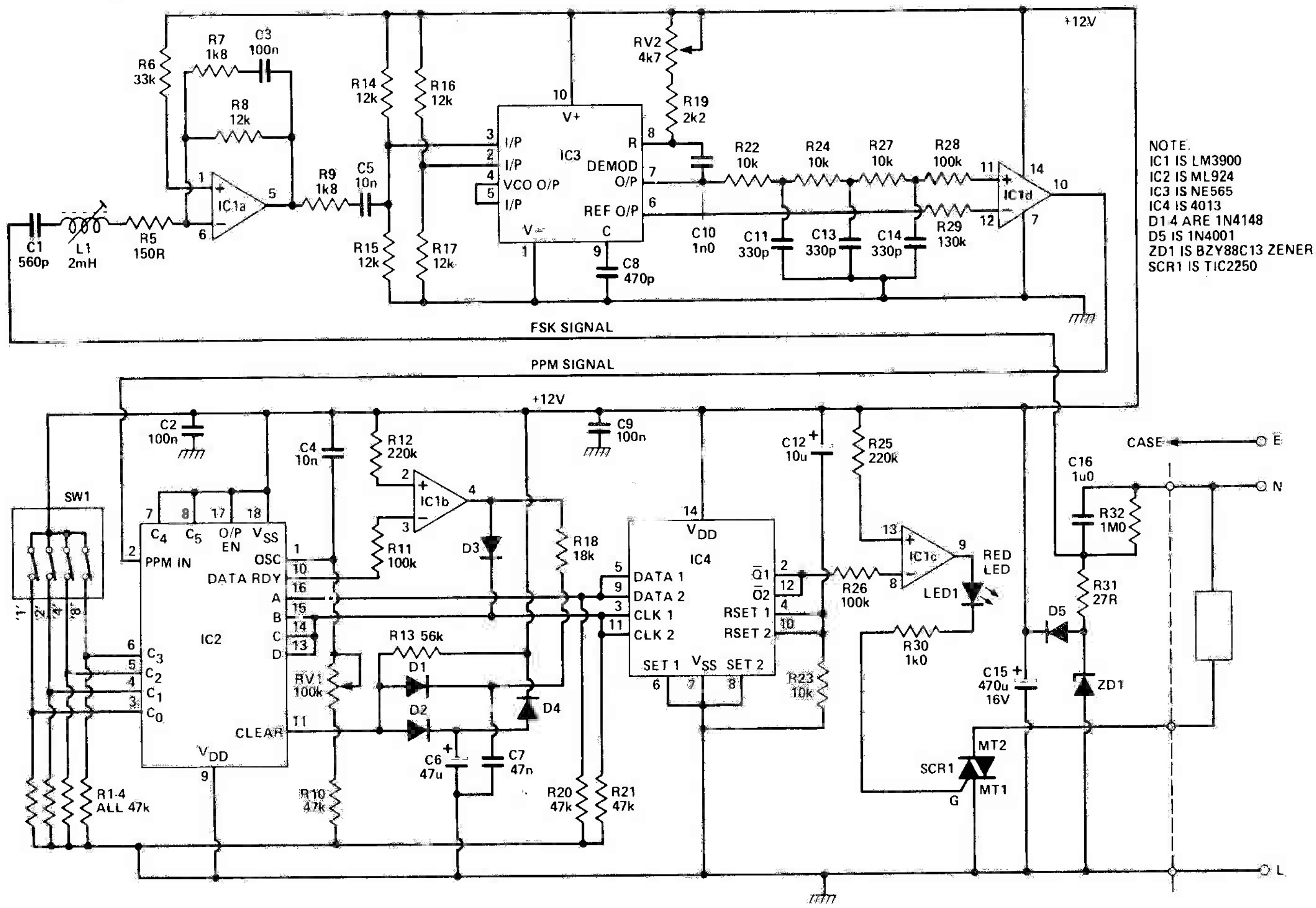


Fig. 2 Circuit diagram of the receiver.

The System

The only desirable features of mains wiring as a transmission channel are that it already exists and that it will serve most areas of a home, office or factory. Electronically it is a low impedance transmission line with unpredictable and varying loss, and which is subject to high levels of broadband noise. Frequency Shift Keying (the digital equivalent of FM) is used in the MainsCom system because of its resiliance under these conditions of varying signal level and impulsive noise.

A carrier frequency of approximately 130 KHz is employed as this is outside the range of most souces of interference, such as harmonics of the mains frequency below and the LF and MF radio transmissions above. The upper range of frequencies must also be avoided so that MainsCom does not cause interference to these services. The chosen frequency is also within the band (125-140 KHz) proposed by the Control Equipment Manufacturers Association for use in this type of application. A deviation of about 10KHz is used, which is relatively wide compared with the bandwidth of the data signal. However, this does provide the high level of noise protection associated with broadband FM.

The system design is simplified by the use of a pair of ICs specifically designed for remote control applications, the Plessey SL490 PPM (Pulse Position Modulation) transmitter and the ML924 receiver. The transmitter uses the SL490 device as a PPM encoder. This device, which employs I^2L bipolar logic, is designed to be connected directly to a cross point matrix keyboard. Interface logic is therefore required to enable the use of a parallel binary signal from a microcomputer port, and the devices used to perform this function are two CMOS analogue switches. These accept logic level inputs and appear to the SL490 as a switch closure. The apparent position of the switch in the matrix is determined by the binary number fed into the inputs of the CMOS switches. The PPM output of the SL490 drives the frequency shift modulator. This is an NE565, more commonly encountered as a Phase Locked Loop decoder, but which can also be persuaded to act as a frequency modulator.

The frequency keyed carrier need only be of a relatively low power to be effective. About 1 watt is sufficient and a higher level would risk interference to other services, such as MF and HF radio broadcasts. A power amplifier stage is needed to amplify the output of the frequency shift keyer and to match this to the low impedance of the mains wiring. At the frequency used, this is in the region of 10 ohms. The power amplifier uses a pair of VMOS transistors, operating in class C push-pull, and matched to the mains wiring by a tuned output transformer. This is an efficient and rugged output configuration which can withstand the large transients sometimes coupled into this stage from the mains wiring. The output state is interfaced with the frequency shift keyer by some CMOS gates. These provide carrier on/off switching and correctly timed pulses to drive the output transistors.

The MainsCom receiver uses four ICs to provide the functions of input amplifier, FSK demodulator, PPM decoder and on/off latch. The latched on/off signal within the receiver is used to drive

HOW IT WORKS — THE RECEIVER

The MainsCom receiver is powered by a 'wattless' dropper arrangement, comprising C16, R31 and ZD1. The reactive current flowing through C16 results in 13 volts appearing across ZD1 during every other half cycle of current flow. This pulse train is converted into a steady supply voltage of about 12 Volts by D6 and C15. The advantage of this type of power supply is that it is an efficient way of obtaining a small amount of low voltage power, without the expense and bulk of a mains transformer, and is probably more efficient than the latter. Efficiency and low power consumption are important considerations in a piece of equipment which is likely to be running continuously over long periods. R31 serves as a surge suppression resistor and also as a fuse in case of the failure of C16. It is important that only the stated wattage of resistor is used in this position. R32 discharges C16 when the unit is disconnected from the mains supply and prevents the possibility of minor, but unpleasant, shocks from the mains plug. The power supply in this unit also serves two less obvious functions. It acts firstly as a snubber network to reduce mains borne transients, which could damage the triac. Its other role is as a high-pass filter to extract the FM carrier from the incoming mains.

The filtered high frequency signals, which appear across line and neutral, contain the FM control signal as well as a lot of noise. These are fed to the input of IC1a via a series tuned LC filter, L1 and C1. This filter is tuned to the centre frequency of the FM signal and separates this signal from HF noise. IC1a amplifies this signal before passing it on to IC3, a standard phase locked loop FM demodulator. The centre frequency of the demodulator is set by C8 and R19 with RV2. The differential output of IC3 is fed through a low pass filter network to the input of IC1d. This section of IC1 acts as a comparator, and converts the low level differential output of IC3 into a 12 volt digital signal, which is the transmitted data stream.

This PPM data stream forms the input to IC2, the PPM decoder. The 'C4' and 'C5' inputs of this IC are strapped to logic high in order to select the desired operating mode and the 4 bit address of the receiver is set up on the 'CO', 'C1', 'C2', and 'C3' inputs by means of SW1, or by hard-wired links. When it has received a valid sequence of address and data messages, IC2 will pulse the DATA READY output high and place the bit pattern from the data message onto the outputs A to D. The internal clock frequency used to time the reception of the PPM data is set by C4 and R10/RV1.

The DATA READY pulse from IC2 is inverted by IC1b to produce a low going clock pulse. The output of IC1b is combined with the B, C, and D outputs of IC2 by wired-OR logic, via D3. This ensures that the clock pulse to IC4 will not occur unless these data outputs are all simultaneously logic 0. This clock pulse is used to latch the logic level appearing on the A output of IC2 into IC4, IC4 is a dual D-type latch with both halves connected in parallel.

The output of IC1b will also reset IC2, a short interval after the receipt of the DATA READY signal, by pulling the CLEAR input low. This ensures that the receiver will require another address message before responding to other data messages. D1, D2, and C6 form a circuit that resets IC2 at power up. A similar function is carried out by C12 and R13 which clear IC4 on power up. This ensures that the MainsCom receiver always comes on in the 'off' state.

The NOT Q outputs of IC4 provide the input to IC1c, which is used as an inverter and driver. The output of IC1b has sufficient current source capability in the high state to light the indicator LED and to switch on the high sensitivity triac, SCR1. The triac, in turn, controls the flow of power to the load attached to the MainsCom system.

a triac which can be used to control an external mains load. Alternatively, the on/off signal can be used directly as a logic level for remote control purposes. The receiver employs a reactive power supply, resulting in a lightweight unit with low power consumptions that can be built into a small diecast box.

Each receiver can be allocated a four bit address code that allows up to 16 'addresses' to be selectively switched on or off. The address code in each receiver can be set permanently by wire links, or can be reset if hexadecimally coded switches are fitted. Several receivers can share an address code, to form a group that can be switched simultaneously.

Pulse Position Modulation

In a PPM transmission, a 1 or 0 is transmitted not by the presence of absence of a pulse as would be the case with more conventional digital coding, but by the use of two different lengths of interpulse time to indicate the binary states. The ICs used in this system employ codes based on 5 bit words,s o that each word requires the transmission of 6 pulses to generate the 5 interpulse periods (Fig. 3). A short interpulse gap signals a logic 1, and a longer gap a logic 0. To enable a receiver to correctly 'frame' the incoming stream of bits into 5 bit words, an even longer gap is used to signal the gap between words.

The ICs used to receive the PPM data stream use an internal oscillator and a counter to time the periods between pulses. Inside the receiving IC, the leading edge of each PPM pulse resets the counter. The state of the counter, when the leading edge of the next pulse comes along, is used to set the timing windows which determine the difference between 1s, 0s and interword markers. Any pulse appearing before the counter has reached 20 is ignored as this is likely to be the result of external noise or multipath reception with some types of remote control. A pulse appearing whilst the count is between 20 and 32 is taken to represent a logic 1, and if it is between 32 and 60, it represents a logic 0. An interpulse period of over 60 clock periods is seen as an interword gap and the receiver logic resets the counter and internal error detection logic if the count reaches 1220 without the appearance of a pulse.

The frequency of the receive IC's internal oscillator is set by an external RC network which should be adjusted so that 40 cycles of its output occur in the period used to represent a logic 0. A logic 1 interpulse period will then equal 26.6 cycles. This setting will place the incoming pulses generally in the receiver's timing window and provide an allowance for frequency drift in the PPM transmitter and receiver devices.

The receiver ICs in this family of devices use a simple and effective method of error checking. The last PPM word received is stored and compared with the one currently being decoded. If the words are the same, only then is the word accepted as a valid message. This does mean that any message must consist of a PPM word transmitted at least twice, so that two consecutive and identical words can be seen by the receiver.

The ML924, which is used in the MainsCom receivers, can be used

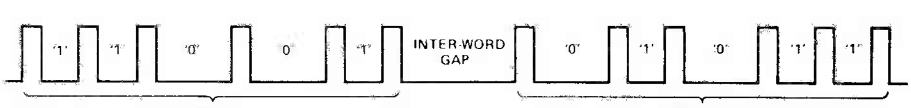


Fig. 3 Data format used in Pulse Position Modulation (PPM).

in several modes, one of which is this simple mode where the receipt of a valid message consisting of two indentical words will result in the 5 bit data pattern apperaring on its A, B, C, and D outputs and the Data Ready output being pulse high. In the MainsCom receiver, a more complex mode of operation is used, in which the IC must be activated by the receipt of an 'address' message before it can accept one or more 'data' messages. As with the simpler mode of operation, each of these messages must be at least two consecutive, identical PPM words. An address message is distinguished by having a most significant bit of 0, and data messages by having a most significant bit of 1.

The addressable mode gives additional security against unwanted messages being generated by noise, since two valid messages in the correct order are necessary. The second advantage of using this mode is that individual receivers or groups of receivers can be selected to receive the message code. The address messages must have a 0 for their most significant bit, but the remaining four bits form an address code which must match the four bits set up on the C0 to C3 inputs of the ML924. An ML924, in the addressed state, will be deactivated if it receives an address message with the wrong address code.

In the MainsCom receiver, additional logic external to the ML924 resets this devices a short while after the receipt of any data message. This is done so that the receiver is not left in an active addressed state where there would be a remote possibility that it could respond to random noise or garbled message and spuriously switch on or off.

Construction

The receiver is built on a small printed circuit board, and this is mounted in a suitably sized diecast box. The diecast box forms a robust enclosure for this unit, an important factor in an item of equipment which could end up in odd corners of the home or office and suffer indignities such as being trodden on. The box acts also as an electrical shield for the unit within, which is connected directly to the mains supply. For this reason the box should always be earthed.

The printed circuit board is held in place at each end by a pair of plastic clip-type support pillars. These provide ample spacing between the printed circuit board assembly and the bottom of the box. The clearance between the edges of the PCB and the sides of the box is very small and to prevent the possibility of short circuits between them, two suitably

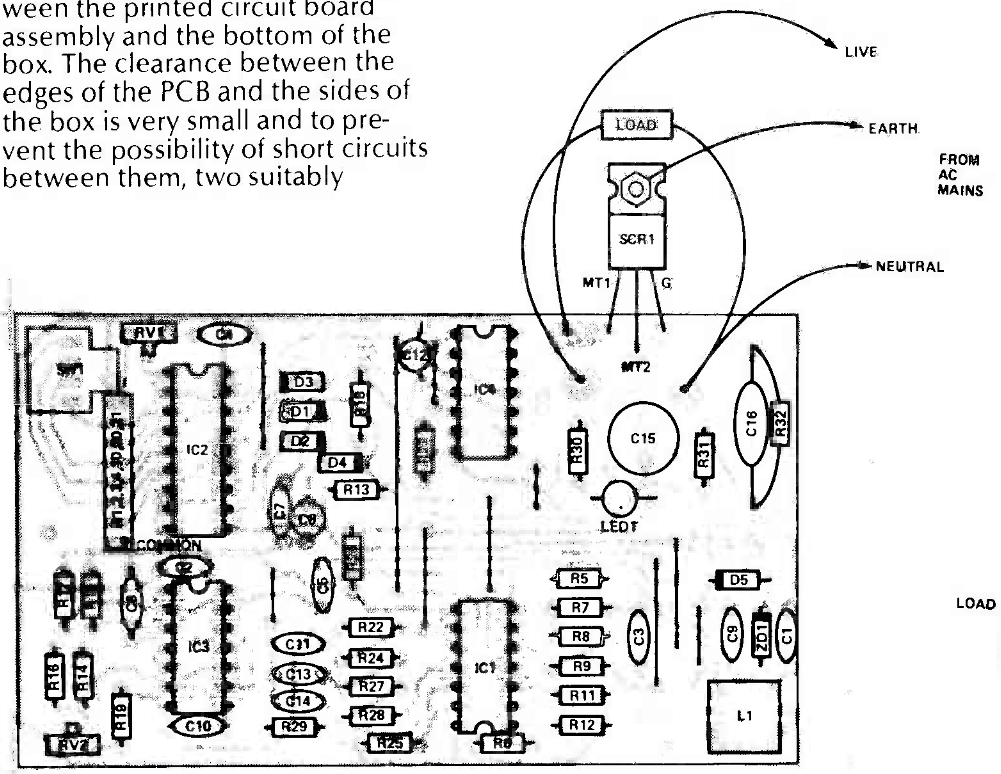


Fig. 4 Component overlay of the receiver PCB.

PARTS LIST — THE RECEIVER

RESISTORS	
(All resistors ¼ W, 5% unless otherwise stated)	
R1-4,10,20,21	7 x 47k SIL resistor pack
R5	150R
R6	33k
R7,9	1k8
R8,14-17	12k
R11,26,28	100k
R13	56k
R18	18k
R19	2k2
R22-24,27	10k
R12,25	220k
R29	130k
R30	1k
R31	27R 0.5 watt metal film
R32	1M0
RV1	100k vertical preset
RV2	4k7 vertical preset
CAPACITORS	
C1	560pF 2% silver mica or polystyrene
C2,3,9	100n 100V ceramic
C4,5	10n 100V ceramic
C6	4.7u 10V tantalum
C7	47n 100V ceramic
C8	470pF 2% silver mica or polystyrene
C10	1n0 100V ceramic
C11,13,14	330pF 2% silver mica or polystyrene
C12	10u 10V tantalum
C15	470u 16V radial electrolytic
C16	1u0 400V DC polyester or paper
SEMICONDUCTORS	
IC1	LM3900
IC2	ML924
IC3	NE565
IC4	4013
D1-4	1N4148
D5	1N4001
ZD1	BZY88-C13
LED1	0.2" red LED
SCR1	TIC-225D (for alternatives, see text)
MISCELLANEOUS	
SW1	Vertical hexadecimal coded rotary switch (RS Components 334-959)
L1	2mH variable inductor TOKO P/No. YXNS30450NK

IC sockets (high quality turned pin type); diecast box, Bimbox 5004/14 or Verospeed P/No. 86-20102B; 13A free socket; 13A mains plug; 3 core mains cable; strain relief bushes; PCB clips; mylar film; triac mounting kit, nut, bolt, etc.

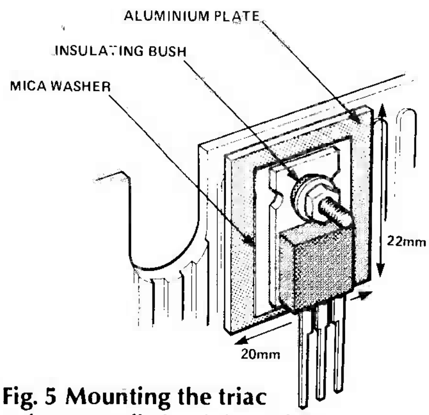


Fig. 5 Mounting the triac using a small aluminium plate.

shaped strips of mylar film are slipped between the PCB and the box. This type of film has a high dielectric strength and is easily obtainable in the form of PCB draughting material.

The triac, SCR1, is situated at the edge of the PCB and uses the diecast box as a convenient heat sink. The type of box recommended has a ridged internal surface to facilitate the vertical mounting of printed circuit boards. This is a nuisance in this instance as it prevents close contact between the triac and the box and will not permit efficient heat transfer, a small rectangle of aluminium sheet, drilled to take the triac mounting bolt and placed between the triac mounting tab and the box, will overcome the problem of heat transfer. The usual mica washer and insulating bush must also be used in mounting the triac to provide electrical isolation (see Fig. 5).

Assembly of components on the PCB should pose few problems if the points listed below are noted. The ICs can be soldered directly to the board, but test and maintenance of the unit is much easier if sockets are employed. If these sockets are of a high quality type, their use will have little effect on the reliability of the unit. Note that IC1 is mounted in the opposite direction to the other three ICs.

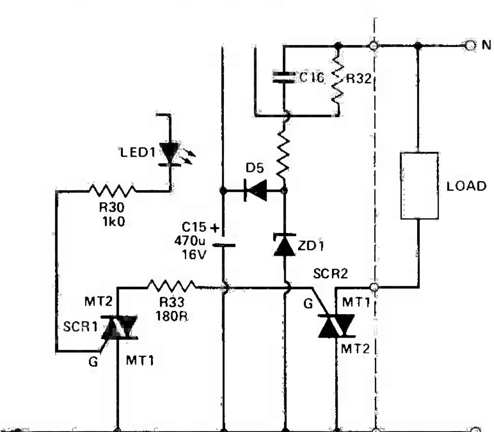


Fig. 6 The modification required to drive high power triacs.

Two components have critical lead lengths. LED 1 must have its leads dressed so that it protrudes through the hole in the lid of the box; the top part of a plastic LED mounting clip, secured to the lid with a drop of instant adhesive, will hold the LED tidily in place when the lid is fitted. The leads of SCR1 should be carefully dressed so that the hole in the triac's mounting tab coincides with the hole drilled in the side of the box. The leads should be bent in an S-shape in order to cushion the triac from any vibration of the PCB.

Veropins, or something similar, are used to provide the live and neutral terminals on the PCB for the incoming and outgoing mains connections. The mains cable connections should be soldered to these pins prior to fitting the PCB into the box. If not done in this order, access to the pins is difficult. For the same reason, test and adjustment of the receiver unit should be completed prior to the fitting of the PCB.

The earth connections of the input and output mains cables are soldered to a tag. This tag is secured under the nut used to mount the triac tab and the electrical connection via the bolt serves to earth the box. The two mains cables coming to the receiver unit are led into the box through cable clamps held in U-shaped cut-outs in the side of the box. The clamps are compressed onto the cable and are themselves held in place by the lid of the box being screwed down.

If a hexadecimal switch has been fitted to set the receiver address, then a small hole, just large enough to take a screwdriver, can be drilled in the end of the box to allow the address to be changed without opening the box.

The current available from the capacitive dropper power supply used in this unit cannot produce sufficient gate current to guarantee triggering of all TIC225D triacs. A small proportion of this type of device will not trigger reliably. The usual symptom of this will be that the triac conducts on alternate half cycles only. The fitting of another triac of the same type will, unless you are unlucky, remove this problem. If the load to be controlled draws less than 4 Amps RMS, a TIC206D triac can be substituted as SCR1. This has a lower gate current threshold than the

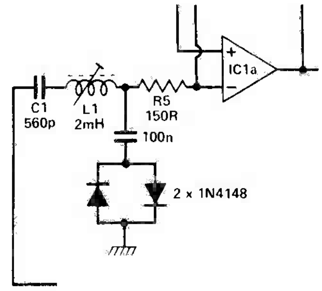


Fig. 7 A modification which will reduce the risk of spurious switching.

TIC225D and all devices of this type should operate satisfactorily in this circuit.

If the receiver is required to control loads drawing more than the 8 amps RMS, which is the maximum that a TIC225D can control, then a variation on the basic receiver circuit may be used. This is shown in Fig. 6. The limitation on the size of power triac that can be used is the gate current required to switch it on. This should be less than 300 milliamps. Therefore, a second low power triac, SCR2, is added to trigger a high power triac, such as a TIC246D which can control up to 16 amps RMS. The additional triac can be a very low power device in a small package, such as a TAG 93D, or a TR1 400-0.35.

If a direct digital output is required from the receiver, rather than the switching of a mains supply, SCR1 can be omitted and an opto-isolator connected between R30 and common. The output of the opto-isolator can then be used as a remotely controlled digital signal. The type of opto-isolator employed should be a high sensitivity type, as the current available to drive it is only of the order of 10 milliamps.

A problem arose in the prototypes of this unit when certain brands of LM3900 were used for IC1. The problem was that the receiver would spuriously switch off the load when large surges occurred in the connected mains wiring. In one instance, this resulted in a television receiver being switched on by the Mains-Com receiver, and then a fraction of a second later being switched off again. The most reliable cure for this was found to be the addition of the components shown in Fig. 7. The capacitor is a 100n, 100V ceramic and the diodes are 1N4148. These can easily be soldered onto the track side of the PCB, but must be kept well clear of the bottom of the box.

Next month, transmitter details and Buylines.

ETI

SCHOOL TIMER

What? you cry! Not another timer circuit using a 555! Well, yes, but the actual timing here is carried out by a less well known and much more interesting IC. Vivian Capel takes care of the introductions.

Timer circuits and projects are not particularly unusual, but this one was designed in response to a request and for a specific purpose.

It was required for a training school to time the speaking assignments of the students, and also those of the instructors. In the case of the students, an audible signal was required at the end of the assigned time which would sound for about two seconds and then stop. For the instructors, the timing signal had to be less obvious, and took the form of a light which could be seen from the rostrum but was not generally visible to the class. The light would remain on until cancelld by the operator. In addition, a warning light was required. This would come on 2 minutes from the end of the set time and remain on until the time had expired, whereupon it would go out and the 'time up' light come on.

At first, the cheap, plentiful and reliable 555 timer was considered for the basic timing circuit, but rejected due to the long interval required to be timed. Instead, the ZN1034E precision timer was used. This IC is well suited to applications requiring long time delays because it incorporates a 12 stage binary divider. The divider output changes state only after 4095 oscillator cycles, allowing a higher oscillator frequency and hence smaller timing components to be used than would be the case were a 555 used to provide a similar delay. The ZN1034E also has an internal shunt regulator which removes the need for external supply regulation, a further regulator giving a 2.5V output to feed the RC timing network, and TTL compatible complementary outputs.

In order to obtain the two minute warning facility required in this application, two separate timing circuits are employed each based on a ZN1034E. The first circuit has a delay which can be varied from five minutes to forty-four minutes in steps of 1 minute. The delay is selected on two rotary switches, one having increments of 1 minute and the other having increments of 10 minutes. In fact, the switching is so arranged that the delay is always two minutes less than that selected. At the end of the timing period, a warning light is switched on and the second timing circuit triggered. The second circuit is similar but has a fixed delay of two minutes. At the end of this time, the warning light is extinguished and a 'time up' light comes on. Alternatively, the lights can be switched out of circuit and an audible alarm substituted. In this case there is no two minute warning, the first timing circuit merely triggering the second.

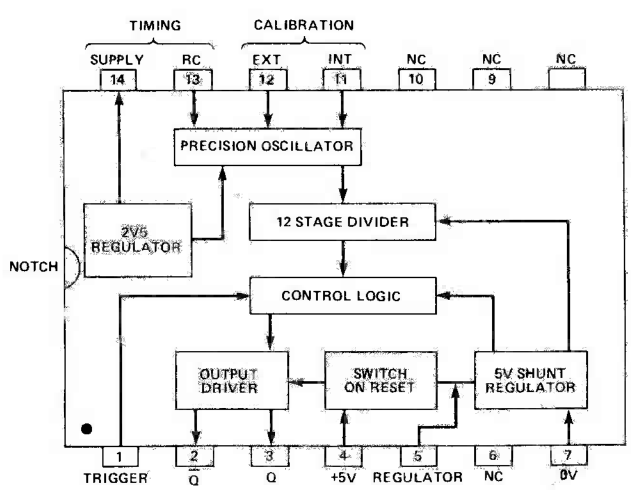


Fig. 1 Internal block diagram of the ZN1034E.

Construction

Everything assembles onto the PCB except the loudspeaker, the range setting resistors, the indicator lamps, the LEDs, the transformer and the switches. Nothing on the PCB should cause any problems, but take the usual care with ICs, the electrolytic capacitors, the transistors and the diodes, all of which must be inserted the right way around. We recommend that you use sockets for the ICs, but this is not essential. No case has been described since the original was built as a module only and was mounted in the PA desk.

The timing range resistors should be soldered directly to the two rotary switches. We have specified ordinary carbon resistors in the parts list but if a high level of timing accuracy is required you would do better to use 1% types, preferably metal film since these have a low temperature coefficient. The design exceeds the original requirements slightly in providing for delays of up to forty-four minutes rather than thirty, but it is quite easy to extend the timing range further should you wish to. Further resistance can be introduced between pins 13 and 14 of IC1, but note that the total should not exceed 5 Mohm or the circuit operation may become unreliable. As the circuit stands, the total is a little over 1.6 Mohm. If even longer timing periods are required, you could try increasing the value of C1. The formula for calculating the required values is RC = 21.94T, where R is resistance in k ohms, C is capacitance in uF, and T is time in minutes. This formula

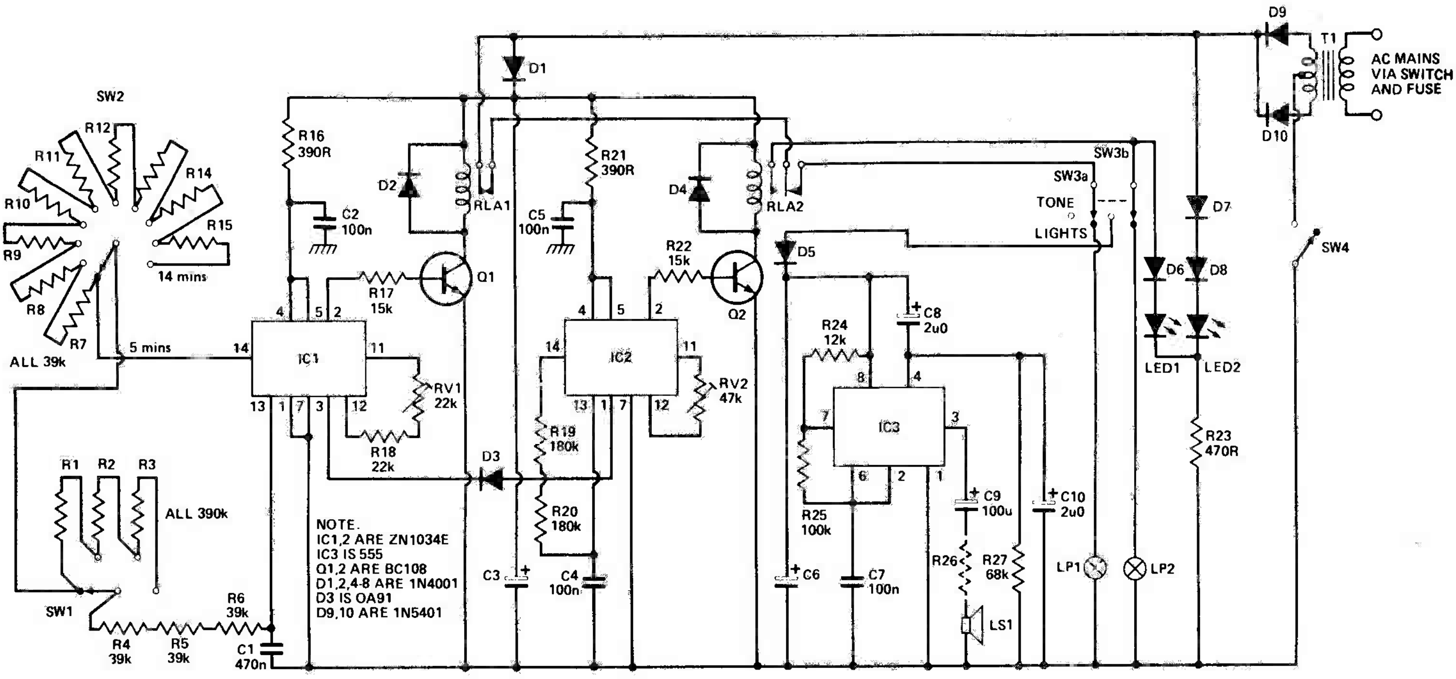


Fig. 2 Circuit diagram of the School Timer.

only applies when the calibration resistance, ie, the resistance between pins 11 and 12 or RV1 and R18 in the circuit, is approximately 47k.

The lamps used in the prototype were a combination indicator/stop/tail lamp set intended for use on caravans and purchased from a motor accessory shop. The amber indicator lamp was used for the two-minute warning and the red combined stop and tail lamp was used for the 'time up' indication. The unit came ready fitted with bulbs, a 21 watt bulb in the indicator section and a 21 + 5 watt bulb in the stop and tail section. The 5 watt section was simply left unconnected.

The loudspeaker should ideally have an impedance of 70 ohms, but an 80 ohm type will work quite satisfactorily. A lower impedance speaker could be used provided a series resistance was added to raise the overall impedance to about 70 ohm, but this would result in less power being available for the loudspeaker. Provision has been made on the PCB for such a resistance to be used (R26) and if it is not needed you should insert a link in this position.

Setting Up

When the construction is complete and the board has been tested and found to work approximately to time, the two presets can be adjusted to set the timing accurately. Start with RV1 and set the five minute range, timing three minutes until the warning lamp comes on. Then set SW2 to fourteen minutes and time the delay for twelve minutes until the warning light comes on. Readjust RV1 if necessary and then check the five minute range again. Some compromise may be required depending upon the accuracy of the range-setting resistors used. The preset affects the fourteen minute setting more than the five minute setting, so make the last adjustment on this range.

The required 47k calibration resistance is split into two parts for this IC, RV1 itself which is 22k and a fixed 22k resistor, R18. If it is found that the required setting is too near one end of the preset or is not on the preset at all, the preset and the fixed resistance can be exchanged for other values.

Having got the five to fourteen minute range working correctly, set SW2 back to five minutes and set SW1 to ten minutes. Start the

PARTS LIST

RESISTORS (all ¼W 5% unless otherwise stated)	
R1, 2, 3	390k (see text)
R4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	39k (see text)
R16, 21	390R
R17, 22	15k
R18	22k
R19, 20	180k (see text)
R23	470R
R24	12k
R25	100k
R26	see text
R27	68k
RV1	22k horizontal skeleton preset
RV1	47k horizontal skeleton preset
CAPACITORS	
C1	470n polycarbonate
C2, 5, 7	100n
C3	2200u 25v radial electrolytic
C6	
C8, 10	2u0 16V radial electrolytic
C9	100u 16v radial electrolytic

SEMICONDUCTORS	
IC1, 2	ZN1034E
IC3	555
Q1, 2	BC108
D 1, 2, 4, 5, 6, 7, 8	1N4001
D3	0A91
D 9, 10	1N5401
LED1	0.2" red LED
LED2	0.2" green LED
MISCELLANEOUS	
SW1	1 pole, 4 way rotary switch
SW2	1 pole, 10 way rotary switch
SW3	DPDT switch, any type
SW4	SPST switch, any type
T1	9-0-9V, 2A mains transformer
LS1	Eagle type TP26G or any speaker of 30 — 80 ohms
RLA1, 2	miniature PC mounting relay, 12V 400R coil

PCB; combination indicator/stop/tail lamp assembly, Sedan Car Accessories type CL845-S00 or similar; 2 off 14 pin and one off 8 pin DIL sockets; knobs for SW1, 2.

HOW IT WORKS

The output from the secondary of T1 is full-wave rectified by D9 and D10 to give a pulsed DC supply of about 12-13V peak. This is then passed via D1 to the reservoir capacitor, C3, to give a smoothed supply of about 12V. The pulsed DC is used to power the two 21W indicator lamps while the smoothed supply feeds the ICs, the use of two separate rails ensuring that the heavy surge currents drawn by the lamps do not upset the timing circuits. ICs 1 and 2 contain internal 5V shunt regulators, and the supply to these is dropped by R16 and R21 and decoupled by C2 and C5.

IC1 is a ZN1034E precision timer. Pin 4 is the switch-on reset and this coupled to pin 5, the regulator input, so that it is held high while timing is in progress. A second internal regulator provides 2.5V via pin 14 to feed the RC network, comprising C1 and resistors R1 to R15. The RC network sets the frequency of the internal oscillator, and 39k and 390k values used here correspond to 1 minute and 10 minutes respectively with the given value of C1, 470nF. R4, 5 and 6 are always in circuit, giving a period of three minutes when SW2 is at its lowest setting, 5 minutes. SW1 and SW2 are so arranged that the timing period is always two minutes less than the period selected. The oscillator frequency is also controlled by an internal resistor so as to ensure temperature stability, but this is trimmed by RV1 to provide fine adjustment.

The oscillator output is fed to a 12 stage binary counter, also on the chip, which triggers the output stage via control logic after 4095 counts. Both active low and active high outputs are provided; pin 2 goes high at the end of the timing period and drives Q1 via R17, thus activating relay RLA1 which connects LP1 to the pulsed DC supply rail. Pin 3 goes low at the end of the timing period, triggering IC2 via D3. D4 prevents back EMF damaging the transistor.

IC2 is also a ZN103E and functions in exactly the same manner as IC1, except that here the timing period is fixed at two minutes by R19, R20 and C4. RV2 allows for fine adjustment of the oscillator frequency and hence the timing period. Pin 2 of IC2 goes high at the end of the timing period and drives Q2 via R22, activating RLA2. RLA2 switches over, breaking the connection to LP1 and connecting the pulsed DC supply to LP2 and circuit comprising D5, LED1 and R23. LP2 and LED1 light up to show that the timing period is over and LP1, the warning light, goes out. LED2 is fed from the pulsed DC supply via D7 and D8 and is therefore illuminated throughout the timing process, but when the time is up and LED1 lights up, LED2 goes out. This happens because red LEDs have a lower forward voltage than green LEDs, so that, since both LEDs share the same series resistor, when LED1 is conducting there is not enough voltage across LED2 for it to conduct. D6 is included to prevent reverse voltage appearing on LED1 via LP2 when the supply to these two is not connected. Since D6 contributes a further voltage drop in series with LED1, it is necessary to include a diode in series with LED2 also if the LED switching described above is to take place. However, the inclusion of one diode in series with each LED makes the extinguishing of the green LED less certain, and so two diodes have been inserted in series with the green LED, D7 and D8, which makes the switching action quite positive.

SW3 selects either the visual indication of timing as described or an audible alarm which sounds only at the end of the complete timing sequence. If SW3 is switched to the Tone position, the circuit operates as before except that the output from IC1 at the end of its timing period is used only to trigger IC2; there is no two minute warning. When IC2 reaches the end of its timing period it activates RLA2 as before, supplying pulsed DC to the circuitry around IC3. The pulsed supply is passed via D5 to the smoothing capacitor, C6, and then applied to C8 and the V_{CC} connection of IC3, a 555 timer. The 555 oscillates at a frequency determined by R24, R25 and C7, and its output is fed via C9 to the loudspeaker, LS1. the voltage supplied to C8 will at first appear mostly across R27, but as C8 charges the voltage on R27 will fall to zero. Thus the voltage on IC3's reset pin will fall, causing it to cease oscillating after several seconds. C10 is fitted to give a sharper cut-off; without it the tone will tail off, dropping in volume and frequency rather than just stopping.

timing and check that the warning light comes on after thirteen minutes. If the warning light is early or late, try substituting another 390k resistance. If you have a sufficiently accurate ohmmeter you could try selecting a suitable resistance with that, remembering that a higher resistance will be needed to increase the time delay and vice versa. The other possibility is to add further small resistances at the rate of 650 ohms per second of error or to substitute a 330k resistance with some smaller values in series if the initial resistance is too high.

When the ten minute range is working correctly, repeat the procedure for the twenty and thirty minute ranges. Bear in mind that the period you are looking for in each case is the period of the range selected plus the five minutes set up on SW2 and less the two minute warning period, ie, twenty-three minutes on the twenty minute range and thirty-three minutes on the thirty minute range. Finally, adjust the two minute period of IC2 using RV2. To avoid waiting while IC1 times its delay period, trigger IC2 by momentarily shorting pin 1 to earth. When RV2 has been set, the completed unit is ready for use.

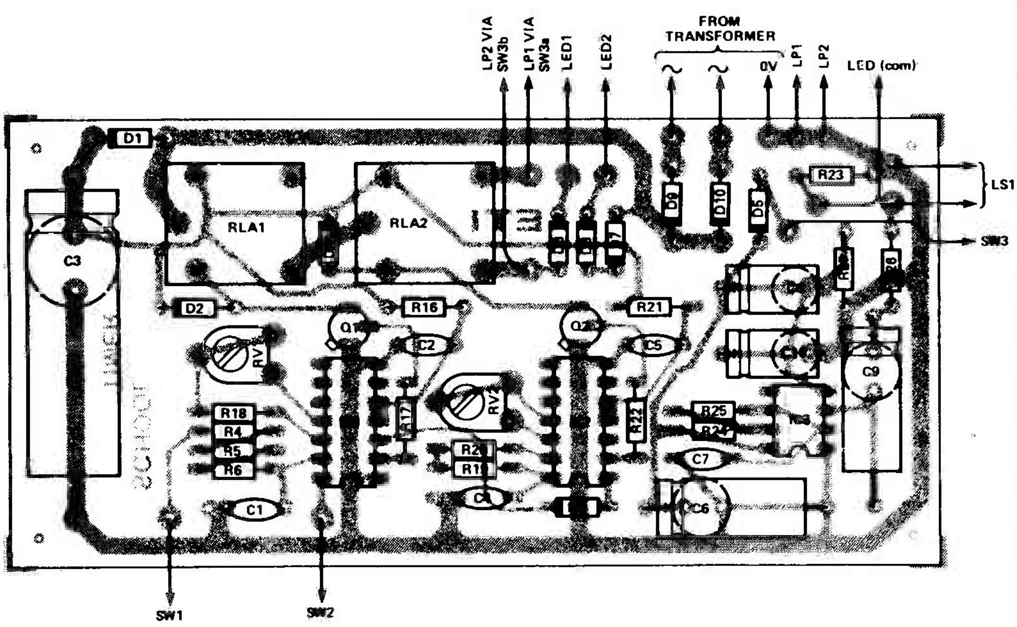


Fig. 3 Overlay diagram of the PCB.

BUYLINES

The ZN1034E is available from several suppliers, as are all the other semiconductors and the general components. The relay is available from Maplin, type no. YX96E. Suitable transformers are available from a number of suppliers but it pays to shop around here as prices vary enormously; a glance through the smaller ads for surplus and end-of-line items would not go amiss. 1% 0.4W metal film resistors, should you wish to use these for the range-setting network, are available from Maplin. The PCB is available from our PCB service, see page 67.

SERVICE SHEET

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March 81	September 83

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 telehone number).

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

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OOPS!

We have in the past published small corrections to projects on the letters page, and major corrections separately. From now on corrections will appear on this page, and will be repeated for several months (just to increase our embarrassment). If a correction is too large to fit on here, we will publish it just once, but will note the fact that a correction does exist, and that copies of it can be obtained from us provided you send in an SAE. But please — request copies only if you really do need them; if this service is abused, we may be forced to withdraw it:

Universal EPROM Programmer (August 1983)
Corrections to this project are listed in the article "Universal EPROM Programmer Revisited" which appeared in the January '84 issue.

Z80 Controller Computer (August 1983)
On the overlay, SW1 is the rectangle beside ICs 5 and 6, C6 should be shown between ICs 3 and 7, and a link through has been missed — to the right of pin 18, IC11.

Typewriter Interface (October 1983)
An update article on this project appears on page 25 of this issue.

Car Alarm (October 1983)
In the semiconductors section of the parts list, Q1, 2, 5, and 7 should be BC212L, Q3 should be BC182L, and Q4, 6 should be TIP31 or BD131. There was also another (inconsequential) silly but we bet you've already spotted that one!

Tech Tips (October 1983)
Ramped Pulse Generator For Stepper Motors — pin 1 of IC2 should be grounded, the Ramp Up and Ramp Down inputs accept negative, not positive, going pulses, and IC7 should be a 4011 rather than a 4001.

Active Loudspeaker (November 1983)
Gremlins attacked the parts list on page 72 leaving a trail of 00's in their wake. The ceramic tiles should be 150 mm (6") square and you need six of them. The BAF wadding needs to be about as wide as the enclosure's internal height, i.e., about 21", and long enough to loosely fill the space when rolled up with a bit left over to cover the back of the bass unit. The thinner the wadding you use, the greater the length you will require.

Mini Drum Synth (November 1983)
On the overlay diagram on page 37, RV2 has been shown as RV3 and vice-versa; the circuit diagram is correct.

Programmable Speech Board — Mini Mynah (February 1984)
The PCB for this project is double sided but only the underside pattern appears on the overlay drawing on page 26 and on the Foil Patterns page. The component side pattern appears on the PCB Foil Patterns page in this issue. The error does not affect PCBs supplied by our PCB service.

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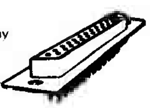

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CONNECTORS

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

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SO239 square chassis skt 38p.
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Pin insertion tool	162
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Spare spool 75p Combs	6

SWITCHES

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

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		6502CPU	325	6875	495	8251	250
		6522VIA	295	6880	100	8253	390
		6532	570	81LS95	85	8255	225
		6551 ACIA	650	81LS96	85	8259	390
		6800CPU	220	81LS97	85	MC1488	55
2114L2	150	6802CPU	250	8080A	250	MC1489	55
2716	240	6809CPU	620	8085AC	340	Z80ACPU	290
2532	290	6810RAM	115	8156	350	Z80APIO	260
2732	290	6821 PIA	110	8212	110	Z80ACTC	260
2764-250	650	6840	360	8216	100	Z80ASIO	900
4116P20	85	6850	110	8224	120	Z80ADMA	1150

SOCKETS

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

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Preset kit. Contains 5 of each value from 100 ohms to 1M (total 65 presets	425

Nut and Bolt kit (total 300 items): 180p
25 6BA ¼" bolts, 50 6BA washers, 50 6BA nuts
25 6BA ½" bolts, 25 4BA ¼" bolts, 50 6BA washers
50 6BA nuts, 25 6BA ¼" bolts

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Speaker cable	10p/m
Standard screened	16p/m
Twin screened	24p/m
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10 way rainbow ribbon	26p/ft
20 way rainbow ribbon	47p/ft
10 way gery ribbon	14P/ft
20 way grey ribbon	28p/ft

REGULATORS

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

DIODES

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

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

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yellow	17	▶TIL111	60
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▶TIL38	40	ILQ74	185
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Com cathode		Com anode	
DL704 0.3"	95	DL707 0.3"	95
▶FND500 0.5"	100	FND507 0.5"	100

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

HARDWARE

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

EURO CONNECTORS

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

TRIACS

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

JUMPER LEADS

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

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

COMPUTER CONNECTORS

ZX81 2 x 23 way edge connector wire wrap suitable for ZX81 add-ons . 150
SPECTRUM 2 x 28 way edge connector wire-wrap suitable for SPECTRUM add-ons . 200

RIBBON CABLE

Grey Ribbon cable. Price per foot

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

CAPACITORS

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

BRIDGE RECTIFIERS

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

IDC CONNECTORS

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

LINEAR

				LM339	40	LM3911	120	NE566	140	TL064	96
				LM348	60	LM3914	225	▶NE567	100	TL071	30
				LM358	50	LM3915	225	▶NE570	370	TL072	45
555CMOS	80	ICL7106	680	LM377	170	LM13600	105	NE571	370	TL074	95
556CMOS	150	ICL7611	95	▶LM380	75	MC1496	68	▶RC4136	55	▶TL081	25
709	25	ICL7621	180	▶LM381	120	MC3340	135	▶RC4558	40	TL082	45
▶741	14	ICL7622	180	LM382	120	▶MF10CN	350	SL480	170	TL084	90
748	35	ICL8038	295	LM384	130	ML922	400	SL490	250	TL170	50
9400CJ	350	ICL8211A	200	LM386	90	ML924	195	SL76018	150	UA2240	120
AY-3-1270	720	ICM7224	785	LM387	120	ML925	210	▶SN76477	380	ULN2003	70
AY-3-8910	370	ICM7555	80	LM393	40	ML926	140	SPO256AL2	850	ULN2004	70
AY-3-8912	540	▶LF351	45	LM709	25	ML927	140	TBA120S	70	XR2206	290
CA3046	60	LF353	85	LM711	60	ML928	140	TBA800	75	ZN414	80
▶CA3080	65	LF356	90	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3089	190	LM10	325	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3090AQ	375	LM301A	25	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3130E	85	LM311	50	LM747	60	NE531	140	TDA1008	320	ZN426E	300
▶CA3140E	36	LM318	120	LM1458	40	NE544	205	▶TDA1022	490	ZN427E	600
CA3161E	100	LM324	30	LM2917	200	▶NE555	16	TDA1024	125	ZN428E	410
CA3189	290	LM334Z	100	LM3900	45	▶NE556	45	TL061	40	ZN459	285
▶CA3240E	100	LM335Z	125	▶LM3909	75	NE565	110	TL062	60	ZN1034E	200

TRANSISTORS

				BC517	40	BF337	40	MPSU56	60	ZTX108	10	2N3055	50
				BC547	7	BFR40	23	TIP29A	30	ZTX109	12	2N3442	120
				BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶2N3702	8
		BC149	9	BC549	10	▶BFR81	20	TIP29C	37	ZTX301	16	2N3703	9
AC126	30	BC157	8	BC558	10	BFX29	25	TIP30A	35	ZTX302	15	▶2N3704	8
AC127	30	BC158	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17	2N3705	9
AC128	30	BC159	8	BCY71	18	BFX85	25	TIP30C	37	ZTX341	30	2N3706	9
AC176	25	BC160	45	BCY72	18	BFX86	28	TIP31A	35	ZTX500	15	2N3707	10
AC187	22	BC168C	10	BD115	55	BFX87	25	TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	BD131	35	BFX88	25	TIP32A	35	ZTX502	15	2N3709	10
AD142	120	BC170	8	BD132	35	BFY50	23	TIP32C	37	ZTX503	18	2N3772	170
AD149	80	BC171	10	BD133	50	BFY51	20	TIP33A	50	ZTX504	25	▶2N3773	195
AD161	40	BC172	8	BD135	40	BFY52	23	TIP33C	75	2N697	20	▶2N3819	20
AD162	40	BC177	18	BD136	30	BFY53	32	TIP34A	60	2N698	40	2N3820	40
AF124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	BD138	30	BFY56	32	TIP35A	105	2N708	20	2N3866	90
AF139	40	BC182	10	▶BD139	35	BRY39	40	TIP35C	125	2N918	35	2N3903	10
AF186	70	▶BC182L	8	▶BD140	35	BSX20	20	TIP36A	125	2N1132	22	2N3904	10
AF239	75	BC183	10	BD204	110	BSX29	25	TIP36C	135	2N1613	30	2N3905	8
BC107	10	BC183L	10	BD206	110	BSY95A	25	TIP41A	45	2N2218A	25	2N3906	10
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	45	2N2219A	25	2N4037	45
▶BC108	10	BC184L	7	BF180	35	BU206	180	TIP120	90	2N2221A	25	2N4058	10
BC108B	12	BC212	10	BF182	35	BU208	170	TIP121	90	2N2222A	20	2N4060	10
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	2N2368	25	2N4061	10
▶BC109	10	BC213	10	BF185	25	MJE340	50	TIP141	98	2N2369	16	2N4062	10
BC109C	12	BC213L	10	BF194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC114	18	BC214	10	BF195	12	MJE521	95	TIP147	110	2N2646	45	2N5458	36
BC115	22	▶BC214L	8	BF196	12	MJE3055	70	TIP2955	60	2N2904	20	2N5459	30
BC117	18	BC237	8	BF197	12	MPF102	40	TIP3055	55	2N2904A	20	2N5485	36
BC118	35	BC238	14	BF198	10	MPF104	40	TIS43	40	2N2905	22	2N5777	45
BC137	40	BC308	12	BF199	18	MPSA05	22	TIS44	45	2N2905A	22	2N6027	30
BC139	40	BC327	14	BF200	30	MPSA06	30	TIS90	30	2N2906	25	40360	40
BC140	28	BC328	14	▶BF244B	22	MPSA12	30	TIS91	30	2N2906A	25	40361	50
BC141	30	BC337	14	BF245	30	MPSA55	30	VN10KM	50	2N2907	25	40362	50
BC142	25	BC338	14	BF256B	45	MPSA56	30	VN46AF	75	2N2907A	25	40408	70
BC143	25	BC477	30	BF257	32	MPSU05	55	VN66AF	85	2N2926	9		
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF	95	▶2N3053	23		
BC148	8	BC479	30	BF259	35	MPSU55	60	ZTX107	10	2N3054	55		

RESISTORS

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

SPECIAL OFFER!

BOXES

Plastic with lid & screws		Aluminium	
		3 x 2 x 1"	65
		4 x 2¾ x 1½"	95
		4 x 2¼ x 2"	95
3 x 2 x 1"	55	6 x 4 x 2"	120
4½ x 3 x 1½"	88	7 x 5 x 2½"	165
7 x 4 x 2"	160	8 x 6 x 3"	205

CMOS

		4016	20	4034	140	4054	78	4081	12	40193	65	4528	45
		4017	30	4036	249	4055	80	4082	12	4502	60	4529	150
		4018	45	4039	280	4059	430	4085	48	4503	32	4532	60
4000	10	4019	25	4040	40	4060	80	4086	50	4507	35	4534	400
4001	10	4020	42	4041	40	4063	80	4089	125	4508	110	4538	60
4002	12	4021	40	4042	38	4066	22	4093	18	4510	45	4543	50
4006	50	4022	45	4043	40	4067	225	4094	68	4511	40	4549	360
4007	14	4023	14	4044	40	4068	14	4095	65	4512	40	4553	215
4008	36	4024	33	4046	40	4069	13	4097	290	4514	115	4555	35
4009	24	4025	12	4047	35	4070	13	4098	70	4515	115	4556	35
4010	24	4026	75	4048	38	4071	13	4099	70	4516	55	4559	390
4011	10	4027	20	4049	21	4072	13	40106	40	4518	40	4560	140
4012	15	4028	40	4050	21	4073	13	40109	110	4520	50	4584	35
4013	20	4029	45	4051	42	4075	13	40163	60	4521	90	4585	60
4014	45	4030	14	4052	48	4076	45	40173	100	4526	60	4724	140
4015	40	4031	125	4053	48	4077	14	40175	75	4527	50		

LS TTL

		LS20	15	LS75	26	LS123	48	LS160	38	LS197	45	LS353	60
		LS21	15	LS76	20	LS125	30	LS161	38	LS221	55	LS365	28
		LS22	15	LS78	20	LS126	30	LS162	38	LS240	60	LS366	28
LS00	14	LS26	15	LS83	35	LS132	35	LS163	38	LS241	55	LS367	28
LS01	14	LS27	15	LS85	42	LS136	28	LS164	40	LS242	58	LS368	29
LS02	14	LS30	15	LS86	24	LS138	60	LS165	50	LS243	58	LS373	58
LS03	15	LS32	15	LS90	25	LS139	30	LS166	70	LS244	100	LS374	60
LS04	15	LS37	16	LS92	25	LS145	60	LS170	80	LS245	78	LS375	43
LS05	15	LS38	16	LS93	25	LS147	95	LS173	60	LS247	50	LS377	60
LS08	15	LS40	16	LS95	40	LS148	90	LS174	36	LS251	36	LS378	57
LS09	15	LS42	30	LS96	95	LS151	40	LS175	36	LS257	32	LS390	45
LS10	15	LS47	38	LS107	40	LS153	40	LS190	40	LS258	35	LS393	40
LS11	15	LS48	38	LS109	30	LS154	95	LS191	40	LS259	60	LS399	56
LS13	15	LS51	15	LS112	27	LS155	30	LS192	40	LS266	24	LS541	78
LS14	33	LS55	15	LS113	28	LS156	30	LS193	40	LS273	55	LS670	35
LS15	15	LS73	20	LS114	28	LS157	26	LS195	36	LS279	32		
		LS74	20	LS122	38	LS158	30	LS196	40	LS283	40		

TTL

		7413	25	7444	70	7483	38	74122	38	74161	46	74190	48
		7414	30	7446	55	7485	80	74123	40	74162	40	74191	48
		7416	26	7447	40	7486	26	74125	33	74163	40	74192	48
7400	14	7417	26	7448	42	7489	165	74126	33	74164	45	74193	40
7401	14	7420	16	7450	16	7490	22	74132	36	74165	45	74194	40
7402	14	7421	22	7451	16	7491	35	74141	45	74167	150	74195	40
7403	14	7422	22	7453	16	7492	25	74145	55	74170	125	74196	45
7404	16	7427	20	7454	16	7493	25	74147	75	74173	58	74197	40
7405	16	7428	22	7460	16	7494	35	74148	60	74174	54	74198	80
7406	28	7430	16	7472	24	7495	35	74150	55	74175	50	74199	80
7407	28	7432	22	7473	27	7496	35	74153	36	74176	40		
7408	16	7433	22	7474	23	7497	90	74154	60	74177	42		
7409	16	7437	25	7475	30	74100	80	74155	36	74179	70		
7410	16	7438	25	7476	27	74107	26	74156	36	74180	40		
7411	16	7440	16	7480	48	74109	30	74157	30	74181	105		
7412	16	7442	32	7482	65	74121	28	74160	40	74182	40		

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THE SAGA OF SILLY-COW VALLEY

Vivian Capel tells a tale from the dawn of the electronic age.

In the days when buffalo roamed freely over the American Praries an Indian village nestled in the hollow known as Silly-Cow Valley. No-one knew how it had acquired the name, whether it was due to a rampaging female buffalo or half-witted Indian squaw, the origin was lost in antiquity.

The white man was rarely seen in those parts, so, unspoiled by 'civilisation', the Indians lived in comparative peace except for occasional skirmishes with nearby tribes. All this was soon to change, for one day a stranger appeared in their valley. His visage and attire was like no other white man they had ever seen. His strange blue straight-sided wigwam perched on a rock overlooking the encampment; but no-one had seen it arrive, it had just appeared as though from nothing.

Being more inquisitive than hostile, the Indians made him welcome to their village, especially as he brought a seemingly inexhaustable supply of gifts. There were large numbers of multi-coloured baubles, insect-like beads with long springy legs that delighted the children, and much more.

For the wives of the chief there were special gifts, fine buffalo hides dyed in bright colours, and for the favourite wife, a real rarity for those parts, a hippopotamus skin. In return all he asked was to be allowed to come and go as he pleased, and to observe and talk to the people.

Chief Sitting-Bull readily agreed, so for many moons the stranger became a familiar visitor to the camp. Often he would be invited to a camp-fire pow-wow and entertainment with the Chief, and they became firm friends. Always though he carried a notebook, and wrote down carefully anything he heard which seemed to interest him.

One evening while they were relaxing after a particularly good meal at the camp fire, the Chief asked him about his book. "What are these marks you keep making in this thing?" he said. "White man's writing," came the reply, "I put down here anything I wish to remember, then later I can read it and recall all I have seen and heard."

The Chief took the book, turned it this way and that, but could make nothing of it. "Why you do this?" he asked.

The stranger paused, looking intently into the burning embers. "I am a traveller," he said at length, "I have travelled far in search of the Eternal Truth, the Great Principle, and I must continue on until it is found."

"Then why you come here?" grunted the Chief.

"I am drawn to this place, I have been here before and seen so many miracles that you could never understand that I know it is here I will find what I seek."

"We've not seen you before, when you come?" demanded the Chief.

A faint smile crossed the strangers visage, "Not of this time," he said, "but far into the future, beyond the days of your sons' sons."

"I no understand what you talk about," growled Chief Sitting-Bull as he handed the notebook back, "pale-face brother speak with forked tongued like snake-in-the-grass." He had a faint suspicion that the stranger was making a fool of him. However, those nearby who heard, seized on the description, and because he had given no other, he was henceforth called by the name Pythonograss, 'snake' seeming somewhat disrespectful.

"This writing though," the Chief added, "it interests me, could paleface brother teach Chief to read?" Having little alternative, Pythonograss agreed.

The Chief proved a quick and adept pupil, and as his ability improved, an avid reader. Poor Pythonograss was kept busy fetching books, papers and periodicals from his wigwam on the rock. Not wishing to keep the benefits of literacy to himself, Chief Sitting-bull taught first his family, then his braves the art of reading, and commanded that they in turn should teach their squaws and young ones.

Next he decided to produce his own newspaper, the *Daily Squawk* which he dedicated to a group of braves who wrote and copied. Soon, specialist periodicals began to appear such as *Scalp-Collectors Weekly*, and *Practical Witch-Doctor*.

One day, when Pythonograss entered the village he sensed a difference. The squaws were not wearing their coloured ornaments nor were the children playing with their 'insects'. On approaching the Chief's wigwam he saw tables piled high with them, while at others braves sat working, trying to piece different items together.

The Chief stood nearby with a periodical in his hand taken from the last pile Pythonograss had brought; it was ETI.

"How;" he greeted, "these things you give the squaws, they 'lectronics — we know, we read." He tapped the magazine.

"Well, yes," admitted Pythonograss, "they're bits from my old guidance computer and time displacement unit. I though the squaws would like the colours. But what are you doing with them?"

"We makeum circuit, like it says here," the Chief replied tapping the magazine again, "only we design our own."

"So what exactly are you trying to make?"

"Sound generator to give us the mating call of the buffalo, then they come to us instead of we hunting them," returned the Chief with a look of satisfaction in his face. "You think good idea, yes?"

"We-ell," responded Pythonograss dubiously, "it sounds alright but it could wipe out the buffalo, make them extinct."

"No!" declared the Chief emphatically, "plenty buffalo on the plains, we huntem plenty, but always more."

Pythonograss left them to it and thoughtfully returned to his rock. So, the future of Silly-Cow Valley was already taking shape, but he was as far off as ever in completing his quest. Surrounding tribes soon got to hear of the village with the Pale-face learning and came to investigate. Sitting-Bull shrewdly encouraged their interest, then sold them as many components and back issues of ETI that he could get out of Pythonograss, at an inflated barter rate. Yes, capitalism had come to Silly-Cow Valley too.

The Chief even set up a special row of wigwams to conduct the trade. At one end he erected a pole with the inscription Totenum Pole Road. Experiments and project building now was the regular pastime at most of the encampments in the area. This could be seen from the frequent puffs of smoke that appeared over them. A small one meant: "should have used a wire-wound for the surge limiter," while a large one declared: "oops, connected the reservoir round the wrong way."

These would be viewed with trepidation by travellers in distant caravan trains with mutterings that "those doggone injuns on the warpath again." Which often was true, as some of the more warlike tribes would ride out and take it out on whoever happened to be around, whenever a project didn't work — which was more often than not.

Meanwhile the village squaws were growing more discontented. Their ornaments had gone, and they hardly ever saw their men who spent their time using arrows for screwdrivers and spears for soldering irons (well everything is big in America).

So they just sat around the camp fire on their own talking squaw talk and looking enviously at the three who still had their gifts, the hides on which they sat. But two of these were even more jealous of the favourite who flaunted her rare hippopotamus skin at every opportunity.

Finally, being able to stand it no longer, they plotted to steal the hide. Each had a son, and these they persuaded to do the deed, disguised as the braves of another tribe. So as she returned to her wigwam one night, the favourite was set upon by these two who tried to wrest the skin from her grasp. Now it so happened she had just read a book on karate, so in minutes her assailants were laid out cold.

The next day, Pythonograss wandered wearily into the village. Things had not gone as he hoped, he had broken the first law about interfering with local cultures and he was no nearer the great Truth that he sought. Casually, he glanced at the copy of the *Daily Squawk* pinned to the totem pole; it consisted mostly of an account of the previous night's fracas.

Suddenly, his eyes widened and clicked back to the headline. "This is it!, this is it!" he shouted throwing his hat in the air and cavorting around the pole. "I've found It, I've found it!" Then he made off as fast as he could back to his wigwam which after a few moments, melted into nothing with a soft whirring noise.

Chief Sitting-Bull who had observed all this from the entrance of his wigwam, pushed back his head-dress and scratched his head in amazement. Then he went over to the paper to discover just what had produced such an astonishing reaction. He could see nothing unusual at all, the headline just read:

"THE SQUAW ON THE HIPPOPOTAMUS IS EQUAL TO THE SON OF THE SQUAWS ON THE OTHER TWO HIDES."

ETI

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Note that these are all the boards that are available — if it isn't listed, we don't have it.

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- ☐ E/794-2 Click Eliminator........... 7.64
- ☐ E/796-1 Accented Beat Metronome 4.14

1980

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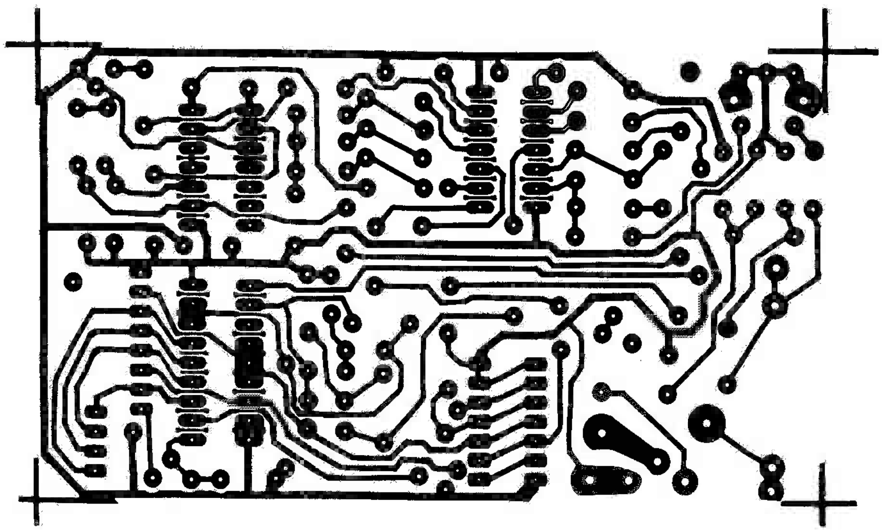

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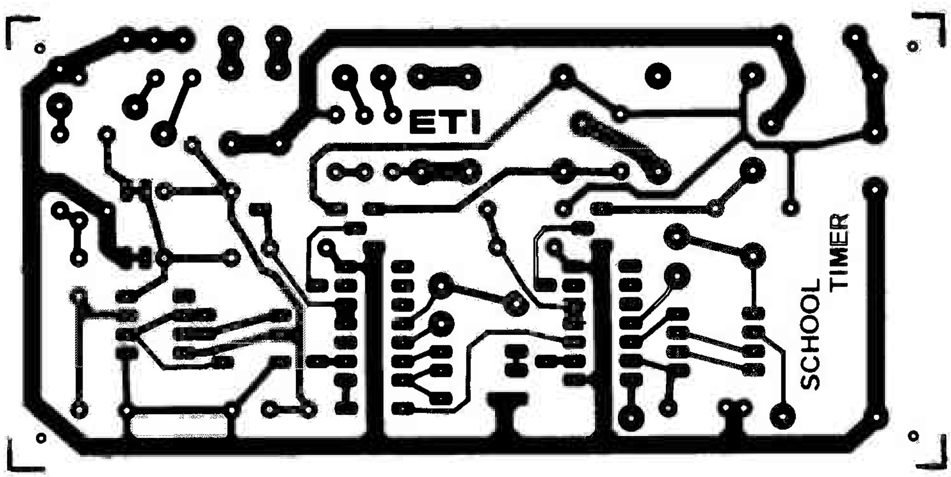

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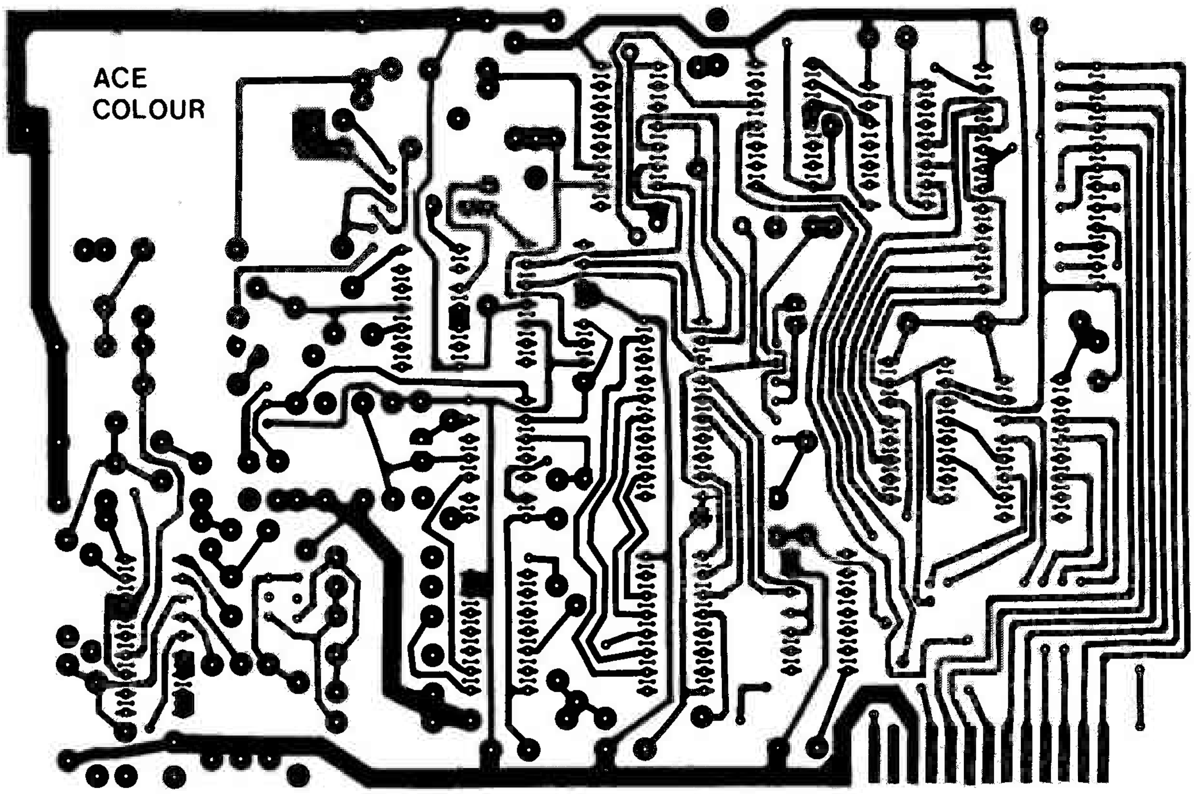

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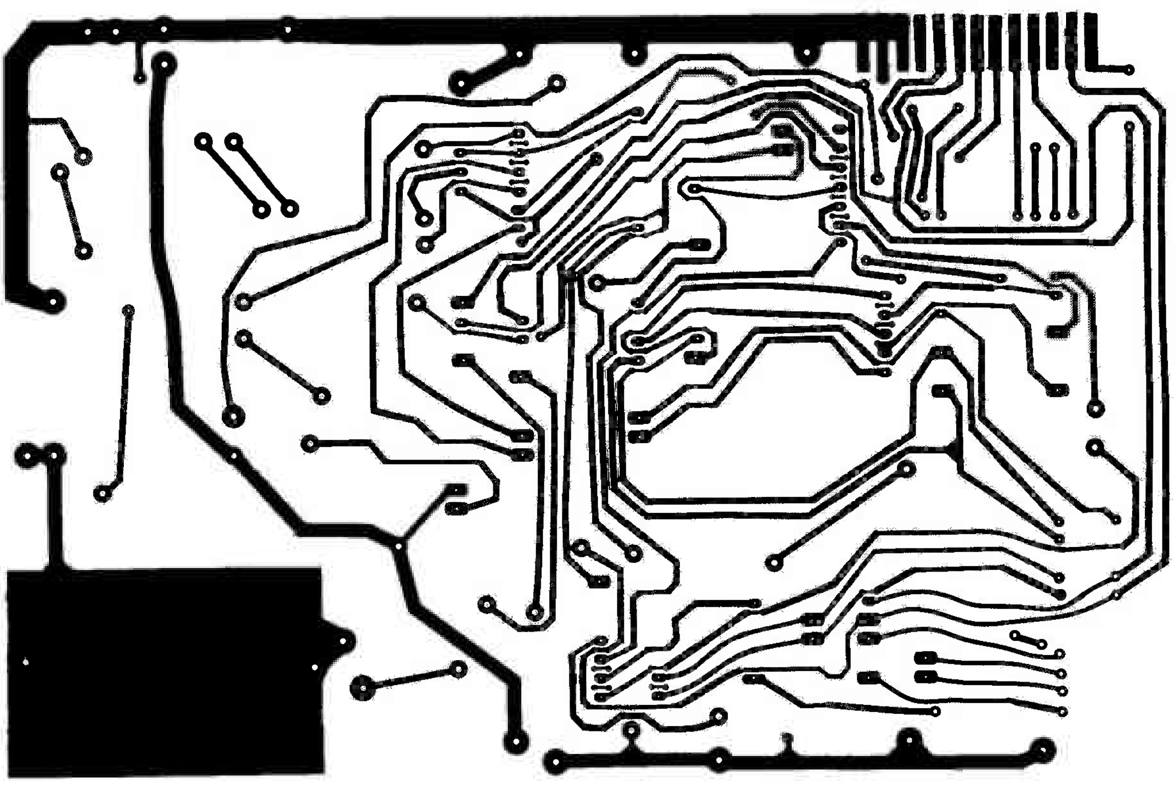

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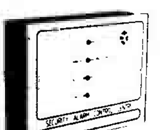

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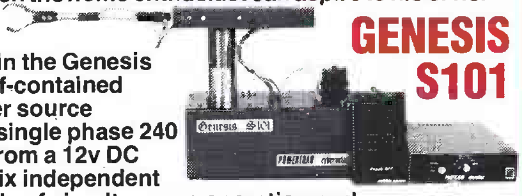

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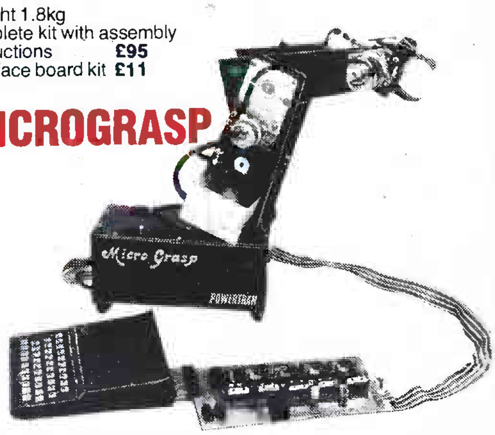

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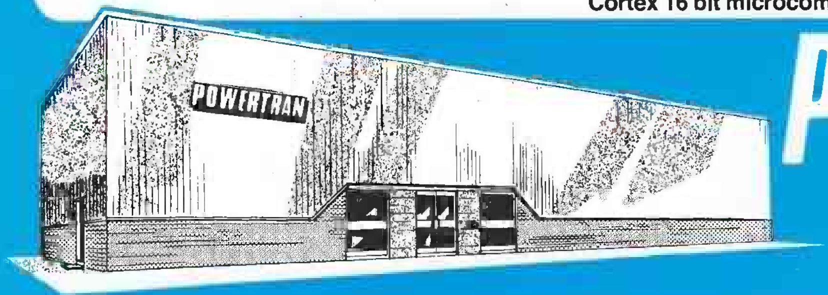

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