

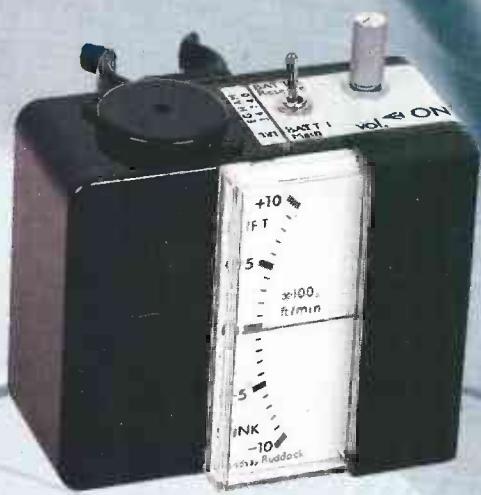
electronics today

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



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

BRITAIN'S LEADING
ELECTRONICS
MAGAZINE

High performance, low price kits for today's musicians

DIGITAL DELAY LINE



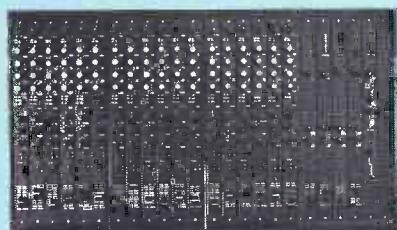
Digital delay circuitry is an absolute necessity for high quality studio work, but usually comes with a four-figure price tag.

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**

'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 portamento 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

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 amplifier



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 (0dBm) makes this amplifier suitable for virtually all pre-amps or mixers.

Complete kit £75.00

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



POWERTRAN

cybernetics ltd.

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

ALL PRICES ARE EXCLUSIVE OF VAT AND APPLY TO THE U.K. ONLY - ALLOW 21 DAYS FOR DELIVERY. OVERSEAS CUSTOMERS - PLEASE CONTACT OUR EXPORT DEPARTMENT FOR THE NAME AND ADDRESS OF YOUR LOCAL DEALER.

electronics today

INTERNATIONAL

APRIL 1984 VOL 13 NO 4



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

PUBLISHED BY:
Argus Specialist Publications Ltd.
1 Golden Square, London W1R 3AB.

DISTRIBUTED BY:
Argus Press Sales & Distribution Ltd.
12-18 Paul Street, London EC2A 4JS
(British Isles)

PRINTED BY:
The Garden City Press Ltd.
COVERS PRINTED BY:
Alabaster Passmore.

OVERSEAS
EDITIONS
and their
EDITORS

AUSTRALIA — Roger Harrison
CANADA — Halvor Moorshead
GERMANY — Udo Wittig
HOLLAND — Anton Kriegsman

Member of the
Audit Bureau
of Circulation

ABC

Electronics Today is normally published on the first Friday in the month preceding cover date. The contents of this publication including all articles, designs, plans, drawings and programs and all copyright and other intellectual property rights therein belong to Argus Specialist Publications Limited. All rights conferred by the Law of Copyright and other intellectual property rights and by virtue of international copyright conventions are specifically reserved to Argus Specialist Publications Limited and any reproduction requires the prior written consent of the Company. © 1984 Argus Specialist Publications Ltd. All reasonable care is taken in the preparation of the magazine contents, but the publishers cannot be held legally responsible for errors. Where mistakes do occur, a correction will normally be published as soon as possible afterwards. All prices and data contained in advertisements are accepted by us in good faith as correct at time of going to press. Neither the advertisers nor the publishers can be held responsible, however, for any variations affecting price or availability which may occur after the publication has closed for press.

Subscription Rates, UK £14.35 including postage. For further details and Airmail rates etc, see the Readers' Services page.

EDITORIAL AND ADVERTISEMENT OFFICE

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

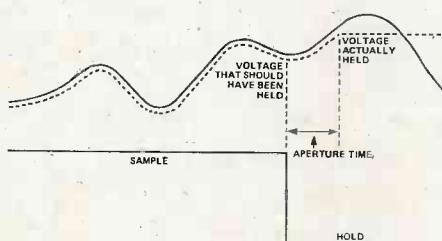
FEATURES

DIGEST 11

Our regular round-up of news and gossip from the world of electronics.

DESIGNER'S NOTEBOOK 27

Sample and hold techniques can be very useful in a wide variety of situations; Joe Pritchard looks at the theoretical and practical aspects.



BASS FOR BEGINNERS 35

Design and build your own bass enclosures, and save yourself some money in the process! Barry Porter has all the equations.

MACHINE CODE PROGRAMMING 49

This month's episode goes into input and output, and includes what must be the worst pun we've ever published...

THE SAGA OF SILLY-COW VALLEY 55

A special little tail-end story for our April issue, a myth from the very dawn of the electronic age, from our resident historian, Vivian Capel.

PROJECTS

VERTICAL SPEED INDICATOR 19

Going up in the world? Or do you have that sinking feeling? This design from Lindsay Ruddock will tell you if your senses are deceiving you.

UNIVERSAL EPROM PROGRAMMER 33

The project that just won't lie down — in the sequel to the sequel, Mike Bedford clears up a few problems.

SUPER SELECTIVE MUSIC FILTER 39

Fussy about the music you'll listen to? Here's a project to turn the radio on and off to your taste — automatically!

ADDING COLOUR TO THE ACE 41

Besides being very attractive to Ace owners, this project should prove an education to everyone who wants to know more about the nitty-gritty of video in home computers.

MAINS BORNE REMOTE CONTROL 53

Ever fancied a sophisticated computer-controlled system but balked at the prospect of wires trailing everywhere? The ETI MainsCom makes this a thing of the past.

SCHOOL TIMER 59

A design to help school-teachers, and their pupils, stop talking bang on time — we're sure that will get a welcome from all concerned!

INFORMATION

NEXT MONTH'S ETI 6

ETI BOOK SERVICE 25

READER'S SERVICES 62

ETI PCB SERVICE 67

PCB FOIL PATTERNS 68

ADVERTISERS' INDEX 74

SWITCHES		DIP SWITCHES		VEROBOARD		VA Board		IDC CONNECTORS		PANEL METERS		RELAYS		
TOGGLE 1 2A 240V	SPST on/off	(SPS1) 4 way 85p; 6 way 80p; 8 way 85p;	2½ x 3½	95p	DIP Board	195p	PCB with Pins	Plugs	Female Header	Female Card	FSD	Single Pole Changeover		
SPST 35p	DPDT 48p	10 way 125p (SPDT) 4 way 190p	2½ x 5	110p	Vero Strip	95p	latch	Female	Female	Edge	60 x 48 x 35mm	RL-91 205R coil 12V DC, (10V5 to 19.5V), 10A at 30V DC or 250V AC		
SUB-MIN TOGGLE	SPDT on/off	ROTARY SWITCHES (Adjustable Stop type)	3½ x 3½	100p	PROTODECs	405p	Pins	Header	Card	Conct	0-50mA	DOUBLE POLE Changeover, 6A 30V DC or 250V AC		
SPDT 58p	SPDT 84p	1 pole/2 to 12 way 2 pole/2 to 6 way 3 pole/2 to 4 way, 4 pole/2 to 3 way	3½ x 5	125p	VeroBlock	395p	Pin	Angle	Edge	0-100mA	RL-100 53R Coil 6V DC (5V4 to 9V9) 190p			
SPDT centre off 85p	SPDT biased both ways	ROTARY: Mains DP 250V 4 Amp on/off	4½ x 17	420p	Eurobreadboard	590p	10 way	90p	85p	120p	0-500mA	RL-111 205R Coil 12V DC (10V7 to 19V5), 10A at 30V DC or 250V AC		
SPDT biased both ways	DPDT 6 ways	ROTARY: (Make-a-switch)	Pkt of 100 pins	55p	Blimboard 1	575p	16 way	130p	150p	110p	0-1mA	RL-114 740R Coil 24V DC (22V to 37V)		
SPDT 145p	SPDT 145p	Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max 6 pole/12 way + DP switch). Mechanism only	Spot face cutter CCP	185p	Superstrip SS2	1350p	20 way	145p	168p	125p	0-5mA	200p		
SPDT 3 positions on/on/on	SPDT 185p	ROCKER: 1 pole/2 to 12 way 2 pole/2 to 6 way 3 pole/2 to 4 way, 4 pole/2 to 3 way	Pin insertion tool	185p	DALO ETCH	205p	26 way	175p	200p	150p	0-10mA	RL-114 740R Coil 24V DC (22V to 37V)		
4-pole 2 way 220p	4-pole 2 way 220p	VERO WIRING PEN + spool	340p	Spare spool	75p	RESIST PEN	205p	34 way	205p	238p	160p	0-50mA	200p	
4-pole 2 way 220p	4-pole 2 way 220p	Combs	8p	Plus spare tip	100p	220p	40 way	220p	250p	180p	340p	0-500mA	200p	
4-pole 2 way 220p	4-pole 2 way 220p	WAFERS: (make before break) to fit the above switch mechanism. 1 pole/2 way, 2 pole/6 way 3 pole/4 way, 4 pole/3 way, 6 pole/2 way 65p	Spacers 4p, Screen 6p	45p	FERRIC CHLORIDE	350p	50 way	235p	270p	200p	395p	0-50V AC	200p	
4-pole 2 way 220p	4-pole 2 way 220p	Mains DP 4A Switch 10ft	45p	1 lb bag Anhydrous	195p	40KHz	60 way	—	—	230p	405p	"VV"	490p each	
4-pole 2 way 220p	4-pole 2 way 220p	Spacers 4p, Screen 6p	45p	195p +50p opamp	45p	ULTRASONIC TRANSDUCER	350p	Gold Flashed Contacts	Female	Sockel	Male	Plug	"S"	"VV"
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER SWITCHES	ROCKER: 5/4250V SPST	28p	COPPER CLAD BOARDS	SR/BP	DIN41617	170p	—	—	175p	490p each	ASTEC UHF MODULATORS	
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT	38p	Fibre glass	Single-sided	S/Speed	DIN41612	3½ way	—	—	175p	32768KHz	Standard 6MHz	
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT d/c off	95p	Double-sided	100p	6" x 6"	DIN41612	2 x 32 A + B	275p	320p	220p	285p	235p	200KHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPST with neon	85p	125p	125p	9.5" x 8.5	DIN41612	2 x 32 A + C	295p	340p	240p	300p	265p	200KHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	DIN41612 x 3	A + B + C	360p	385p	280p	395p	370p	455KHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	100p	125p	9.5" x 8.5	DIL SOCKETS	10 way	15p	28p	16p	40p	275p	1MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	125p	125p	110p	DIL PLUG (Header)	14 pin	40p	80p	15p	28p	275p	1.2MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	RIBBON CABLE	16 pin	48p	105p	20p	40p	300p	200KHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ZIF DIL SOCKETS	20 pin	290p	290p	20p	40p	300p	455KHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	24 pin	585p	—	20 way	30p	30p	375.9MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	SIL SOCKET	26 pin	750p	—	24 way	40p	85p	3.6864MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	40 pin	799p	—	26 way	55p	80p	4.0MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	24 pin	750p	—	28 way	60p	85p	4.2361MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	26 pin	799p	—	30 way	70p	135p	4.608MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	28 pin	840p	—	32 way	80p	160p	4.8MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	30 pin	895p	—	34 way	90p	180p	5.1MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	32 pin	940p	—	36 way	100p	215p	5.2428MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	34 pin	985p	—	38 way	110p	230p	5.6MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	36 pin	1030p	—	40 way	120p	240p	6MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	38 pin	1075p	—	42 way	130p	250p	6.4MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	40 pin	1120p	—	44 way	140p	260p	6.8MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	42 pin	1165p	—	46 way	150p	280p	7.2MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	44 pin	1210p	—	48 way	160p	300p	7.6MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	46 pin	1255p	—	50 way	170p	320p	8MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	48 pin	1300p	—	52 way	180p	340p	8.4MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	50 pin	1345p	—	54 way	190p	360p	8.8MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	52 pin	1390p	—	56 way	200p	380p	9.2MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	54 pin	1435p	—	58 way	210p	400p	9.6MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	56 pin	1480p	—	60 way	220p	420p	10MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	58 pin	1525p	—	62 way	230p	440p	10.4MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	60 pin	1570p	—	64 way	240p	460p	10.8MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	62 pin	1615p	—	66 way	250p	480p	11.2MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	64 pin	1660p	—	68 way	260p	500p	11.6MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	66 pin	1705p	—	70 way	270p	520p	12MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	68 pin	1750p	—	72 way	280p	540p	12.4MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	70 pin	1800p	—	74 way	290p	560p	12.8MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	72 pin	1845p	—	76 way	300p	580p	13.2MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	74 pin	1890p	—	78 way	310p	600p	13.6MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	76 pin	1935p	—	80 way	320p	620p	14MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	78 pin	1980p	—	82 way	330p	640p	14.4MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	80 pin	2025p	—	84 way	340p	660p	14.8MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	82 pin	2070p	—	86 way	350p	680p	15.2MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	84 pin	2115p	—	88 way	360p	700p	15.6MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	86 pin	2160p	—	90 way	370p	720p	16MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	88 pin	2205p	—	92 way	380p	740p	16.4MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	90 pin	2250p	—	94 way	390p	760p	16.8MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	92 pin	2295p	—	96 way	400p	780p	17.2MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	94 pin	2340p	—	98 way	410p	800p	17.6MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	96 pin	2385p	—	100 way	420p	820p	18MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	98 pin	2430p	—	102 way	430p	840p	18.4MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	100 pin	2475p	—	104 way	440p	860p	18.8MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	102 pin	2520p	—	106 way	450p	880p	19.2MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	104 pin	2565p	—	108 way	460p	900p	19.6MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	106 pin	2610p	—	112 way	470p	920p	20MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	108 pin	2655p	—	116 way	480p	940p	20.4MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	110 pin	2700p	—	120 way	490p	960p	20.8MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	112 pin	2745p	—	124 way	500p	980p	21.2MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	114 pin	2790p	—	128 way	510p	1000p	21.6MHz
4-pole 2 way 220p	4-pole 2 way 220p	ROCKER: 10A/250V SPDT with neon	85p	225p	225p	110p	ANTEX Soldering IRONS	116 pin	2835p	—	132 way	520p	1020p	22MHz
4-pole 2 way 220p	4-pole 2													

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.

The Logic Probes

Spend Less

Test More



LP-1 Logic Probe

The LP-1 has a minimum detachable pulse width of 50 nanoseconds and maximum input frequency of 10MHz. This 100 K ohm probe is an inexpensive workhorse for any shop, lab or field service tool kit. It detects high-speed pulse trains or one-shot events and stores pulse or level transitions, replacing separate level detectors, pulse detectors, pulse stretchers and pulse memory devices.

All for less than the price of a DVM

£34.50*

© Model LP-3 illustrated



LP-2 Logic Probe

The LP-2 performs the same basic functions as the LP-1, but, for slower-speed circuits and without pulse memory capability. Handling a minimum pulse width of 300 nanoseconds, this 300 K ohm probe is the economical way to test circuits up to 1.5 MHz. It detects pulse trains or single-shot events in TTL, DTL, HTL and CMOS circuits, replacing separate pulse detectors, pulse stretchers and mode state analysers.

(Available in kit form LPK-1 £14.50)

£21.00*

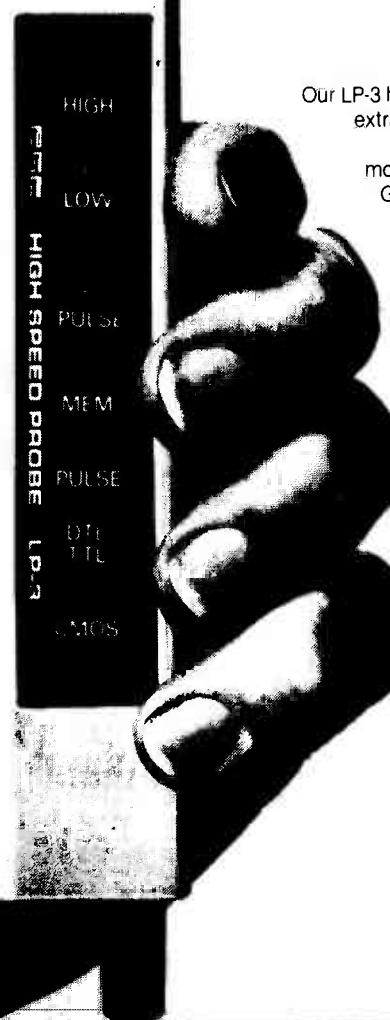
© Model LP-3 illustrated

*price excluding P&P and 15% VAT

GLOBAL SPECIALTIES CORPORATION



G.S.C. (UK) Limited, Dept. 911,
Unit 1, Shire Hill Industrial Estate,
Saffron Walden, Essex CB11 3AQ.
Telephone: Saffron Walden (0799) 21682



LP-3 Logic Probe

Our LP-3 has all the features of the LP-1 plus extra high speed. It captures pulses as narrow as 10 nanoseconds, and monitors pulse trains to over 50 MHz. Giving you the essential capabilities of a high-quality memory scope at 1/1000th the cost. LP-3 captures one shot or low-rep-events all-but-impossible to detect any other way.

All without the weight, bulk, inconvenience and power consumption of conventional methods.

£53.50*

© Model LP-3 illustrated

The New Pulser DP-1

The Digital Pulser: another new idea from G.S.C. The DP-1 registers the polarity of any pin, pad or component and then, when you touch the 'PULSE' button, delivers a single no-bounce pulse to swing the logic state the other way. Or if you hold the button down for more than a second, the DP-1 shoots out pulse after pulse at 1000 Hz. The single LED blinks for each single pulse, or glows during a pulse train. If your circuit is a very fast one, you can open the clock line and take it through its function step by step, at single pulse rate or at 100 per second. Clever! And at a very reasonable price.

£56.00*

© Model LP-3 illustrated

GOODS DESPATCHED WITHIN 48 HRS.

G.S.C. (UK) Limited, Dept. 911, Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.
Prices include P&P and 15% VAT.

LP-1	£41.40	Only	LP-2	£25.87	Only	LP-3	£63.82	Only	DP-1	£66.70	Only	LPK-1	£17.82	Only
------	--------	------	------	--------	------	------	--------	------	------	--------	------	-------	--------	------

Name _____ Address _____

I enclose Cheque/P.O. for £ _____ or debit my Barclaycard/Access/
American Express card no. _____ exp. date. _____

FOR IMMEDIATE ACTION — The G.S.C. 24 hour, 5 day a week service.
Telephone (0799) 21682 and give us your Barclaycard, Access, American Express
number and your order will be in the post immediately

for FREE
catalogue
tick box

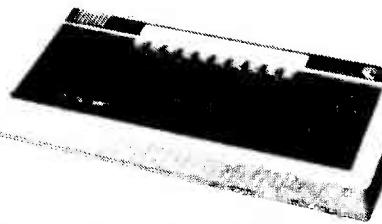
01-452 1500

TECHNOMATIC LTD

01-450 6597

BBC Micro Computer System OFFICIAL DEALER

Please phone for availability



Software from ACORN/ACORN/PROGRAM POWER/GEMINI in stock

CASSETTE RECORDERS

SANYO DR101 Data Recorder £34 +
£2.50 carriage
BBC Tape Recorder £28.50 + £2.50 carriage
Cassette Lead £3 + £1 carriage
HOBBIT Floppy Tape £135 + £2.50 carriage
HOBBIT Zero Memory Option £25 + £1 carriage
Computer Grade C12 cassette 50p each.
£4.50 for 10 + £1 carriage

BBC Model B £348
B + Econet £389
B + DFS £409
B + DFS + Econet £450
Carriage £7

Model A to Model B
Upgrade Kit £75
Installation £15

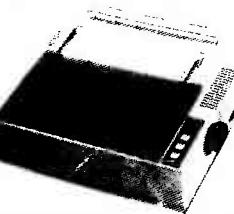
LANGUAGE ROMS
BCPL ROM + Disc +
Manual £87
PASCAL-T ROM £44

UTILITY ROMS
BBC Ultralac £65 Toolkit £20
EXMON £20; DISC DOCTOR £28; FX Dump £15; Graphics ROM £28; Termi ROM £29

MONITORS
MICROVITEC 1430 14" RGB/PAL Std Res £249
MICROVITEC 1451 14" RGB Med Res £345
MICROVITEC 1441 14" RGB Hi Res £440
MICROVITEC 2031 20" RGB Std Res £287
KAGA VISION 12" RGB Std Res £230
KAGA VISION III 12" RGB Hi Res £385
KAGA 12" GREEN Hi Res £108
SANYO DM8112CX 12" Green Hi Res £99
All leads included. Carriage £7

PRINTERS & PLOTTERS

EPSON FX80 £325
EPSON RX80 FT £250
EPSON FX-100 £555
SEIKOSHA GP 100A £170
SEIKOSHA GP 250X £190
JUKI 6100 Daisy Wheel £365
MSP 40 Col Printer/Plotter £109
Colour Graphics Plotter A3 size £270
GRAFPAD Graphics Tablet £125
Carriage £7



ACCESSORIES
Parallel Printer Lead £10 + £1 carriage
Serial Printer Lead £8 + £1 carriage
Epson Serial Interface 2K £40 + £1 carriage
Epson Serial Interface £50 + £1 carriage
NEC Serial Interface £42 + £1.50 carriage
Epson Paper Roll Holder £17 + £1.50 carriage
FX80 Tractor Attachment £37 + £1.50 carriage
FX Tractor Attachment £37 + £1 carriage
Paper Fanfold 2000 sheets £13.50 + £2.50 carriage

BBC EPROM PROGRAMMER

A fully self-contained Eprom Programmer with its own power supply, able to program 2516, 2716/32/32A/64/128 single rail Eproms.
★ Personality selection simplified by a single rotary switch.
★ Programming voltage selector switch is provided with a safe position.
★ Warning indicator to show programming in progress.
★ Programmer can read, blank check, program and verify at any address/addresses on the EPROM.
★ Simple menu driven software supplied on cassette (transferable to disc).
★ Full editor with ASCII disassembler.
Programmer complete with cables, software and operating instructions: £89.00 - £2 p. & p.

PRODUCTION PROGRAM: P8000

P8000 provides reliable gang programming of up to 8 EPROMS simultaneously with device sizes up to 16k x 8 bytes. Devices supported range from 2704 to 27128 in single and three rail versions. Simple menu driven operation ensure easy eprom selection and reliable programming in minimum programming times. £695 + £6 carriage.

ACORN IEEE INTERFACE

This IEEE 488 standard interface is a general purpose system for exchanging digital data between a number of devices in a local area. The interface complies with the IEC 625-1 standard and can be connected to upto 14 other devices. Interface board is supplied complete with software in ROM, interconnecting cables IEEE cable for connection to an external device and a comprehensive manual. £282.50 + £2.50 carriage.

SMARTMOUTH

Speech Synthesiser for BBC
The 'infinite vocabulary' self-contained speech synthesiser unit. Uses only 5-10 bytes per word - no ROMs required - simply plugs into the user port. (Has Aux. Audio output skt.). Supplied with Demo/Development programs and simple software instructions, £37 + £2 p. & p.

NEW COMPREHENSIVE CATALOGUE AVAILABLE - PLEASE SEND FOR PRICE LIST

FLOPPY DISC INTERFACE

£84 + £15 installation

BBC COMPATIBLE DISC DRIVES

All drives are supplied with manual, form disc and cables.

Single Drive; 100k £150; 200k £180*;

400k £235

Single Drive with PSU: 100k £185; 200k £260; 400k £240

Dual Drive with PSU: 2 x 100k £330;

2 x 200k £400*; 2 x 400k £420

* These drives are switchable between 40/80 tracks, 40/80 Switch Module 1 x 400k and 2 x 400k Drive £32

DISKETTES: in packs of 10 W: Wabash M: 3M 40 track SSSD W: £15 M: £17.50; 40 track DSDD M: £22;

80 track SSDD W: £24 M: £26; 80 track DSDD W: £26 M: £30;

FLOPPICLENE Drive Head Cleaning Kit £14.50

Phone or send for our BBC leaflet

TORCH Z80 DISC PACK

Your BBC computer can be converted into a business machine with the addition of a TORCH Z80 disc pack. The Torch pack with twin disc drive and the Z80 processor card greatly enhances the computer's data storage and processing capability. Z80 card comes complete with 64K RAM and a CP/M compatible operating system. In addition to BBC owner's user guide and a systems disc the package is supplied with PERFECT software package comprising of DATABASE, WORD PROCESSOR & SPREADSHEET and COMANEX a interactive business management game. Complete Pakcage for £730 + £8 carr.

BOOKS (no VAT; p&p £1)

Advanced User Guide (£2 p&p)	£12.95
Assembly Lang. Prog. for BBC	£8.95
Assembly Lang. programming on BBC Micro by Ferguson and Shaw	£7.95
Basic Prog. for BBC	£5.95
BBC An Expert Guide	£6.95
Easy Programming on BBC	£5.95
Further Programming on BBC	£5.95
Introducing BBC Micro	£5.95
Programming the BBC	£6.50
30 Hour Basic	£5.95
35 Educational Programs	£6.95
BBC Sound & Graphics	£7.95
Creating Adventure Programs	£6.95
Discovering Machine Code	£6.95
Structured Programming	£6.50
The Friendly Computer Book BBC	£4.50
Beyond Basic BBC	£7.25

Many more books in stock.

EPROM ERASERS

UV1T Eraser with a built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays. It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. £59 + £2 p.p.
UV1 as above but without the timer £47 + £2 p.p.
UV140 up to 14 Eproms £61
UV141 as above but with timer £79

★★ ATTENTION ★★

All prices in this double page spread are subject to change without notice.

I.D. CONNECTORS

(Speedblock Type)

No. of Header Receptacle Conn.

10 90p 85p 120p

20 145p 125p 195p

26 175p 150p 240p

34 200p 160p 320p

40 220p 190p 340p

50 235p 200p 390p

Male

Soldered 80p 105p 160p 250p

Angled 150p 210p 250p 365p

Female

Soldered 105p 160p 200p 335p

Angled 165p 215p 290p 440p

Hoods 90p 85p 90p 100p

IDC 25-way plug 385p. Socket 450p

No. of ways 9 15 25 37

SOCKETS 24-pin £5.75

28-pin £8.00

TEXTOOL ZIF 40-pin £9.75

4-way 70p

6-way 100p

8-way 130p

10-way 150p

JUMPER LEADS

24" Ribbon Cable with Headers

1 end 2 ends 145p 165p 210p 230p 345p 540p

24" Ribbon Cable with Sockets

20 pin 26 pin 34 pin 40 pin

1 end 2 ends 160p 200p 280p 300p

Ribbon Cable with D Conn

25-way Male 500p Female 550p

Jumper Leads 40p 65p 165p 275p

30pin 40pin

14pin 40p 100p

16pin 50p 110p

24pin 100p 150p

40pin 200p 225p

14pin 210p 270p

21pin 230p 300p

21pin 240p 320p

21pin 250p 340p

21pin 260p 350p

21pin 270p 370p

21pin 280p 400p

21pin 290p 420p

21pin 300p 440p

21pin 310p 460p

21pin 320p 480p

21pin 330p 500p

21pin 340p 520p

21pin 350p 540p

21pin 360p 560p

21pin 370p 580p

21pin 380p 600p

21pin 390p 620p

21pin 400p 640p

21pin 410p 660p

21pin 420p 680p

21pin 430p 700p

21pin 440p 720p

21pin 450p 740p

21pin 460p 760p

21pin 470p 780p

21pin 480p 800p

21pin 490p 820p

21pin 500p 840p

21pin 510p 860p

21pin 520p 880p

21pin 530p 900p

21pin 540p 920p

21pin 550p 940p

21pin 560p 960p

21pin 570p 980p

21pin 580p 1000p

21pin 590p 1020p

21pin 600p 1040p

21pin 610p 1060p

21pin 620p 1080p

21pin 630p 1100p

21pin 640p 1120p

21pin 650p 1140p

21pin 660p 1160p

21pin 670p 1180p

21pin 680p 1200p

21pin 690p 1220p

21pin 700p 1240p

21pin 710p 1260p

21pin 720p 1280p

21pin 730p 1300p

21pin 740p 1320p

21pin 750p 1340p

21pin 760p 1360p

21pin 770p 1380p

21pin 780p 1400p

21pin 790p 1420p

21pin 800p 1440p

21pin 810p 1460p

21pin 820p 1480p

21pin 830p 1500p

21pin 840p 1520p

21pin 850p 1540p

21pin 860p 1560p

21pin 870p 1580p

21pin 880p 1600p

21pin 890p 1620p

21pin 900p 1640p

21pin 910p 1660p

21pin 920p 1680p

21pin 930p 1700p

21pin 940p 1720p

21pin 950p 1740p

21pin 960p 1760p

21pin 970p 1780p

21pin 980p 1800p

21pin 990p 1820p

21pin 1000p 1840p

21pin 1010p 1860p

21pin 1020p 1880p

21pin 1030p 1900p

21pin 1040p 1920p

21pin 1050p 1940p

21pin 1060p 1960p

21pin 1070p 1980p

21pin 1080p 2000p

21pin 1090p 2020p

21pin 1100p 2040p

21pin 1110p 2060p

21pin 1120p 2080p

21pin 1130p 2100p

21pin 1140p 2120p

21pin 1150p 2140p

21pin 1160p 2160p

21pin 1170p 2180p

21pin 1180p 2200p

21pin 1190p 2240p

21pin 1200p 2280p

21pin 1210p 2320p

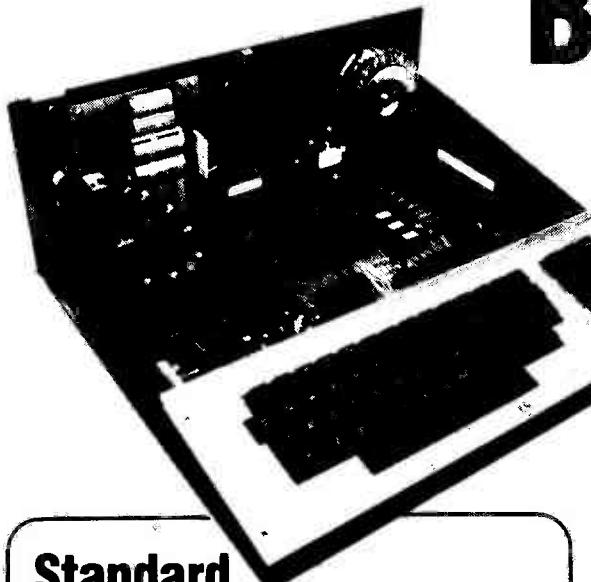
21pin 1220p 2360p

21pin 1230p 2400p

21pin 1240p 2440p

21pin 1250p 248

BUILD YOUR OWN **Cortex** -16bit, 64k RAM colour computer



Standard features —

- High speed 24K byte extended basic interpreter
 - Powerful TMS9995 16 bit microprocessor
 - 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		SOR	MOD	>=
ON	.	LOAD	TEXT	DIM	RUN	RND	KEY	><	
GOTO	1 UNIT	MOTOR	PLOT	LET	SIZE	? :	SYN	KEY	<=
GOSUB	BAUD	ESCAPE	UNPLOT	DEF	CONT	%	TIC	KEY	<>
POP	CALL	NOESC	COLOUR	NEW	MON	\$	ABS	SGN	OPERATORS
REM	DATA	RANDOM	CHAR	END	DELIMITERS		ADR	BIT	-
FOR	READ	ENTER	SPRITE	BIT	!	ASC	ATN	+	
NEXT	RESTOR	LIST	SHAPE	CRB	TO	:	CRB	LOR	/
ERROR	RETURN	PURGE	SPUT	CRF	TAB	!	SIN	CRF	*
INPUT	STOP	NUMBER	SGET	MEM	STEP	^	COS	AND	^
					THEN	&	MWD	LAND	
							EXP	NOT	
							FRA	LEN	
							MCH	LNOT	
							LYC0		

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 5 1/4" disc drives (SS)	£300.00
Pair of 5 1/4" disc drives (DS)	£590.00

*Full assembly instructions
and 216 page users manual*

POWERTRAN cybernetics ltd.

Portway Industrial Estate, Andover SP10 3ET. Tel: 0264 64455

to POWERTRAN CYBERNETICS LTD, Portway Industrial Estate,
Andover, Hants SP10 3ET.

Please send me

I enclose cheque for _____

Access/
Barclaycard
A/C No.

Name _____
Address _____

2

or charge to:



1

1

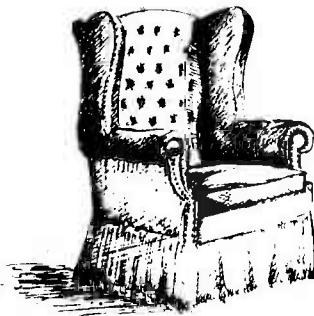
1

1

1

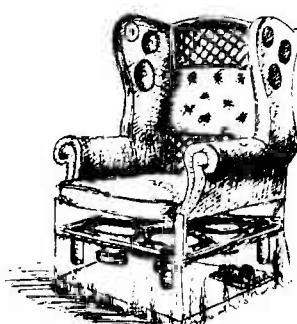
DIGEST

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

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 CR0 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,

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 Tannoy 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.

ogy 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.



This list contains only a fraction of CRICKLEWOOD'S stock. Please add 60p p&p & 15% VAT to all orders. Official orders from schools, colleges, Govt. Depts. etc. welcome.

PRICES ARE SUBJECT TO ALTERATION. PLEASE CONTACT SALES DESK FOR CURRENT PRICES, AND BEST U.K. DELIVERY TIMES

CRICKLEWOOD ELECTRONICS LTD
40 CRICKLEWOOD BROADWAY
LONDON NW2 3ET
01-452 0161/01-450 0995 Tlx: 914977

RESISTORS	Silicons	74S1	4072	19p	1 Amp T0220	4041	50p	23p	ZTX500	14p	6 Amp type	L480	2.99
CARTRIDGE FILM	AXIALS/Wires	74S161	4073	19p	7905T	57p	70p	23p	ZTX500	14p	Square with hole	SL490	3.47
5% HI STAR	each end	74S162	4073	19p	7912T	57p	1.80	23p	ZTX502	14p	W01/100 950	SN78003	2.95
LOW NOISE	Ufd	74S163	4075	19p	7913T	57p	1.00	23p	ZTX502	17p	PW02/200 99p	SN78013	2.95
100 TC	V	74S164	4076	45p	7915T	57p	1.00	23p	ZTX503	17p	PW04/1400/1.30	SN78023	2.40
10MD		74S165	4077	19p	7924T	57p	1.00	23p	ZTX504	24p	PW06/1600/1.39	SN78024	2.20
%WE24	2p	74S166	4078	19p					ZTX505	24p	Double Sided	TA7204	1.99
%WE24	2p	74S167	4081	19p					ZTX506	100p	100% 200 2.20	TA7205	1.20
1W/2E4	6p	74S168	4082	19p					ZTX531	25p		TA7222	1.76
2W/E4	12p	74S169	4083	19p					ZTX650	45p		TBA7222	1.76
METAL FILM	2.2	74S170	4086	60p	2N219A	27p	14p	BU109	3.29		TBA601	2.82	
ULTRA STABLE	2.2	74S171	4089	1.23	2N220	22p	28p	BU126	1.47	1N34A	TBA601	3.25	
0.4 W/EXTRA	2.2	74S172	4093	19p	2N221	22p	28p	BU127	1.47	1N821	TBA601	3.25	
LOW NOISE	2.2	74S173	4094	69p	2N223A	21p	51p	BU128	1.47	K051600	TBA601	4.10	
100 TO 1MΩ	2.2	74S174	4095	69p	2N224	24p	42p	BU129	1.47	WB4	TBA601	3.09	
2% E24	5p	74S175	4096	60p	2N224A	25p	42p	BU130	1.47	WB488	TBA601	2.85	
1% E24	3.3	74S176	4097	2.88p	2N224B	25p	42p	BU131	1.47	WB488	TBA601	2.85	
LOW OHMIC	4.7	74S177	4098	74p	2N223A	4.15	AC176	BU132	3.95	WB488	TBA601	2.75	
GLAZE XW	4.7	74S178	4099	89p	2N236B	28p	45p	BU133	3.95	WB488	TBA601	2.75	
0.220 to 8.20	4.7	74S179	4100	55p	2N236A	25p	45p	BU134	3.95	WB488	TBA601	2.75	
E24 11p	4.7	74S180	4101	55p	2N236C	28p	45p	BU135	3.95	WB488	TBA601	2.75	
WIRE WOUND	10	74S181	4102	19p	2N237A	4.15	AC177	BU136	3.95	WB488	TBA601	2.75	
ON CERAMIC	10	74S182	4103	19p	2N237B	4.15	AC178	BU137	3.95	WB488	TBA601	2.75	
E 12 SERIES	10	74S183	4104	19p	2N237C	4.15	AC179	BU138	3.95	WB488	TBA601	2.75	
2 to 3W 0.22f	10	74S184	4105	19p	2N238A	4.15	AC179	BU139	3.95	WB488	TBA601	2.75	
10 to 2W 0.26p	10	74S185	4106	19p	2N238B	4.15	AC179	BU140	3.95	WB488	TBA601	2.75	
4 to 7W 0.47p	22	74S186	4107	19p	2N238C	4.15	AC179	BU141	3.95	WB488	TBA601	2.75	
to 6K8	22	74S187	4108	19p	2N239A	4.15	AC179	BU142	3.95	WB488	TBA601	2.75	
10 to 11W 1n	22	74S188	4109	19p	2N239B	4.15	AC179	BU143	3.95	WB488	TBA601	2.75	
to 33K	37p	74S189	4110	19p	2N239C	4.15	AC179	BU144	3.95	WB488	TBA601	2.75	
POIS &	47	74S190	4111	19p	2N240A	4.15	AC179	BU145	3.95	WB488	TBA601	2.75	
PRESETS	47	74S191	4112	19p	2N240B	4.15	AC179	BU146	3.95	WB488	TBA601	2.75	
As above with DP Mains Switch	88p	74S192	4113	19p	2N240C	4.15	AC179	BU147	3.95	WB488	TBA601	2.75	
As above stereo switch	80p	74S193	4114	19p	2N241A	4.15	AC179	BU148	3.95	WB488	TBA601	2.75	
PRESETS (DUSTPROOF)	47	74S194	4115	19p	2N241B	4.15	AC179	BU149	3.95	WB488	TBA601	2.75	
E310C100(10M)	47	74S195	4116	19p	2N241C	4.15	AC179	BU150	3.95	WB488	TBA601	2.75	
Min/Virt 15p	47	74S196	4117	19p	2N242A	4.15	AC179	BU151	3.95	WB488	TBA601	2.75	
Mini Horiz 15p	47	74S197	4118	19p	2N242B	4.15	AC179	BU152	3.95	WB488	TBA601	2.75	
Standard Vert 18p	47	74S198	4119	19p	2N242C	4.15	AC179	BU153	3.95	WB488	TBA601	2.75	
Standard Horiz 18p	47	74S199	4120	19p	2N243A	4.15	AC179	BU154	3.95	WB488	TBA601	2.75	
CERMET 20	74LS TTL	4121	19p	2N243B	4.15	AC179	BU155	3.95	WB488	TBA601	2.75		
TURN PRECISION	74LS TTL	4122	19p	2N243C	4.15	AC179	BU156	3.95	WB488	TBA601	2.75		
PRESETS	47	74S200	4123	19p	2N244A	4.15	AC179	BU157	3.95	WB488	TBA601	2.75	
RADIALS (PCB)	47	74S201	4124	19p	2N244B	4.15	AC179	BU158	3.95	WB488	TBA601	2.75	
50Ω to 500Ω 89p	74S202	4125	19p	2N244C	4.15	AC179	BU159	3.95	WB488	TBA601	2.75		
CAPS		74S203	4126	19p	2N245A	4.15	AC179	BU160	3.95	WB488	TBA601	2.75	
CERAMIC 100V DISC PLATE	10	74S204	4127	19p	2N245B	4.15	AC179	BU161	3.95	WB488	TBA601	2.75	
E12 MICRO MINI TYPICALLY	10	74S205	4128	19p	2N245C	4.15	AC179	BU162	3.95	WB488	TBA601	2.75	
5% 1nF to 10nF 7p	10	74S206	4129	19p	2N246A	4.15	AC179	BU163	3.95	WB488	TBA601	2.75	
POLYCARB 5%	20	74S207	4130	19p	2N246B	4.15	AC179	BU164	3.95	WB488	TBA601	2.75	
SIEMENS 5.5mm	40	74S208	4131	19p	2N246C	4.15	AC179	BU165	3.95	WB488	TBA601	2.75	
MINI BLOC E12	40	74S209	4132	19p	2N247A	4.15	AC179	BU166	3.95	WB488	TBA601	2.75	
4 to 6nF 8p	40	74S210	4133	19p	2N247B	4.15	AC179	BU167	3.95	WB488	TBA601	2.75	
Bn to 6nF 8p	40	74S211	4134	19p	2N247C	4.15	AC179	BU168	3.95	WB488	TBA601	2.75	
6nF to 15nF 10p	40	74S212	4135	19p	2N248A	4.15	AC179	BU169	3.95	WB488	TBA601	2.75	
100nF to 150nF 11p	40	74S213	4136	19p	2N248B	4.15	AC179	BU170	3.95	WB488	TBA601	2.75	
100nF to 270nF 14p	40	74S214	4137	19p	2N248C	4.15	AC179	BU171	3.95	WB488	TBA601	2.75	
300nF to 390nF 20p	40	74S215	4138	19p	2N249A	4.15	AC179	BU172	3.95	WB488	TBA601	2.75	
470nF to 560nF 20p	40	74S216	4139	19p	2N249B	4.15	AC179	BU173	3.95	WB488	TBA601	2.75	
680nF 20p	40	74S217	4140	19p	2N249C	4.15	AC179	BU174	3.95	WB488	TBA601	2.75	
1μF 100mF 35p	40	74S218	4141	19p	2N250A	4.15	AC179	BU175	3.95	WB488	TBA601	2.75	
POLYESTER 1μF	40	74S219	4142	19p	2N250B	4.15	AC179	BU176	3.95	WB488	TBA601	2.75	
250nF RADIAL 1μF	40	74S220	4143	19p	2N250C	4.15	AC179	BU177	3.95	WB488	TBA601	2.75	
CARD 1μF	40	74S221	4144	19p	2N251A	4.15	AC179	BU178	3.95	WB488	TBA601	2.75	
10nF 15nF 33nF	40	74S222	4145	19p	2N251B	4.15	AC179	BU179	3.95	WB488	TBA601	2.75	
22nF 68nF 47nF	40	74S223	4146	19p	2N251C	4.15	AC179	BU180	3.95	WB488	TBA601	2.75	
100nF 150nF 10p	40	74S224	4147	19p	2N252A	4.15	AC179	BU181	3.95	WB488	TBA601	2.75	
100V 100nF 11p	40	74S225	4148	19p	2N252B	4.15	AC179	BU182	3.95	WB488	TBA601	2.75	
180nF to 270nF 14p	40	74S226	4149	19p	2N252C	4.15	AC179	BU183	3.95	WB488	TBA601	2.75	
330nF to 390nF 20p	40	74S227	4150	19p	2N253A	4.15	AC179	BU184	3.95	WB488	TBA601	2.75	
470nF to 470nF 20p	40	74S228	4151	19p	2N253B	4.15	AC179	BU185	3.95	WB488	TBA601	2.75	
680nF 20p	40	74S229	4152	19p	2N253C	4.15	AC179	BU186	3.95	WB488	TBA601	2.75	
1μF 1nF 35p	40	74S230	4153	19p	2N254A	4.15	AC179	BU187	3.95	WB488	TBA601	2.75	
1.5μF 39p	40	74S231	4154	19p	2N254B	4.15	AC179	BU188	3.95	WB488	TBA601	2.75	
2.2μF 39p	40	74S232	4155	19p	2N254C	4.15	AC179	BU189	3.95	WB488	TBA601	2.75	
FEEDTHROUGH 4726	40	74S233	4156	19p	2N255A	4.15	AC179	BU190	3.95	WB488	TBA601	2.75	
HIGH VOLTAGE Capacitors please enquire many types in stock	40	74S234	4157	19p	2N255B	4.15	AC179	BU191	3.95	WB488	TBA601	2.75	
1.5V 39p	40	74S235	4158	19p	2N255C	4.15	AC179	BU192	3.95	WB488	TBA601	2.75	
2.2V 39p	40	74S236	4159	19p	2N256A	4.15	AC179	BU193	3.95	WB488	TBA601	2.75	
4.7V 44p	40	74S237	4160	19p	2N256B	4.15	AC179	BU194	3.95	WB488	TBA601	2.75	
4.7V 44p	40	74S238	4161	19p	2N256C	4.15	AC179	BU195	3.95	WB488	TBA601	2.75	
4.7V 44p	40	74S239	4162	19p	2N257A	4.15	AC179	BU196	3.95	WB488	TBA601	2.75	
4.7V 44p	40	74S240	4163	19p	2N257B	4.15	AC179	BU197	3.95	WB488	TBA601	2.75	
4.7V 44p	40	74S241	4164	19p	2N257C	4.15	AC179	BU198	3.95	WB488	TBA601	2.75	
4.7V 44p	40	74S242	4165	19p	2N258A	4.15	AC179	BU199	3.95	WB488	TBA601	2.75	
4.7V 44p	40	74S243	4166	19p	2N258B	4.15	AC179	BU200	3.95	WB488	TBA601	2.75	
4.7V 44p	40	74S244	4167	19p	2N258C	4.15	AC179	BU201	3.95	WB488	TBA601	2.75	
4.7V 44p	40	74S245	4168	19p	2N259A	4.15	AC179						

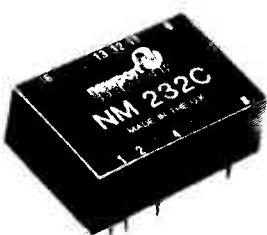


2 Inch Video Monitor

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

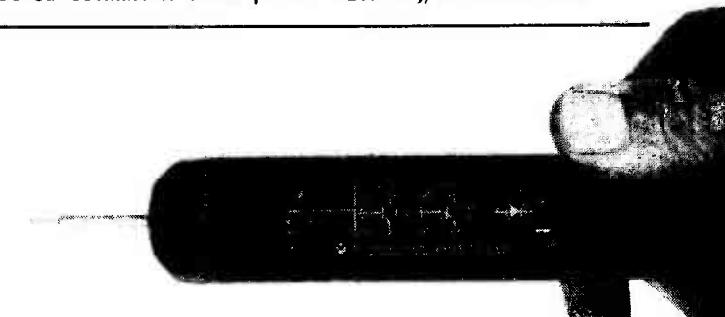


battery powered designs requiring RS232C capability with low power consumption. The device uses less board space than the standard integrated circuit solution and does not require $\pm 12V$ supply rails. Indeed the internally generated positive and negative supplies are also made available for external use, although at limited current levels. Newport Components Ltd, 134 Tanners Drive, Blakelands North, Milton Keynes MK14 5BP, tel 0908-615232.

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 49 mm, 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.



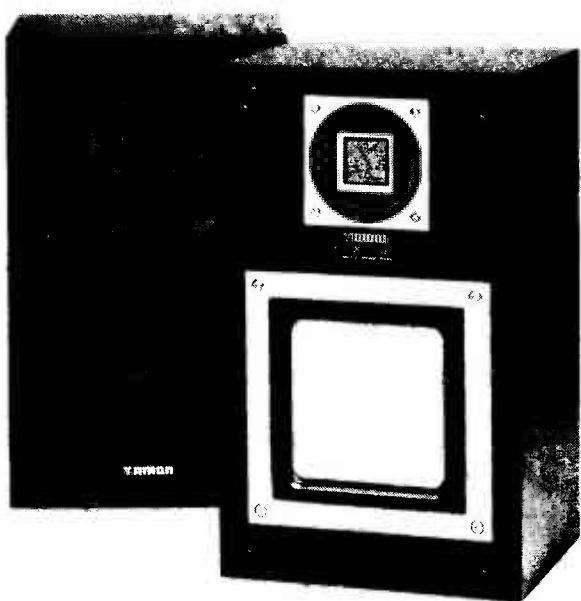
Hand-held Transistor Tester

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 identified 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.

COMPUTER WAREHOUSE

1000's OF BARGAINS FOR CALLERS

THE ALADDIN'S CAVE OF COMPUTER AND ELECTRONIC EQUIPMENT

HARD DISK DRIVES

Fully refurbished DIABLO/DRE series 30 2.5 Mb disk drives. DEC RK05, NOVA, TEXAS compatible.

Front load. Free stand or rack mount
Exchangeable type (via lid removal)

me3029 PSU unit for 2 drives

£550.00
£295.00
£725.00

DIABLO/DRE 44-4000/A/B 5+5 ex stock from 1000's of spares for S30, 4000, 3200, HAWK ex stock.

Plus in house repair, refurbishing service.

Call for details or quotation.

£995.00

£995.00

£995.00

SOLID STATE SWITCHES

Matchbox size solid state switch type IR D2402 enables on off control of 240 V AC loads up to 600 watts, direct from your micro etc. Fully isolated 3-32 v DC input with zero voltage switching.

Complete with data £6.99 + pp

250,000 other relays EX STOCK call for details.

COOLING FANS

Keep your hot parts COOL and RELIABLE with our range of BRAND NEW professional cooling fans.

ETRI 99XUOI Dim. 92 x 92 x 25 mm. Miniature 240 v equipment fan complete with finger guard. £9.95.

GOULD JB-3AR Dim. 3" x 3" x 2.5" compact very quiet running 240 v operation. NEW £8.95. BUHLER 69.11.22. 8-16 v DC micro miniature reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Measures only 62 x 62 x 22 mm. Current cost £32.00. OUR PRICE ONLY £19.95 complete with data.

MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 & 10 v at £4.95 or BRAND NEW 240 v at £10.50. 1000's of others Ex Stock. Call for Details. Post & Packing all items £1.60

8" WINCHESTERS

BASF 6172 23 mb 8" Winchester disk drive. Complete unit consists of sealed cavity with 3 x 8" platters and CPU based control logic on 3 PCB's. Multiplexed i/o with the BASF "DISK BUS" interface is via a single 40 way cable. Units have been carefully removed from beloved working equipment - but at the staggering price of ONLY £125.00 are sold without guarantee. Supplied complete with 200 + page tech manual. Additional +5V DC, -12VDC, +24VDC £65.00. Carriage & Ins £10.00

SOFTY 2

The amazing SOFTY 2. The complete "toolkit" for the open heart software surgeon. Copies, Displays, Emulates ROM, RAM and EPROMS of the 2516, 2532 variety. Many other features include keyboard, UHF modulator. Cassette interface etc. Functions exceed capabilities of units costing 7 times the price! Only £169.00 pp £1.95 Data sheet on request

DATA MODEMS

Join the communications revolution with our range of EX TELECOM data modems. Made to most stringent spec and designed to operate for 24 hrs per day. Units are made to the CCITT tone spec. With RS232 i/o levels via a 25 way D skt. Units are sold in a tested and working condition with data. Permission may be required for connection to PO lines.

MODEM 2B "Hackers Special" fully fledged up to 300 baud full duplex. ANSWER or CALL modes. AUTO ANSWER. Data /o via standard RS232 25 way D socket. Just 2 wire connection to comms line, ideal networks etc. Complete with data, tested, ready to run at a NEW SUPER LOW PRICE of ONLY £65.00 + VAT + Carriage.

MODEM 20-1 Compact unit for use with MICRONET, PRESTEL or TELECOM GOLD etc. 2 wire direct connect. 75 baud transmit 1200 baud receive. Data /o via RS232 D' socket. Guaranteed working with data £49.95. MODEM 20-2 same as 20-1 but 75 baud receive 1200 baud transmit £130.00

DATEL 4800 sync service. RACAL type MPS4800 ex TELECOM good condition. £195.00 + VAT.

NEW DSL2123 Multi Standard modem selectable V21 300-300 bps, V23 75-1200, V23 1200-75 full duplex. Or 1200-1200 half duplex modes. Full auto answer via modem or CPU. LED status indicators. CALL or ANS modes. Switchable CCITT or BELL 103 & 202. Housed in ABS case size only 25" x 8.5" x 8" £286.00 + VAT

For further data or details on other EX STOCK modems contact sales office.

Carriage on all modems £10.00 + VAT.

HOT LINE DATA BASE

DISTEL C

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

01-679 1888

MAINS FILTERS

Cure those unnerving hang ups and data glitches caused by mains interference.

SD5A As recommended by ZX81 news letter, matchbox size up to 1000 watt load L2179 compact completely cased unit with 3 pin fitted socket.

Up to 750 watts

£5.95
£9.99

**SAVE
£250**

SUPER PRINTER SCOOP BRAND NEW CENTRONICS 739-2

The "Do Everything Printer" at a price that will NEVER be repeated. Standard CENTRONICS parallel interface for direct connection to BBC,

ORIC, DRAGON etc. Superb print quality with full pin addressable graphics and 4 type fonts plus

HIGH DEFINITION internal PROPORTIONAL SPACED MODE for WORD PROCESSOR applications. 80-132 columns, single sheet, sprocket or roll paper handling plus much more. Available ONLY from DISPLAY ELECTRONICS at the ridiculous price of ONLY £199.00 + VAT Complete with full manual etc. Limited time offer - Hurry while stocks last.

Options: Interface cable (specify) for BBC, ORIC, DRAGON or CENTRONICS 36 way pig £12.50. Spare ribbon £3.00. BBC graphics screen dump utility program £8.50. Carriage and Insurance £10. V.A.T.

COMPUTER 'CAB'

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

VIDEO MONITORS

5" CASED Superb little unit made by HITACHI in ergonomically designed free standing case. Very high definition will display small but readable 132 columns wide! 12v DC opp. @ 800 ma, so ideal for mobile use. Supplied in AS NEW condition complete with data. Composite 75 ohm vid in. Black & White CRT £45.00 or Green CRT £55.00 Carr & Ins £5.00.

12" CASED. Made by the British KGM Co. Designed for continuous use as a data display station, unit is totally housed in an attractive brushed aluminium case with ON-OFF, BRIGHTNESS and CONTRAST controls mounted to one side. Much attention was given to construction and reliability of this unit with features such as, internal transformer isolated regulated DC supply, all components mounted on two fibre glass PCB boards - which hinge out for ease of service, many internal controls for linearity etc. The monitor accepts standard 75 ohm composite video signal via SO239 socket on rear panel. Bandwidth of the unit is estimated around 20 MHz and will display most high def graphics and 132 x 24 lines. Units are secondhand and may have screen burns. However where burns exist they are only apparent when monitor is switched off. Although unguaranteed all monitors are tested prior to despatch. Dimensions approx. 14" high x 14" wide by 11" deep. Supplied complete with circuit 240 volt AC operation. ONLY £49.00 PLUS £9.50 Carr & AC

24" CASED. Again made by the KGM Co with a similar spec as the 12" monitor. Originally used for large screen data display. Very compact unit in lightweight alloy case dim. 19" H x 17" D x 22" W. All silicon electronics and composite video input make an ideal unit for schools, clubs, shops etc. Supplied in a used but working condition

SEMICONDUCTOR 'GRAB BAGS'

Mixed Semis amazing value contents include transistors, digital, linear, I.C.'s triacs, diodes, bridge rectifiers, etc. All devices guaranteed brand new full spec with manufacturer's markings, fully guaranteed. 50+ £2.95 100+ £5.15.

TTL 74 Series A gigantic purchase of an "across the board" range of 74 TTL series I.C.'s enables us to offer 100+ mixed "mostly TTL" grab bags at a price which two or three chips in the bag would normally cost to buy. Fully guaranteed all I.C.'s full spec. 100+ £6.90 200+ £12.30 300+ £19.50

DEC CORNER

MOSTEK CRT 80E Brand new dual eurocard, Z80 based VT1000 PLUS emulator with graphics etc

BA11-M 3.5" Box, PSU, LTC

DLV11-J 4 x EIA interface

RK05-J 2.5 Mb disk drives

PDP1105 Cpu, Ram, I/o, etc.

RT11 ver. 3B doc kit

LA36 Decwriter EIA or 20 ma

KLBJA PDP 8 async i/o

MIBE PDP 8 Bootstrap option

DILOG DQ100 RK05 LIS 4 x RK05 disk controller

LAXX-NW LA180 RS232 serial interface and buffer option

LA34-AL LA34 tractor feed

1000's of EX STOCK spares for DEC PDP8 PDP11 PDP15 & peripherals.

Call for details. All types of Computer equipment and spares wanted for prompt

CASH PAYMENT

SUPER DEAL? NO - SUPER STEAL!! The FABULOUS 25 CPS TEC Starwriter

BRAND NEW AT ONLY £499 + VAT

Made to the very highest spec the TEC Starwriter FP1500-25 features a heavy duty die cast chassis and DIABLO type print mechanism giving superb registration and print quality. Microprocessor electronics offer full DIABLO/QUOME command compatibility and full control via CPM Wordstar etc.

Many other features include bi directional printing, switchable 10 or 12 pitch, full width 381 mm paper handling with upto 163 characters per line, friction feed rollers for single sheet or continuous paper, internal buffer, standard RS232 serial interface with handshake.

Supplied absolutely BRAND NEW with 90 day guarantee and FREE daisy wheel and dust cover. Order NOW or contact sales office for more information

Optional extras: RS232 data cable £10.00. Tech manual £7.50. Tractor feed £140.00. Spare daisy wheel £3.00. Carriage & Ins. (UK Mainland) £10.00.

Save over £400

a fraction of its original cost.

66% DISCOUNT

ELECTRONIC COMPONENTS EQUIPMENT

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

2.5kls £4.25 + pp £1.25

5kls £5.90 + £1.80

10kls £10.25 + pp £2.25

20 kls £17.50 + £4.75

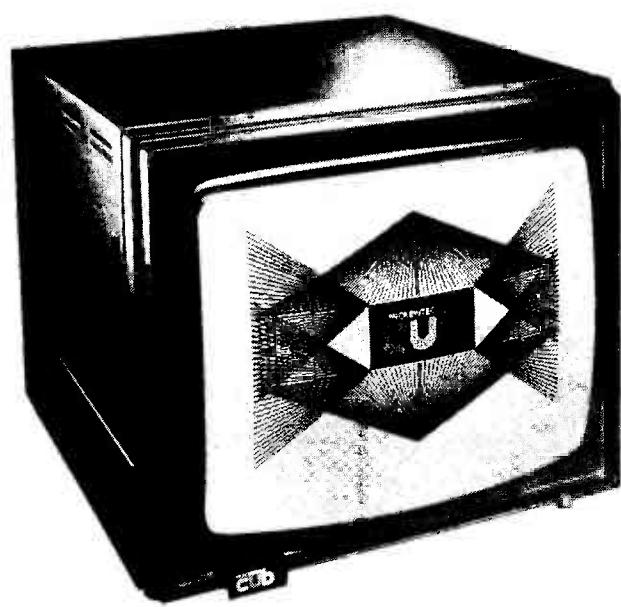
ALL PRICES PLUS VAT

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

DISPLAYS
-ELECTRONICS-

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





Spectrum-Compatible Colour Monitor

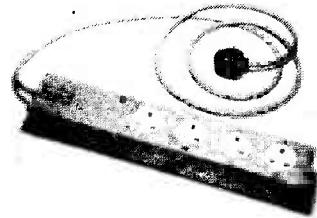
After a period of selling to the education market, Microvitec have launched their Sinclair Spectrum-compatible colour

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.

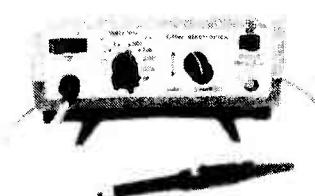
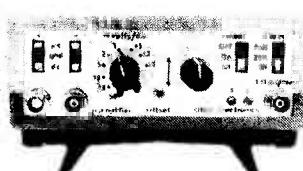
a bandwidth limiting switch is provided to reduce the upper frequency limit to 20KHz or 1KHz.

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 oscilloscope for very low level signal observation.

rejection. The output remains constant at 100mV/division giving a useful gain boost for older, less sensitive 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.



The μ amplifier enables signals as minute as 100 μ V from DC to 2MHz to be viewed and measured on most oscilloscopes. The amplifier offers sensitivities from 100 μ V/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

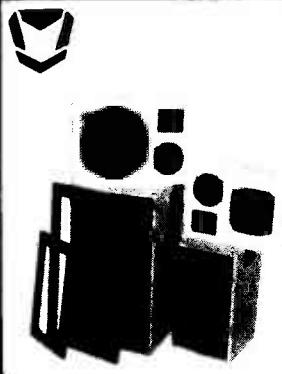
The isolation amplifier offers a safe way of making measurements on floating circuits up to 1,500V from ground. The input amplifier offers sensitivities from 10mV/division to 5V/division (50V with probe set to X10) AC or DC coupled. Signals from the input amplifier are coupled to the output amplifier by a pair of differentially connected optocouplers, thus ensuring good linearity and high common mode

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 previously requiring the use of several components to be realised in a minimum of printed circuit board area.

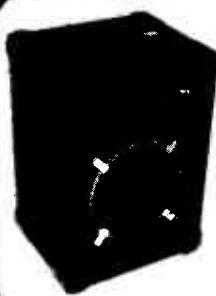
For further details, or a complete 400-page catalogue listing over 7500 components, contact Verospeed, Stansted Road, Boyatt Wood Industrial Estate, Eastleigh, Hants, tel 0703 641111.



MULLARD SPEAKER KITS

Purposely designed 40 watt R.M.S. and 30 watt R.M.S. 8 ohm speaker systems recently developed by MULLARD'S specialist team in Belgium. Kits comprise Mullard woofe (8" or 5") with foam surround and aluminium voice coil. Mullard 3" high power domed tweeter. B.K.E. built and tested crossover based on Mullard circuit, combining low loss components, glass fibre board and recessed loudspeaker terminals. SUPERB SOUNDS AT LOW COST. Kits supplied in polystyrene packs complete with instructions. 8" 40W system - recommended cabinet size 240 x 216 x 445mm Price £14.90 each + £2.00 P & P. 5" 30W system - recommended cabinet size 160 x 175 x 295mm Price £13.90 each + £1.50 P & P.

Designer approved flat pack cabinet kits, including grill fabric. Can be finished with iron on veneer or self adhesive vinyl etc. 8" system cabinet kit £9.00 each + £2.50 P & P. 5" system cabinet kit £7.00 each + £2.00 P & P.



OMP 12 LOUDSPEAKER

The very best in quality and value.

Ported tuned cabinet in hard-wearing black vinyl with protective corners and carry handle. Built and tested, employing 12in British driver and Piezo tweeter. Spec 100 watts RMS; 8 ohms; 45Hz-20KHz; Size: 20in x 15in x 12in; Weight: 30 pounds.

Price: £63.00 each

£120 per pair

Carriage: £5 each £7 per pair

BK ELECTRONICS

Prompt Deliveries
VAT inclusive prices
Audio Equipment
Test Equipment by Thandar and Leader

PANTEC

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

FM MICROTRANSMITTER (BUG) 90/105MHz with very sensitive microphone. Range 100/300 metres. 57 x 46 x 14mm (9 volt)

Price: £7.99p

DIGITAL THERMOMETER -9.9 C to +99.9 C. LED display. Complete with sensor. 70 x 70 mm (9 volt) Price: £27.80p

3 WATT FM TRANSMITTER 3 WATT 85/115MHz varicap controlled, professional performance. Range up to 3 miles 35 x 84 x 12 mm (12 volt) Price: £12.49p

SINGLE CHANNEL RADIO CONTROLLED TRANSMITTER/ RECEIVER 27MHz Range up to 500 metres. Double coded modulation. Receiver output operates relay with 2amp/240 volt contacts. Ideal for many applications. Receiver 90 x 70 x 22 mm 9/12 volt) Price: £16.49 Transmitter 80 x 50 x 15 mm (9/12 volt) Price £10.29 P&P All Kits + 75p each S.A.E. for complete list.



3 watt FM Transmitter

BSR P256 TURNTABLE

P256 turntable chassis • S shaped tone arm • Belt driven • Aluminium platter • Precision calibrated counter balance • Anti-skate (bias device) • Damped cueing lever • 240 volt AC operation (Hz) • Cut out template supplied • Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required

Price £32.35 each. £2.50 P&P



OMP POWER AMPLIFIER MODULE

READY BUILT



NEW OMP100 Mk.II POWER AMPLIFIER MODULE Power Amplifier Module complete with integral heat sink, toroidal transformer power supply and glass fibre PCB assembly. Incorporates drive circuit to power a compatible LED Vu meter. New improved specification makes this amplifier ideal for P.A., Instrumental and Hi-Fi applications.

SPECIFICATION

Output Power:— 110 watts R.M.S.
Loads:— Open and short circuit proof 4/16 ohms.

Frequency Response:— 15Hz - 30KHz -3dB.

T.H.D.:— 0.01%.

S.N.R. (Unweighted):— -118dB ±3.5dB.

Sensitivity for Max Output:— 500mV @ 10K.

Cone 8 ohm imp. Res. Freq. 45Hz. Price £24.00 + £3 carriage.

12" 85 watt R.M.S. McKENZIE C1285GP (LEAD GUITAR, KEYBOARD, DISCO) 2" aluminium voice coil, aluminium centre dome. 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 6.5kHz, Sens. 98dB. Price £24.00 + £3 carriage.

12" 85 watt R.M.S. McKENZIE C1285TC (P.A., DISCO) 2" aluminium voice coil. Twin cone 8 ohm imp., Res. Freq. 45Hz., Freq. Resp. to 14KHz. Price £24.00 + £3 carriage.

16" 150 watt R.M.S. McKENZIE C16 (BASS GUITAR, P.A.) 3" aluminium voice coil. Die cast chassis. 8 ohm imp., Res. Freq. 40Hz., Freq. Resp. to 4KHz. Price £49.95 + £4 carriage. Cabinets fixings in stock S.A.E.

New model.
Improved specification

MOSFET versions available up to 300W. R.M.S.

HOME PROTECTION SYSTEM

Better to be 'Alarmed' than terrified.

Thandar's famous 'Minder' Burglar Alarm System. Superior microwave principle. Supplied as three units, complete with interconnection cable. **FULLY GUARANTEED.**

Control Unit — Houses microwave radar unit, range up to 15 metres adjustable by sensitivity control. Three position, key operated facia switch — off — test — armed. 30 second exit and entry delay.

Indoor alarm — Electronic swept freq. siren, 10dB output.

Outdoor Alarm — Electronic swept freq. siren, 98dB output. Housed in a tamper-proof heavy duty metal case.

Both the control unit and outdoor alarm contain rechargeable batteries which provide full protection during mains failure. Power requirement 200/260 Volt AC 50/60Hz. Expandable with door sensors, panic buttons etc. Complete with instructions.

SAVE £128 Usual price £228.85

BKE's PRICE £99.95 P&P

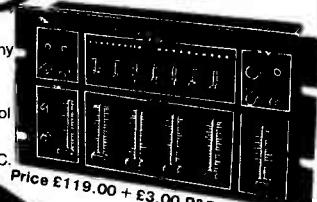
S.A.E. for colour brochure

READY BUILT



Thandar
SECURITY

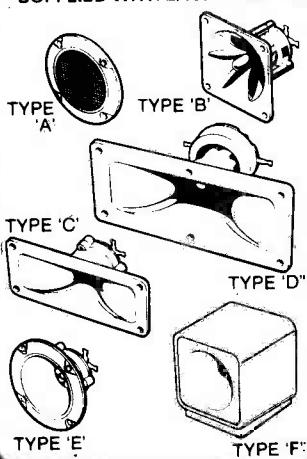
STEREO DISCO MIXER



Price £119.00 + £3.00 P&P.

PIEZOELECTRIC TWEETERS - MOTOROLA

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



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium size Hi-Fi speakers. Price £4.99 each.

TYPE 'B' (KSN1005A) 3 1/2" super horn. For general purpose speakers, disco and P.A. systems etc. Price £4.99 each.

TYPE 'C' (KSN6016A) 2" x 5" wide dispersion horn. For quality Hi-Fi systems and quality discs etc. Price £5.99 each.

TYPE 'D' (KSN1025A) 2" x 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-Fi systems and quality discs. Price £7.99 each.

TYPE 'E' (KSN1038A) 3" horn tweeter with attractive silver finish trim. Suitable for Hi-Fi monitor systems etc. Price £4.99 each.

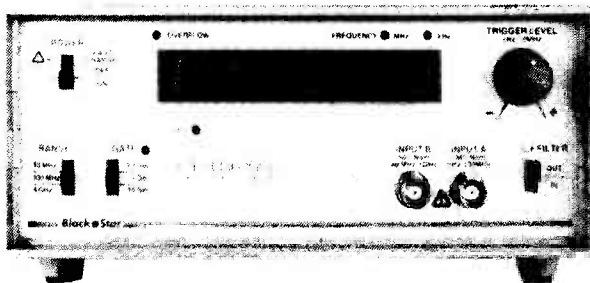
TYPE 'F' (KSN1057A) Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. Price £10.75 each

P&P 30p ea. (or SAE for Piezo leaflets).

B.K. ELECTRONICS

UNIT 5, COMET WAY, SOUTHEND-ON-SEA, ESSEX, SS2 6TR

★ SAE for current lists. ★ Official orders welcome. ★ All prices include VAT. ★ Sales Counter. ★ Please phone 0702 527572 ★
★ All items packed where applicable in special energy absorbing PU foam. ★



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 $\pm 0.5\text{ppm}$ from -10°C to $+40^\circ\text{C}$, and an ageing rate of $<\pm 1\text{ppm}$ per year, and setability of $<\pm 0.2\text{ppm}$. 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 filter 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.

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 SO10HX, 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 Silicon 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 Bridge 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. Bridge 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 Microelectronics, 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.

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 Microron. So hang in there, TUG members, and wait and see what happens.

- 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 discusses 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.

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 NW 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.

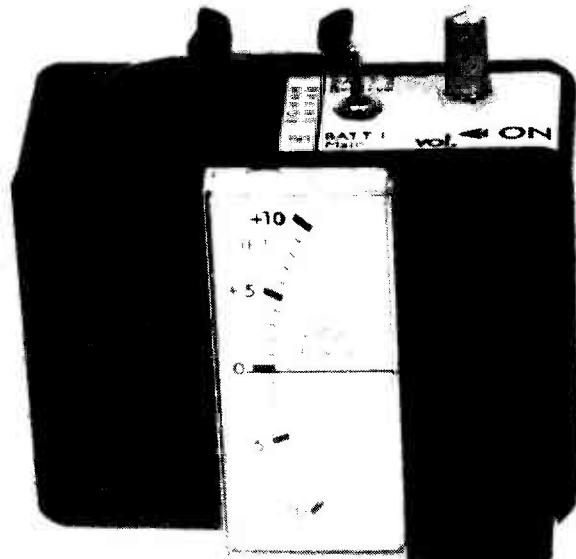
The circuit described generates interrupted tone audio, the type recognised as being the easiest to follow. It sounds as a series of

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 2 Hz at zero lift and progresses steadily to 4 Hz 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

PROJECT : Vertical Speed Indicator

(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 eliminate 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 pur-

poses, 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 (± 1000 fpm) at the output is $\pm 1.25V$, which corresponds to $\pm 18\mu V$ at the transducer output.

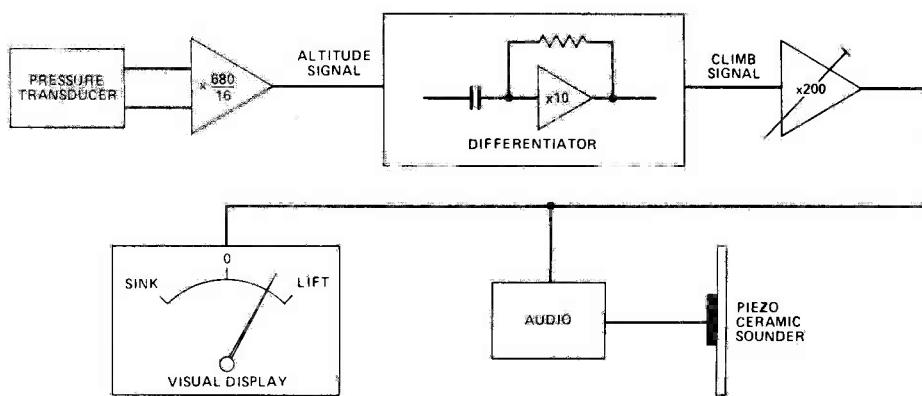


Fig. 1 Block diagram of the vario.

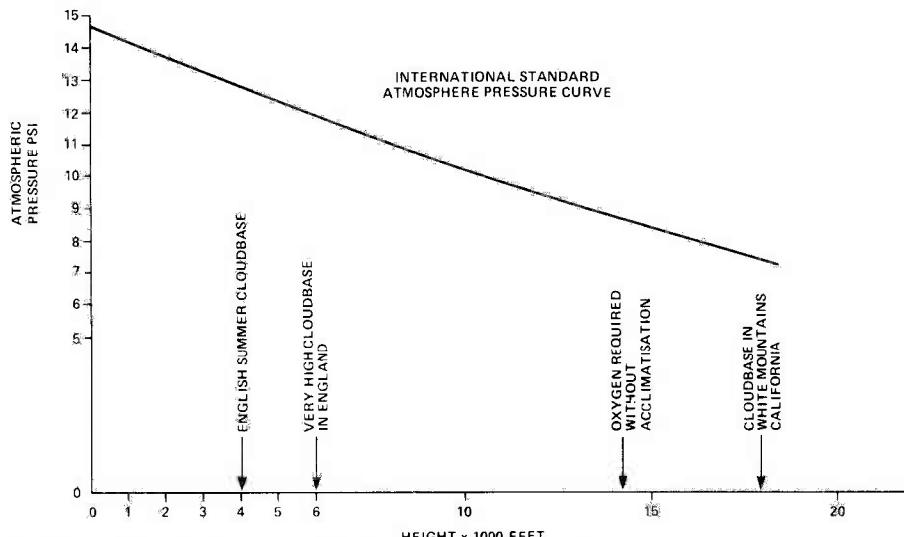


Fig. 2 International Standard Atmosphere (ISA) curve.

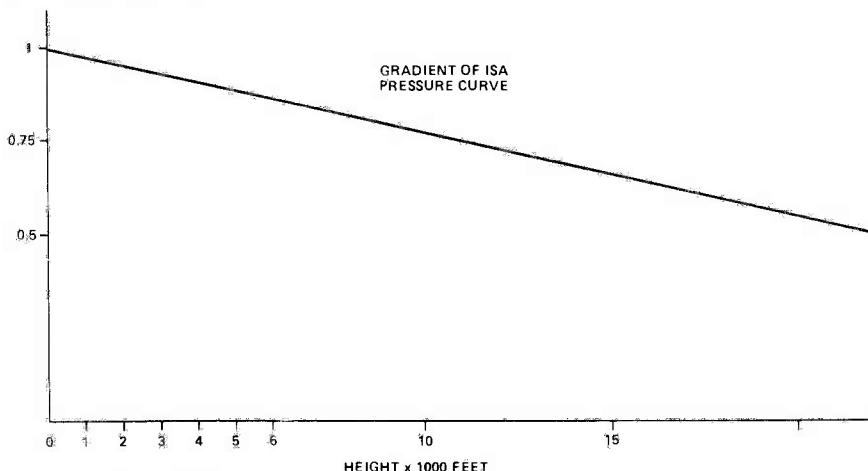


Fig. 3 Gradient of ISA pressure curve.

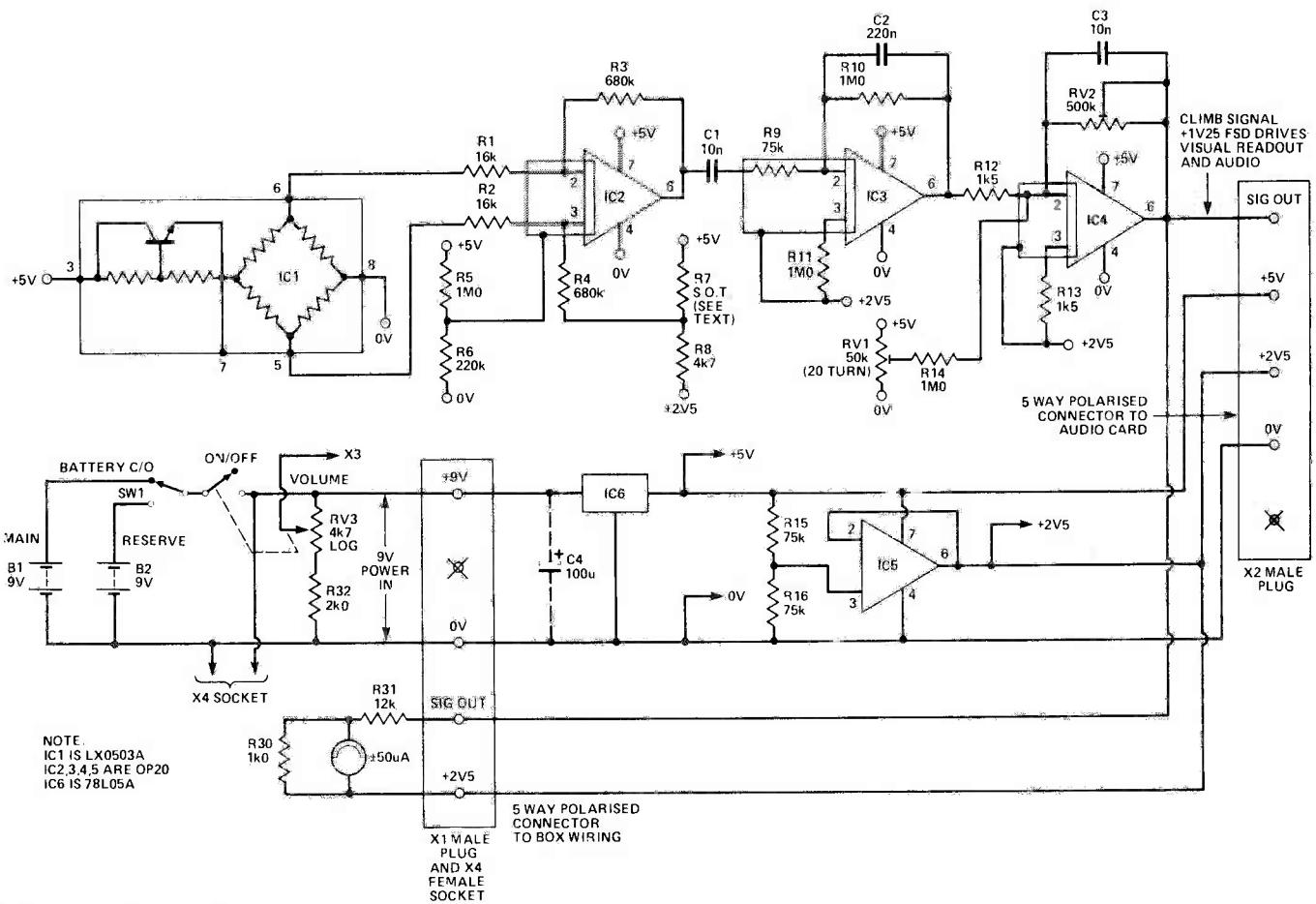


Fig. 4 Circuit diagram of the vario.

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, pins 5 and 6 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 $\pm 1000'$). 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 10 μ F capacitor, C1, is never more than ± 0.25 V at switch on. Too large a voltage across this capacitor at switch on would cause too much dielectric absorption 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.

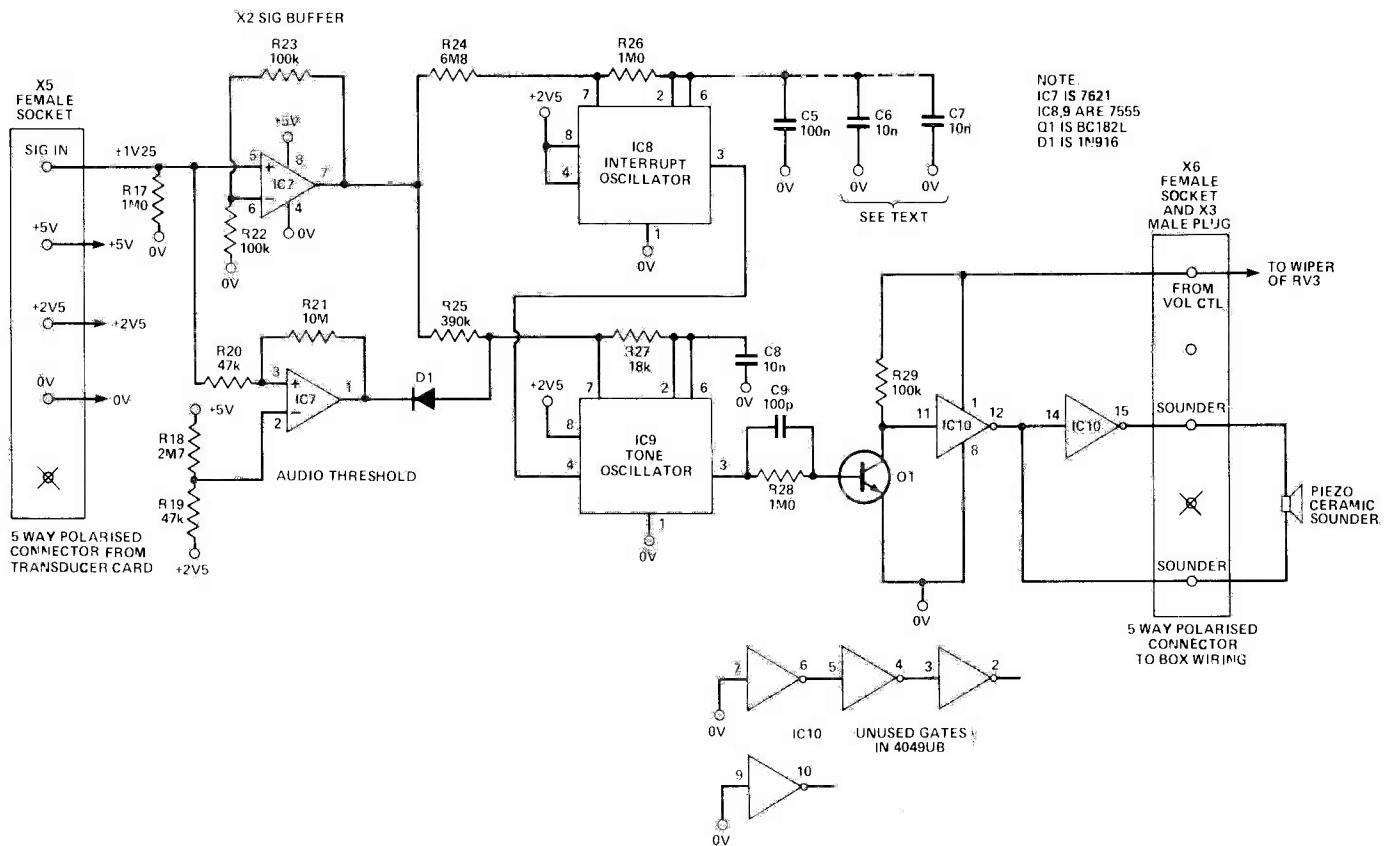
A crude guard track is used around the input pins of the op-amp. The principle of a guard track is that sensitive high impedance points or tracks in a circuit can be surrounded by a low impedance guard track at the same potential. Because there is no potential difference across the PCB surface, no leakage 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 0.22 μ F 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 ± 1.25 V 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

PROJECT : Vertical Speed Indicator



WORKS

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

The output of IC4 drives a $\pm 50\mu\text{A}$ 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 allows 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 250μs 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 78105A regulator IC6, while IC5 provides a split rail to act as signal ground. A 100μF capacitor (C4) decouples the 9V input lead if necessary.

PROJECT : Vertical Speed Indicator

We want to resolve to $\pm 20\text{ fpm}$ or $\pm 2\%$ 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 200 fpm 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.

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

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

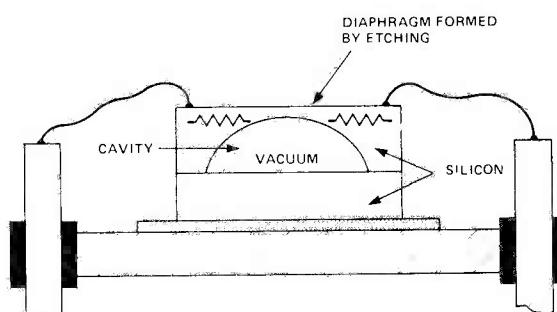


Fig. 5 Internal construction of the transducer element.

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

electronics today international BOOK SERVICE

How to order: indicate the books required by ticking the boxes and send this page, together with your payment, to: ETI Book Service, Argus Specialist Publications Ltd, 1, Golden Square, London W1R 3AB. Make cheques payable to ETI Book Service. Payment in sterling only please. All prices include P & P. Prices may be subject to change without notice.

BEGINNERS GUIDE

<input type="checkbox"/> Beginner's Guide to Basic Programming Stephenson	£5.35
<input type="checkbox"/> Beginner's Guide to Digital Electronics	£5.35
<input type="checkbox"/> Beginner's Guide to Electronics	£5.35
<input type="checkbox"/> Beginner's Guide to Integrated Circuits	£5.35
<input type="checkbox"/> Beginner's Guide to Computers	£5.35
<input type="checkbox"/> Beginner's Guide to Microprocessors	£5.35

COOKBOOKS

<input type="checkbox"/> Master IC Cookbook Hallmark	£10.15
<input type="checkbox"/> Microprocessor Cookbook M. Hordeski	£7.70
<input type="checkbox"/> IC Op Amp Cookbook Jung	£14.25
<input type="checkbox"/> PLL Synthesiser Cookbook H. Kinley	£7.70
<input type="checkbox"/> Active Filter Cookbook Lancaster	£13.40
<input type="checkbox"/> TV Typewriter Cookbook Lancaster	£11.15
<input type="checkbox"/> CMOS Cookbook Lancaster	£11.85
<input type="checkbox"/> TTL Cookbook Lancaster	£10.95
<input type="checkbox"/> Micro Cookbook Vol. 1 Lancaster	£15.30
<input type="checkbox"/> BASIC Cookbook K. Tracton	£6.00
<input type="checkbox"/> MC6809 Cookbook C. Warren	£7.25

ELECTRONICS

<input type="checkbox"/> Principles of Transistor Circuits Amos	£8.50
<input type="checkbox"/> Design of Active Filters with experiments Berlin	£11.30
<input type="checkbox"/> 49 Easy to Build Electronic Projects Brown	£6.00
<input type="checkbox"/> Electronic Devices & Circuit Theory Boylestad	£13.20
<input type="checkbox"/> How to build Electronic Kits Capel	£3.55
<input type="checkbox"/> How to Design and build electronic instrumentation Carr	£9.35
<input type="checkbox"/> Introduction to Microcomputers Daglecs	£7.20
<input type="checkbox"/> Electronic Components and Systems Dennis	£15.00
<input type="checkbox"/> Principles of Electronic Instrumentation De Sa	£11.40
<input type="checkbox"/> Giant Handbook of Computer Software	£12.95
<input type="checkbox"/> Giant Handbook of Electronic Circuits	£17.35
<input type="checkbox"/> Giant Handbook of Electronic Projects	£11.75
<input type="checkbox"/> Electronic Logic Circuits Gibson	£5.55
<input type="checkbox"/> Analysis and Design of Analogue Integrated Circuits Gray	£30.25
<input type="checkbox"/> Basic Electronics Grob	£11.30
<input type="checkbox"/> Lasers - The Light Fantastic Hallmark	£7.70
<input type="checkbox"/> Introduction to Digital Electronics & Logic Joynson	£5.25
<input type="checkbox"/> Electronic Testing and Fault Diagnosis Loveday	£7.85
<input type="checkbox"/> Electronic Fault Diagnosis Loveday	£6.25
<input type="checkbox"/> Essential Electronics A-Z Guide Loveday	£7.50
<input type="checkbox"/> Microelectronics Digital & Analogue Circuits and Systems Millman	£12.70
<input type="checkbox"/> 103 Projects for Electronics Experimenters Minis	£8.30
<input type="checkbox"/> VLSI System Design Muroga	£34.10
<input type="checkbox"/> Power FETs and their application Oxner	£9.40
<input type="checkbox"/> Practical Solid State Circuit Design Olesky	£25.00
<input type="checkbox"/> Master Handbook of IC Circuits Powers	£12.85
<input type="checkbox"/> Electronic Drafting and Design Raskhodoff	£22.15
<input type="checkbox"/> VOM - VTVM Handbook Rispe	£8.50
<input type="checkbox"/> Video and Digital Electronic Displays Sherr	£28.85
<input type="checkbox"/> Understanding Electronic Components Sinclair	£7.50
<input type="checkbox"/> Electronic Fault Diagnosis Sinclair	£4.50
<input type="checkbox"/> Physics of Semiconductor Devices Sze	£17.35
<input type="checkbox"/> Digital Circuits and Microprocessors Taub	£32.00
<input type="checkbox"/> Active Filter Handbook	£7.60
<input type="checkbox"/> Designing with TTL Integrated Circuits Texas	£15.20
<input type="checkbox"/> Transistor Circuit Design Texas	£15.20
<input type="checkbox"/> Digital Systems: Principles and Applications Tocci	£12.95
<input type="checkbox"/> Master Handbook of Telephones Traister	£10.00
<input type="checkbox"/> How to build Metal/Treasure Locators Traister	£6.00
<input type="checkbox"/> 99 Fun to Make Electronic Projects Tymony	£8.50
<input type="checkbox"/> 33 Electronic Music Projects you can build Winston	£6.95

COMPUTERS & MICROCOMPUTERS

<input type="checkbox"/> BASIC Computer Games Ahl	£6.35
<input type="checkbox"/> From BASIC to PASCAL Anderson	£9.95
<input type="checkbox"/> Mastering Machine Code on your ZX81 T. Baker	£7.25
<input type="checkbox"/> UNIX - The Book Banaham	£8.75
<input type="checkbox"/> Z80 Microcomputer Handbook Barden	£10.95
<input type="checkbox"/> Microcomputer Maths Barden	£11.90
<input type="checkbox"/> Digital Computer Fundamentals Barter	£9.90
<input type="checkbox"/> Visicalc Book. APPLE Edition Bell	£15.55
<input type="checkbox"/> Visicalc Book. ATARI Edition Bell	£15.55
<input type="checkbox"/> Introduction to Microprocessors Brunner	£23.00
<input type="checkbox"/> Programming your APPLE II Computer Bryan	£9.25
<input type="checkbox"/> Microprocessor Interfacing Carr	£7.70
<input type="checkbox"/> Microcomputer Interfacing Handbook A/D & D/A Carr	£9.50
<input type="checkbox"/> Musical Applications of Microprocessors Chamberlain	£28.85
<input type="checkbox"/> 30 Computer Programs for the Home Owner in BASIC D. Chance	£9.25
<input type="checkbox"/> Microcomputers Dirkson	£9.30
<input type="checkbox"/> APPLE Personal Computer for Beginners Dunn	£9.50
<input type="checkbox"/> Microcomputers/Microcomputers - An Intro Gioone	£11.80

<input type="checkbox"/> Troubleshooting Microprocessors and Digital Logic Goodman	£9.25
<input type="checkbox"/> Getting Acquainted with your VIC 20 Hartnell	£8.50
<input type="checkbox"/> Getting Acquainted with your ZX81 Hartnell	£5.95
<input type="checkbox"/> Let your BBC Micro Teach you to program Hartnell	£7.90
<input type="checkbox"/> Programming your ZX Spectrum Hartnell	£8.50
<input type="checkbox"/> The ZX Spectrum Explored Hartnell	£6.95
<input type="checkbox"/> How to Design, Build and Program your own working Computer System Haviland	£9.30
<input type="checkbox"/> BASIC Principles and Practice of Microprocessors Heffer	£7.15
<input type="checkbox"/> Hints and Tips for the ZX81 Hewson	£5.25
<input type="checkbox"/> What to do when you get your hand on a Microcomputer Holtzman	£9.95
<input type="checkbox"/> 34 More Tested Ready to Run Game Programs in BASIC Horn	£7.70
<input type="checkbox"/> Microcomputer Builders' Bible Johnson	£12.40
<input type="checkbox"/> Digital Circuits and Microcomputers Johnson	£14.55
<input type="checkbox"/> PASCAL for Students Kemp	£7.20
<input type="checkbox"/> The C - Programming Language Kernighan	£18.20
<input type="checkbox"/> COBOL Jackson	£9.25
<input type="checkbox"/> The ZX81 Companion Maundier	£9.50
<input type="checkbox"/> Guide to Good Programming Practice Meek	£6.40
<input type="checkbox"/> Principles of Interactive Computer Graphics Newman	£13.95
<input type="checkbox"/> Theory and Practice of Microprocessors Nicholas	£11.35
<input type="checkbox"/> Exploring the World of the Personal Computer Niles	£12.95
<input type="checkbox"/> Microprocessor Circuits Vol. 1. Fundamentals and Microcontrollers Noll	£9.80

<input type="checkbox"/> Beginner's Guide to Microprocessors Parr	£5.35
<input type="checkbox"/> Microcomputer Based Design Peatman	£11.30
<input type="checkbox"/> Digital Hardware Design Peatman	£9.80
<input type="checkbox"/> BBC Micro Revealed Ruston	£9.45
<input type="checkbox"/> Handbook of Advanced Robotics Safford	£14.45
<input type="checkbox"/> 1001 Things to do with your own personal computer Sawusch	£8.50
<input type="checkbox"/> Easy Programming for the ZX Spectrum Stewart	£7.15
<input type="checkbox"/> Microprocessor Applications Handbook Stout	£34.40
<input type="checkbox"/> Handbook of Microprocessor Design and Applications Stout	£37.60
<input type="checkbox"/> Programming the PET/CBM West	£17.80
<input type="checkbox"/> An Introduction to Microcomputer Technology Williamson	£8.20
<input type="checkbox"/> Computer Peripherals that you can build Wolfe	£12.40
<input type="checkbox"/> Microprocessors and Microcomputers for Engineering Students and Technicians Wooland	£7.10

REFERENCE BOOKS

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

VIDEO

<input type="checkbox"/> Servicing Home Video Cassette Recorders Hobbs	£12.95
<input type="checkbox"/> Complete Handbook of Videocassette Recorders Kybett	£9.25
<input type="checkbox"/> Theory and Servicing of Videocassette Recorders McGinty	£12.95
<input type="checkbox"/> Beginner's Guide to Video Matthewson	£5.35
<input type="checkbox"/> Video Recording: Theory and Practice Robinson	£14.40
<input type="checkbox"/> Video Handbook Van Wezel	£21.90
<input type="checkbox"/> Video Techniques White	£12.95

Please send me the books indicated. I enclose cheque/postal order for £..... Prices include postage and packing. I wish to pay by Access/Barclaycard. Please debit my account.

5 2 2 4

4 9 2 9

Signed

Name

Address

CAMBRIDGE LEARNING

SELF-INSTRUCTION COURSES



GSC SUPERKIT £19.90

Learn the wonders of digital electronics!

This practical kit for beginners comes complete with an instruction manual, components, and

EXP300 breadboard to teach you all the basics of digital electronics. The course needs no soldering iron; the only extra you need to buy is a 4½V battery.

Using the same board you can construct literally millions of different circuits.

The course teaches boolean logic, gating, R-S and J-K flipflops, shift registers, ripple counters, and half-adders.

It is supported by our theory courses

DIGITAL COMPUTER LOGIC £7.00

which covers: basic computer logic; logical circuit elements; the design of circuits to carry out logical functions; flipflops and registers; and

DIGITAL COMPUTER DESIGN £9.50

Our latest, most up-to-date course on the design of digital computers, both from their individual logic elements and from integrated circuits. You are first shown the way in which simple logic circuits operate and then, through a series of exercises, arrive at a design for a working machine.

Other courses available include:

MICROPROCESSORS & MICROELECTRONICS @ £6.50 COMPUTER PROGRAMMING IN BASIC @ £11.50

GUARANTEE No risk to you. If you are not completely satisfied, your money will be refunded upon return of the item in good condition within 28 days of receipt.

CAMBRIDGE LEARNING LIMITED, UNIT 17 RIVERMILL SITE, FREEPOST, ST IVES, CAMBS, PE17 4BR, ENGLAND.
TELEPHONE: ST IVES (0480) 67446. VAT No 313026022

All prices include worldwide postage (airmail is extra - please ask for prepayment invoice). Giro A/c No 2789159. Please allow 28 days for delivery in UK.

.....SUPERKIT(S) @ £19.90
.....DIGITAL COMPUTER DESIGN(S) @ £9.50
.....DIGITAL COMPUTER LOGIC @ £7.00

I enclose a *cheque/PO payable to Cambridge Learning Ltd for £..... (*delete where applicable)

Please charge my:

*Access / American Express / Barclaycard / Diners Club
Eurocard / Visa / Mastercharge / Trustcard

Expiry Date..... Credit Card No

Signature.....

Telephone orders from card holders accepted on 0480 67446
Overseas customers (including Eire) should send a bank draft in sterling drawn on a London bank, or quote credit card number.

Name.....

Address.....

Cambridge Learning Limited, Unit 17 Rivermill Site, FREEPOST, St Ives, Huntingdon, Cambs, PE17 4BR, England. (Registered in England No 1328762).

T.V. SOUND TUNER SERIES II

BUILT AND TESTED Complete with case. £26.50 + £2.00 p&p.



Also available with built-in headphone amp. ONLY £32.50 + £2.00 p&p.

In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is 'Will anyone notice if we save money by chopping this out?' In the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are common and all this is really quite sad, as TV companies do their best to transmit the highest quality sound. Given this background a compact and independent TV tuner that connects direct to your Hi-Fi is a must for quality reproduction. The unit is mains-operated.

This TV SOUND TUNER offers full UHF coverage with 5 pre-selected tuning controls. It can also be used in conjunction with your video recorder. Dimensions: 10½" x 7½" x 2½".

E.T.I. kit version of above without chassis, case and hardware. £16.20 plus £1.50 p&p.

PRACTICAL ELECTRONICS STEREO CASSETTE RECORDER KIT

COMPLETE WITH CASE

ONLY £34.50 plus £2.75 p&p.

- NOISE REDUCTION SYSTEM • AUTO STOP • TAPE COUNTER • SWITCHABLE E.Q. • INDEPENDENT LEVEL CONTROLS.
- TWIN V.U. METER • WOW & FLUTTER 0.1% • RECORD/PLAYBACK I.C. WITH ELECTRONIC SWITCHING • FULLY VARIABLE RECORDING BIAS FOR ACCURATE MATCHING OF ALL TYPES.

Kit includes tape transport mechanism, ready punched and back printed quality circuit board and all electronic parts, i.e. semiconductors, resistors, capacitors, hardware, top cover, printed scale and mains transformer. You only supply solder & hook-up wire. Featured in April P.E. reprint 50P. Free with kit.



SPECIAL OFFER! Replacement st. cassette tape heads. £1.80 ea. Add 50p p&p to order. Philips st. mag. cartridge. £3.95 + 60p p&p.

PLINTH to suit BSR Record Player Deck (with cover). Size 16½" x 14½" x 2½". Cover size: 14½" x 13½" x 3½". Due to fragile nature, Buyer collect only. Price: £8.95.

BSR RECORD DECKS

Auto-Changer model - takes up to 6 records with manual override. Supplied with stereo ceramic cartridge.

£12.95 plus £1.75 p&p



3 speed, auto, set-down, with auto return. Fitted with viscous damped cue, tubular aluminium counter-weighted arm, fitted with ceramic head. Ideally suited for home or disco use.
£17.50 plus £1.75 p&p

Manual single play record deck with auto return and cueing lever. Fitted with stereo ceramic cartridge 2 speeds with 45 rpm spindle adaptor ideally suited for home or disco use.
£14.95 plus £1.75 p&p



STEREO TUNER KIT

SPECIAL OFFER!

£13.95

+ £2.50 p&p.

This easy to build 3 band stereo AM/FM tuner kit is designed in conjunction with P.E. (July '81). For ease of construction and alignment it incorporates three Mullard modules and an I.C. IF System. Front scale size 10½" x 2½" approx. Complete with diagram and instructions



125W HIGH POWER AMP MODULES

The power amp kit is a module for high power applications - disco units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, result, a high powered rugged unit. The PC board is back printed, etched and ready to drill for ease of construction and the aluminium chassis is preformed and ready to use. Supplied with all parts, circuit diagrams and instructions.

Accessories: Stereo mains power supply kit with trans. £10.50 + £2p&p. Mono: £7.50 + £2p&p.

SPECIFICATIONS:

Max. output power (RMS): 125 W. Operating voltage (DC): 50 - 80 max. Loads: 4 - 16 ohm. Frequency response measured @ 100 watts 25Hz - 20KHz. Sensitivity for 100w: 400mV @ 47K. Typical T.H.D. @ 50 watts, 4 ohms: 0.1%. Dimensions: 205x90 and 190x36mm.

KIT £10.50

+ £1.15 p&p.

BUILT £14.25
+ £1.15 p&p.

HI-FI SPEAKER BARGAINS

AUDAX 8" SPEAKER £5.95 + £2.20 p&p.

High quality 40 watts RMS bass/mid. Ideal for either HiFi or Disco use this speaker features an aluminium voice coil and a heavy 70mm dia. magnet. Freq. Res.: 20Hz to 7kHz. Imp.: 8 ohms.



AUDAX 40W FERRO-FLUID HI-FI TWEETER Freq. res.: 5KHz - 22KHz. Imp.: 8 ohms. 60mm sq. £5.50 + 60p p&p.

GOODMANS TWEETERS 8 ohm soft dome radiator tweeter (3½"sq) for use in systems up to 40W. £3.95 ea + £1 p&p. £6.95 pr + £1.50.

All mail to: 21E HIGH ST, ACTON W3 6NG. Callers: Mon - Sat 9.30 - 5.30. Half day Wed. Access phone orders on 01-992 8430.

Note: Goods despatched within 10 working days of receipt of order.

All items subject to availability. Prices correct at 30/11/83 and subject to change without notice. Please allow 14 working days from receipt of order for despatch. RTVC Limited reserve the right to update their products without notice. All enquiries send S.A.E. Telephone or mail orders by ACCESS welcome

MONO MIXER AMP

Ideal for halls and clubs.

£45.00

+ £2 p&p.

50 Watt, six individually mixed inputs for 2 pickups (Cer. or mag), 2 moving coil microphones and 2 auxiliary for tape tuner, organs etc. Eight slider controls - 6 for level and 2 for master bass and treble, 4 extra treble controls for mic. and aux. inputs. Size: 13½" x 6½" x 3½" app. Power output 50 W RMS (cont.) for use with 4 to 8 ohm speakers. Attractive black vinyl case with matching fascia and knobs. Ready to use.

CALLERS TO: 323 EDGWARE ROAD, LONDON NW2. Telephone: 01-723 8432. (5 minutes walk from Edgware Road Tube Station) Now open 6 days a week 9 - 5.30. Prices include VAT.



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 possessed 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 switch was opened. We shall call the input voltage V_{in} , and the impedance of the source 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.

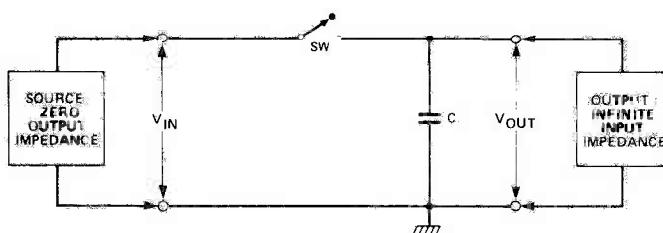


Fig. 1 Ideal sample and hold.

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:

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

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

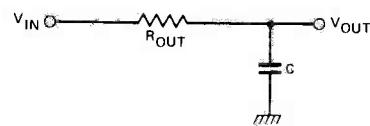


Fig. 2 The effect of the source impedance.

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.

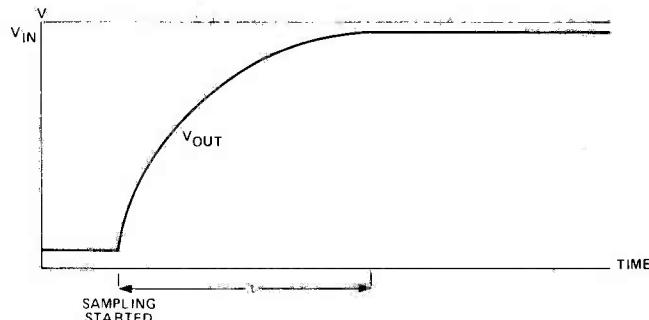


Fig. 3 The effect of the source impedance.

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.

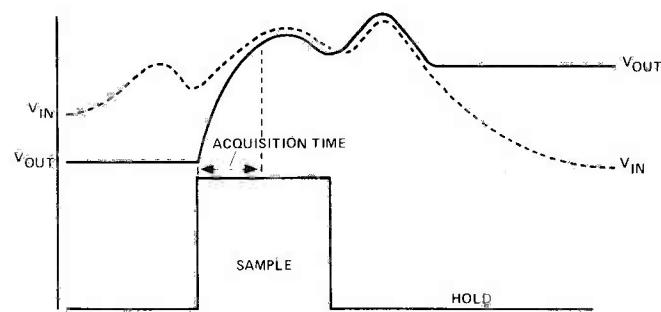


Fig. 4 The acquisition time.

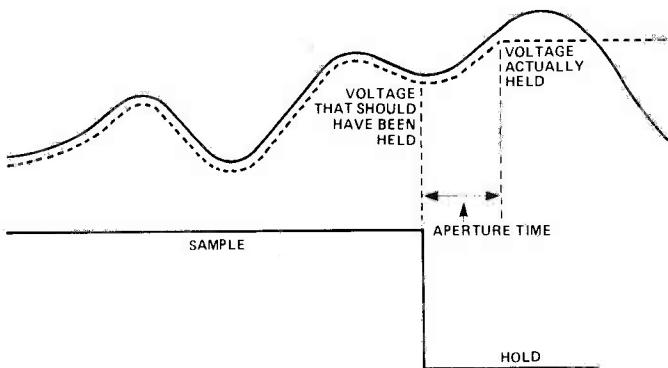


Fig. 5 Aperture time.

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,

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

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 50 pF, reacts with the on resistance of the switch to give a low pass filter, thus limiting the input frequency

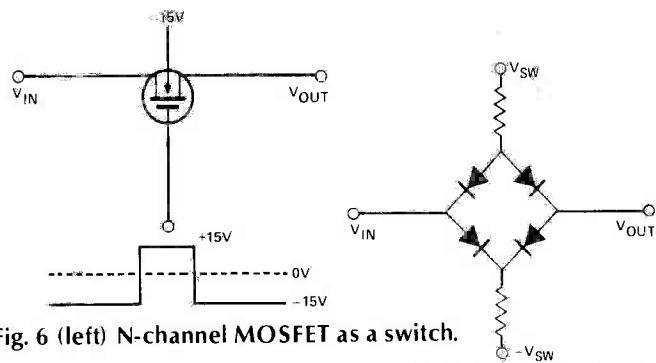


Fig. 6 (left) N-channel MOSFET as a switch.

Fig. 7 (right) Diode switch.

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-

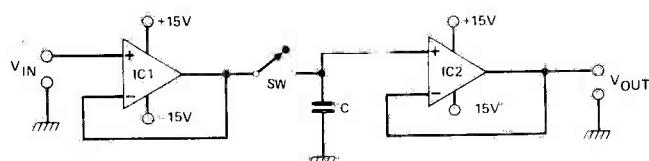


Fig. 8 A basic sample and hold circuit.

FEATURE : Designer's Notebook

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 into 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 $100 \text{ V}/\mu\text{s}$. 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

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

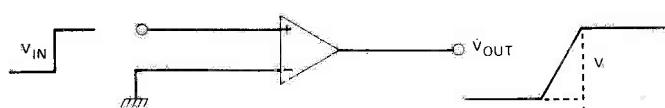


Fig. 9 Op-amp slew rate.

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 $10 \text{ V}/\mu\text{s}$ into a 100 nF capacitor; the current it must supply is 10 mA .

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.

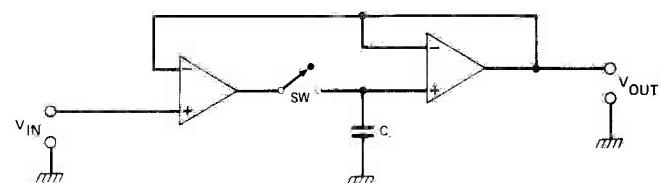


Fig. 10 Alternative sample and hold circuit.

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 $1\mu\text{F}$, then the maximum drift should be around 0.2 mV per second.

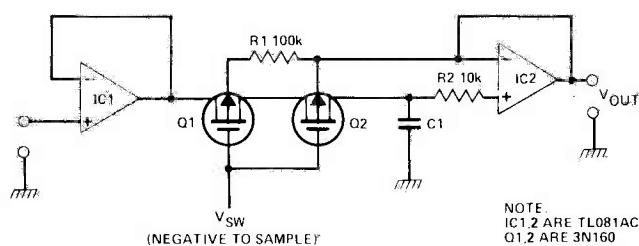


Fig. 11 (above) Practical sample and hold circuit.

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

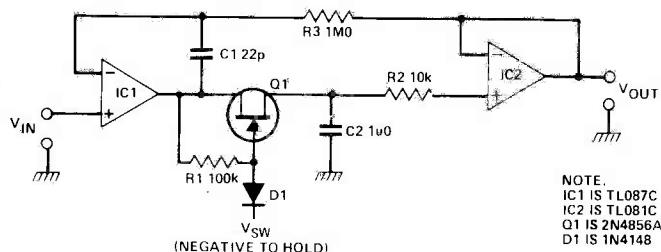


Fig. 12 is a high-accuracy sample and hold; since IC2 is within a closed loop, the effect of its offset voltage is negligible. IC1 is chosen to be a type with a very low offset voltage, maximum 0.5 mV at 25 degrees centigrade. Components C1 and R3 are to improve loop gain in the sampling mode. The one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

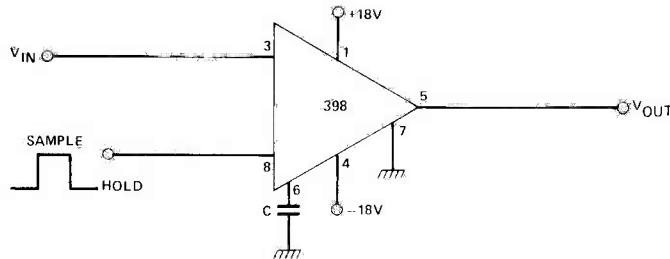


Fig. 13 A ready-made unit, the LM398.

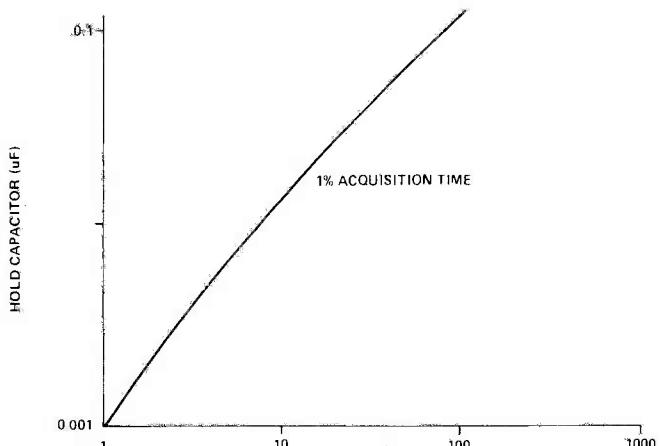


Fig. 14 Choosing the capacitor value for Fig. 13.

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.

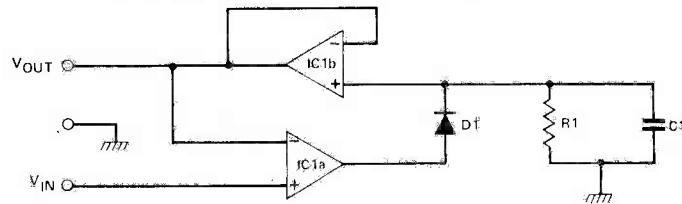
A capacitor of a value of 1nF will give a settling time of around $5\mu\text{s}$, indicating that after this time after sampling has started a voltage will be available at the output. Thus after this time you can hold and get an accurate result. This device has found use in analogue to digital conversion 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.



NOTE
IC1 IS TL082C
D1 IS 1N4148
R1, C1 TO SUIT APPLICATION

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.

HENRY'S

AUDIO ELECTRONICS

COMPUTERS • COMMUNICATIONS • TEST EQUIPMENT • COMPONENTS

VISIT OR PHONE • OPEN 6 DAYS A WEEK • ALL PRICES INC VAT

STEREO TUNER/AMPLIFIER

4 wave-band stereo tuner amplifier by GEC MW/LW/SW/stereo FM radio. 10+10 watt stereo amplifier. Inputs for PU tape in/out. Supplied as two assembled units, as illustrated £21.95 - easy to connect. (UK C/P £1.50)

CASSETTE MECHANISMS

Fitted counter, motor, record and erase heads, solenoid, etc. Brand new available 6V DC or 12V DC (state which) £5.95 (UK C/P 65p)

TOROIDAL TRANSFORMER

100 watts isolation 230/240 V AC plus 8.0-8V 4A 15.0-15V 0.645A 30V 0.16A. Size approx 4½" dia x 1½" £7.95 (UK C/P 75p)

ASTEC UHF MODULATORS

(UK UM1233 cased for computers, etc. £3.50 C/P 40p)

MULLARD MODULES

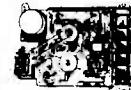
(UK C/P 65p per 1-3)
LP1171 IF and LP1179 AM/FM Tuner pr £5.75
LP1186 Varicap Tuner £5.00
LP1157 AM Tuner £2.50

PRESTEL ADAPTOR

3 card set with data etc (P/S -/+ 12V and -5V) £28.95 inc. VAT

MODEM CARD

BT approved ready assembled unit with data and accessories. £39.95 inc. VAT



COMPLETE WITH FULL HANDBOOK, 3 ROLLS PAPER

£1.05 inc VAT

[List approx £1.87]

SUITABLE FOR TANDY • BBC • ORIC • NASCOM • GEMINI • ACORN • NEW BRAIN • DRAGON • etc. etc. Interface unit with leads £15 - state model! (Your enquiries invited)

STOCKISTS FOR Frequency counters • Signal generators Power supplies • Plus huge range of components, tools, accessories and parts for callers.

Send large SAE for details (state items)

ORDER

BY



POST



OR



PHONE



HENRY'S Shop at

404-406 Edgware Road, London, W2
Computers 01-402 6822 Equipment 01-724 0323

Components 01-723 1008

AUDIO ELECTRONICS Shop at
301 Edgware Road, London, W2
Test Equipment, Audio Communications 01-724 3564

DIGITAL MULTIMETERS

- Hand Held Models
• All feature AC/DC volts.
DC Amps (Many with AC Amps) Ohms etc.
(UK C/P 65p)

Controls S = Slide
R = Rotary PB = Push Button



models with carry case

KD25C ■ 12 range 20A DC 2 Meg ohm (S) £26.95

KD305 ■ 14 range 10A DC 2 Meg ohm (S) £27.95

KD30C ■ 26 range 1A AC/DC 20 Meg ohm (R) £33.50

METEX 3000 ■ 30 range 10A AC/DC 20 Meg ohm (R) £39.95

KD615 ■ 16 range 10A DC 2 Meg ohm

Plus HFE tester (R) £39.95

7030 ■ As 0010 but 0.1% basic (PB) £47.50

KD3350 ■ Autorange plus Cont. Tester 18 ranges 10A AC/DC 2 Meg ohm (R) £49.95

Bench Models (UK C/P £1.00)

TM355 3½ digit 29 range 10A 10AC/DC 20 Meg ohm £97.75

TM356 3½ digit 27 range LCD 10A AC/DC 20 Meg ohm £109.25

GENERATORS

(UK C/P £1.00)

LSG17 RF 100KHz to 1MHz [Up to 450MHz Harmonics] £108.25

SG402 20MHz 30MHz £82.80

AG202A Audio Sine/Square 20Hz to 200KHz £102.35

LA627 Audio sine/Square 10Hz to 1MHz £106.95

only £13.95 + VAT

A COMPLETE INTRUDER ALARM

EASILY ASSEMBLED ULTRASONIC UNIT CK 5063

Requires no installation. Easily assembled using our professionally built and tested modules.

- Adjustable range up to 25ft.
- Built-in entrance & exit delay
- Built-in timed alarm
- Key operated switch - Off, Test and Operate
- Provision for an extension speaker
- Fully self-contained
- Uses US 5063 PSL 1865, Key Switch 3901, 3" Speaker 3515

only £37.00 + VAT.

Now you can assemble a really effective intruder alarm at this low price using tried and tested Riscomp modules. Supplied with full instructions, the kit contains everything necessary to provide an effective warning system for your house or flat. With a built-in LED indicator and test position the unit is easily set-up requiring no installation. It may simply be placed on a cupboard or desk. Movement within its range will then cause the built-in siren to produce a penetrating 90db's of sound, or even 110db's with an additional speaker. All parts included and supplied with full instructions for ease of assembly. Size 200 x 180 x 70mm Order as CK 5063

DIGITAL ULTRASONIC DETECTOR

US 5063



only £13.95 + VAT.
NEW

ALARM CONTROL UNIT

CA 1250



Price £18.95 + VAT.

The heart of any alarm system is the control unit. The CA 1250 offers every possible feature that is likely to be required when constructing a system whether a highly sophisticated installation, or simply controlling a single magnetic switch on the front door.

- Built-in electronic siren drives 2 loud speakers with fixed alarm time
- Provides exit and entrance delays together with battery back-up
- Battery back-up with trickle charging facility
- Operates with magnetic switches, pressure pads, ultrasonic or LR units
- Anti-tamper and panic facility
- Stabilised output voltage
- 2 operating modes - full alarm/anti-tamper and panic facility
- Screw connections for ease of installation
- Separate relay contacts for external loads
- Test loop facility

ULTRASONIC MODULE

US 4012



£10.95 + VAT.

● Adjustable range from 5-25ft. This popular low cost ultrasonic detector is already used in a wider range of applications from intruder detectors to automatic light switches and door opening equipment, featuring 2 LED indicators for ease of setting up.

INFRA-RED SYSTEM

IR 1470 only £25.61 + VAT.



SIREN & POWER SUPPLY MODULE

PSL 1865

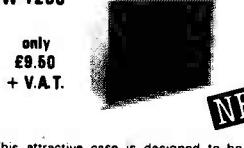


only £9.95 + VAT.

A complete siren and power supply module which is capable of providing sound levels of 110db's at 2 metres when used with a horn speaker. In addition, the unit provides a stabilised 12V output up to 100mA. A switching relay is also included so that the unit may be used in conjunction with the US 5063 to form a complete alarm.

HARDWARE KIT

HW 1250



only £9.50 + VAT.

This attractive case is designed to house the control unit CA 1250, together with the appropriate LED indicators and key switch. Supplied with the necessary mounting pillars and punched front panel, the unit is given a professional appearance by an adhesive silk screened label. Size 200 by 180 by 70mm

ULTRASONIC MODULE ENCLOSURE

SL 157



only £2.95 + VAT.

Suitable metal enclosure for housing an individual ultrasonic module type US 5063 or US 4012. Supplied with the necessary mounting pillars and screws etc. For US 5063 order SC 5063; for US 4012 order SC 4012.

RISCOMP LIMITED

Dept. ET110
21 Duke Street,
Princes Risborough,
Bucks HP17 0AT
Princes Risborough (084 44) 6326

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 fraction 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 correspondence 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 00 00 3C 3C 3C
1C10  3C 3C 3C 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 08 02 08 02 06 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 DO 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.

UPDATE : EPROM Programmer

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 ?

Fig. 2 The modified section of the assembler program.

ETI

138	1CF7	AEOC1C	LDX	TYPE	:EPROM TYPE
139	1CFA	BC3A1C	LDY	PTBYFE,X	:BYTE TO TGGLE
140	1CFD	B920BC	LDA	IC1PIA,Y	:LOAD IT
141	1D00	5D311C	EOR	PTB1F,X	:TOGGLE BIT
142	1D03	9920BC	STA	IC1PIA,Y	:PUT IT BACK AGAIN
143	1D06	A01D	LDY	£1DH	:CARRY
144	1D08	A2FF	LDX	£OFFH	:OUT
145	1D0A	CA	DEL :	DEL	:50 MS
146	1D0B	DOFD	DEX		:DELAY
147	1D0D	8B	BNE		:FOR
148	1D0E	DOFA	DEY		
149	1D10	AEOC1C	LDX	TYPE	:PROGRAMME
150	1D13	BC3A1C	LDY	PTBYFE,X	:TOGGLE BIT BACK
151	1D16	B920BC	LDA	IC1PIA,Y	:
152	1D19	5D311C	EOR	PTB1F,X	:
153	1D1C	9920BC	STA	IC1PIA,Y	:
154	1D1F	4CCB1C	JMP	LOOOPP	:ROUND AGAIN
155					

BIMconsoles — METAL Brown base Beige top		BIMBOARDS Prototype with plug-in breadboards Component support brackets supplied with all except Eurobreadboard.						
Part No	A	B	C	D	E	Type	No of Con. Points	
BIM 2601	178	51	210	385	70	10.96	Eurobreadboard	500 6.25
BIM 2602	280	51	210	385	70	12.19	Eurobreadboard PCB	500 0.75
BIM 2603	381	51	210	385	70	14.10	Bimcard 1	550 6.55
BIM 2604	483	51	210	385	70	16.01	Bimstrip	80 2.50
BIM 2605	480	51	261	385	70	17.85	Bimboard PCB	630 1.44
BIM 2701	178	76	210	385	70	11.52	Bimboard Layout Pad	0.46
BIM 2702	280	102	210	385	70	13.40	MPU/breadboard	1422 17.25
BIM 2703	381	102	210	385	70	14.86	Bimboard Designer	77.00
BIM 2704	483	102	210	385	70	16.97		
BIMconsoles — ABS Black or Grey base with Grey Aluminium top.		E D C SIDE B PLAN A						
All prices inc VAT. Add 60p per order on Bimboards, £2.50 per order on Bimconsoles for p&p. SAE for full list. Mail Order only.								
BIMSALES Dept ETI/4, 48a Station Road, Cheadle Hulme, Cheadle, Cheshire. SK8 7AB. Tel: 061 485 6667.								

PARNDON ELECTRONICS LTD. Dept. 23, 44 Paddock Mead, Harlow, Essex. CM18 7RR. Tel: 0279 32700							
RESISTORS: 1/4 Watt Carbon Film E24 range ± 5% tolerance Bandalised and colour coded. Full Range 1R0-10M. £1.00 per hundred mixed (Min 10 per value) £8.50 per thousand mixed (Min 50 per value) Special stock pack 60 values. 10 of each £5.50							
RECTIFIERS 1 Amp 3 Amp 50V 3p 14p 100V 4p 14p 200V 5p 14p 400V 6p 19p 600V 8p 20p 1000V 9p 25p							
VOLTAGE REGULATORS -1 amp/T0220 Positive voltage 5.8, 12, 15, 24V 40p Negative voltage 5.12, 15V 43p							
CAPACITORS — Mixed special £2.00 pack. Tant bead: 5 off OR AL ELEC: 30 off. Our choice of Values/Voltages.							
DIL SOCKETS 8 pin - 10p. 14 pin - 11p. 16p pin - 12p. 18p pin - 19p. 20p pin - 21p 22 pin - 23p. 24 pin - 25p. 28 pin - 27p 40 pin - 42p.							
DIODES: IN4148 £1.60 per hundred ALL PRICES INCLUDE V.A.T. & POST & PACKING — NO EXTRAS MIN ORDER — UK £1.00 OVERSEAS £5 CASH WITH ORDER PLEASE X-Stock Items Same Day Despatch							

FREQUENCY COUNTERS

The brand new Meteor series of 8-digit Frequency Counters offer the lowest cost professional performance available anywhere.

- ★ Measuring typically 2Hz ~ 1.2GHz
- ★ Sensitivity <50mV at 1GHz
- ★ Setability 0.5ppm
- ★ High Accuracy
- ★ 3 Gate Times
- ★ Low Pass Filter
- ★ Battery or Mains
- ★ Factory Calibrated
- ★ 1-Year Guarantee
- ★ 0.5" easy to read L.E.D. Display

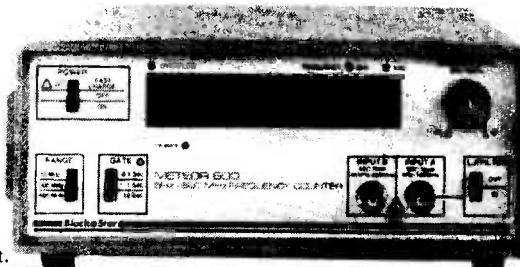
PRICES (Inc. adaptor/charger, P & P and VAT)

METEOR 100 (100MHz) £104.36

METEOR 600 (600MHz) £134.26

METEOR 1000 (1GHz) £184.86

Illustrated colour brochure with technical specification and prices available on request.



Designed and manufactured in Britain.

Black Star

BLACK STAR LTD (Dept. ETI). 9A Crown Street. St. Ives. Huntingdon. Cambs. PE17 4EB. England
Tel: (0480) 62440 Telex 32339

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 ft³ 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

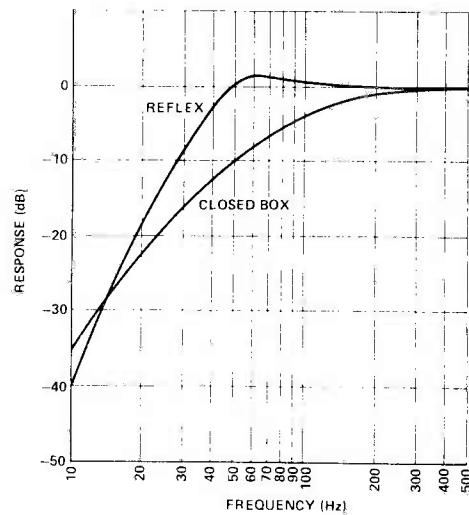


Fig. 1 Comparison of reflex and closed box responses for similar sized speakers.

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 ft³ 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:

$$V_B = 20 V_{AS} Q_{TS}^{1/3} = 67.66 \text{ litres.}$$

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:

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

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

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

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

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:

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

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 ($D_V = 75 \text{ mm}$) the length (L_V) is given by:

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

FEATURE : Bass for Beginners

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:

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

We now hit a slight problem. The resonant frequency (f_{SB}) 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_1) of your drive unit ($f_{SB} = 2f_1$). 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:

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

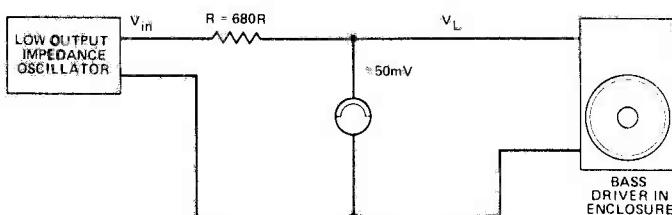


Fig. 2 Test set up for f_{SB} and Q_{TC} measurements.

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:

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

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

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

Now for the frequency response plot, calculated by:

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

where f_N is defined as:

(see over page)

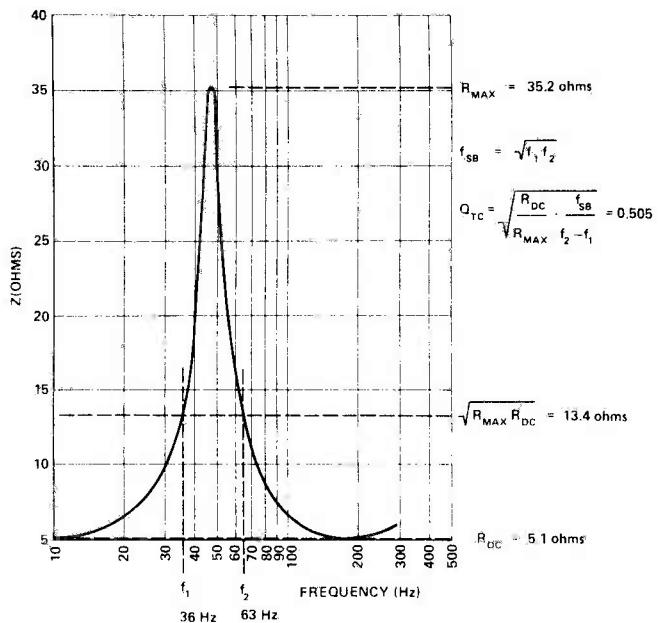


Fig. 3 Impedance curve used to measure f_{SB} and Q_{TC} .

FEATURE

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

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... **ET**

FT

TOROIDALS

The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognise the advantages toroidals offer in size, weight, lower radiated field and, thanks to L. L. P. PRICE

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 7 DAYS together with a short lead time on quantity orders which can be programmed to your requirements with no price penalty.

15 VA			50 VA			120 VA		
62 x 34mm	0.35Kg	Regulation 19%	80 x 35mm	0.9Kg	Regulation 13%	90 x 40mm	1.2Kg	Regulation 11%
SERIES	SECONDARY	RMS	No	Volt	Current	No	Volt	Current
No	Volt	Current						
0x010	6+6	1.25	2x010	6+6	4.16	4x010	6+6	10.00
0x011	9+9	0.83	2x011	9+9	2.77	4x011	9+9	6.66
0x012	12+12	0.63	2x012	12+12	2.08	4x012	12+12	5.00
0x013	15+15	0.50	2x013	15+15	1.66	4x013	15+15	4.00
0x014	18+18	0.42	2x014	18+18	1.38	4x014	18+18	3.33
0x015	22+22	0.34	2x015	22+22	1.13	4x015	22+22	2.72
0x016	25+25	0.30	2x016	25+25	1.00	4x016	25+25	2.40
0x017	30+30	0.25	2x017	30+30	0.83	4x017	30+30	2.00
(encased in ABS plastic)			2x028	110	0.45	4x018	35+35	1.71
30 VA			2x029	220	0.22	4x028	110	1.09
70 x 30mm 0.45Kg			2x030	240	0.20	4x029	220	0.54
Regulation 18%			4x030	240	0.50	4x030	240	0.50
90 x 30mm 1Kg			80 VA			110 x 40mm 1.8Kg		
Regulation 12%			90 x 30mm	1Kg	Regulation 12%	110 x 40mm	1.8Kg	Regulation 8%
No	Volt	Current	No	Volt	Current	No	Volt	Current
1x010	6+6	2.50	3x010	6+6	6.64	5x011	9+9	8.88
1x011	9+9	1.66	3x011	9+9	4.44	5x012	12+12	6.66
1x012	12+12	1.25	3x012	12+12	3.33	5x013	15+15	5.33
1x013	15+15	1.00	3x013	15+15	2.66	5x014	18+18	4.44
1x014	18+18	0.83	3x014	18+18	2.22	5x015	22+22	3.63
1x015	22+22	0.68	3x015	22+22	1.67	5x016	25+25	3.20
1x016	25+25	0.60	3x016	25+25	1.60	5x017	30+30	2.66
1x017	30+30	0.50	3x017	30+30	1.33	5x018	35+35	2.28
Regulation 18%			3x028	110	0.72	5x026	40+40	2.00
Regulation 12%			3x029	220	0.56	5x028	110	1.45
Regulation 8%			3x030	240	0.33	5x029	220	0.72
Regulation 8%			5x030	240	0.66			

¹Prices including P&P and VAT

VA	Size	£	VA	Size	£
15	0	7.43	160	5	12.90
30	1	8.08	225	6	16.30
50	2	10.10	200	7	18.55
80	3	10.81	500	8	25.73
120	4	11.73	625	9	31.63

For 110V primary insert "D" in place of "X" in type number.
For 220V primary (Europe) insert "1" in place of "X" in type number.
For 240V primary (UK) insert "2" in place of "X" in type number.
(IMPORTANT: Regulation - All voltages quoted are FULL LOAD.
Please add regulation figure to secondary voltage to obtain off load voltage.

Mail Order — Please make your crossed cheques or postal orders payable to IFL Electronics Ltd.

Trade — We will open your credit account immediately upon receipt of your first order.

Post to: ILP Electronics Ltd., Dept. 2
Graham Bell House, Roper Close,
Canterbury, Kent. CT2 7EP
Tel: (0227) 54778 **Telex:** 965780



ELECTRONICS LTD.

1. You have not received the goods or had your money returned; and
 2. You write to the publisher of this publication explaining the position not earlier than 28 days from the day you sent your order and not later than 2 months from that day.

Please do not wait until the last moment to inform us. When you write, we will tell you how to make your claim and what evidence of payment is required.

We guarantee to meet claims from readers made in accordance with the above procedure as soon as possible after the advertiser has been declared bankrupt or insolvent to a limit of £1,800 per annum for any one advertiser, so affected, and up to £5,400 p.a. in respect of all insolvent advertisers. Claims may be paid for higher amounts, or when the above procedures have not been complied with, at the discretion of this publication, but we do not guarantee to do so in view of the need to set some limit to this commitment and to learn quickly of reader's difficulties.

This guarantee covers only advance payment sent in direct response to an advertisement in this magazine (not, for example, payments made in response to catalogues, etc., received as a result of answering such advertisements):

CLASSIFIED ADVERTISEMENTS ARE EXCLUDED.

High efficiency enabling conservative rating whilst maintaining size advantages.
Lower operating temperature.

- Why ILP?**
 - Ex-stock delivery for small quantities.
 - Gold service available. 21 days manufacture for urgent deliveries.
 - 5 year no quibble guarantee.
 - Realistic delivery for volume orders.
 - No price penalty for call off orders

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 choice 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 interact 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.

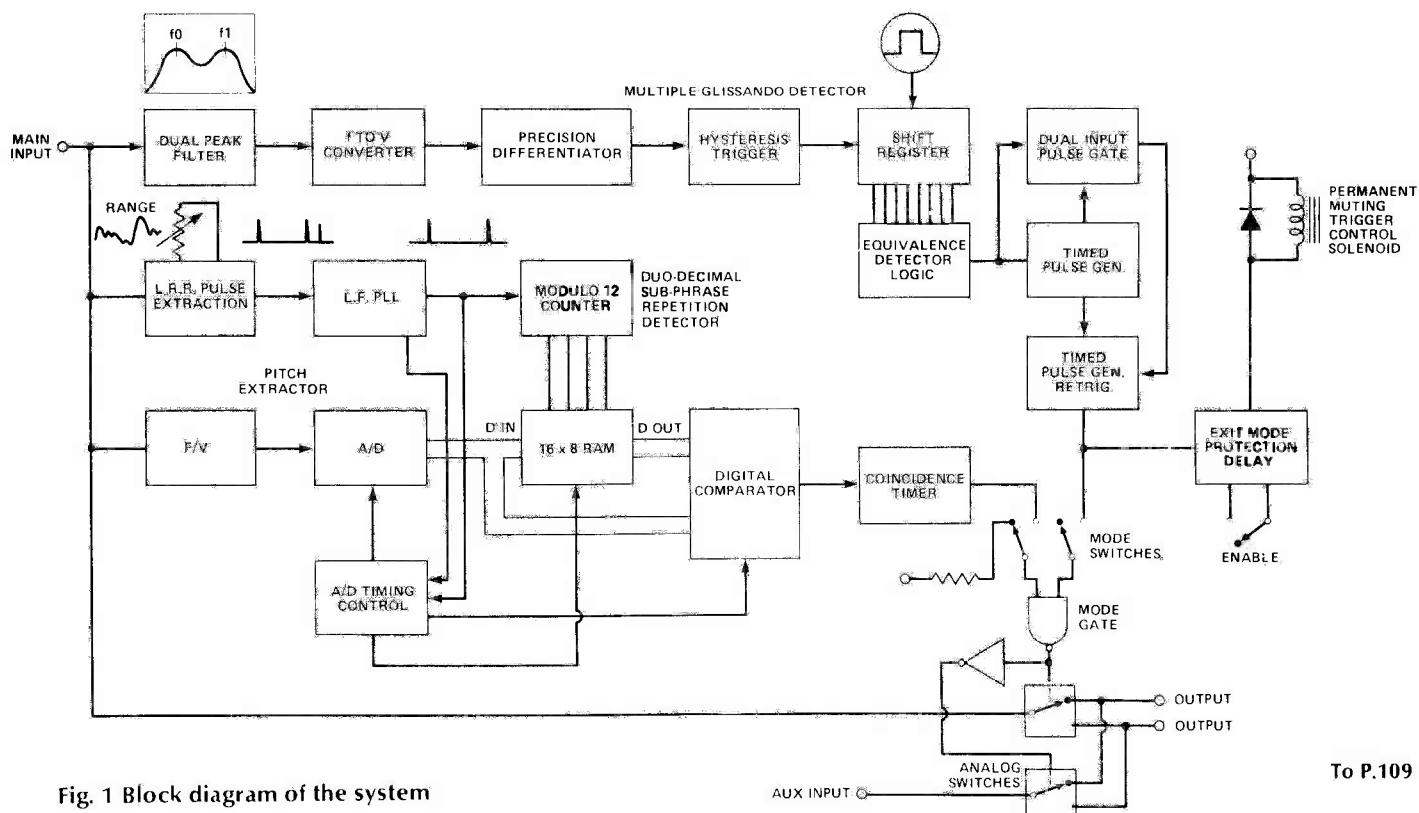
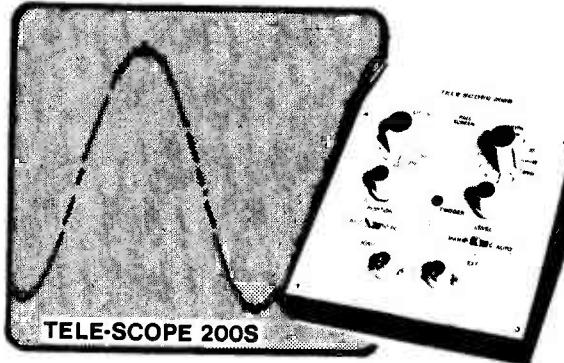


Fig. 1 Block diagram of the system



TELE-SCOPE 200S

Look into the World of Electronics with the Tele-Scope. 10MHz storage for less than £100.

Capture those elusive waveforms on your own T.V. Screen. The Tele-Scope converts analogue data to a digital format for storage in its memory, displaying continuously until refreshed with new data. Build it yourself for £109 (exclusive of VAT and package and posting), or buy it built and tested for £129 (excluding VAT and package and posting). Package and posting for either unit is £2.95. The manual is available for £2.00 which is refunded on subsequent unit purchase.

Also available from Hawk are Apple expansion I/O Cards with 32 channels of controllability, or convert your Apple to an IEEE Controller with GPIB Controller card (interfaces directly in Applesoft!) £59.95 and £189 respectively (excluding VAT).

For more data contact:-

HAWK ELECTRONIC TEST EQUIPMENT

Bircholt Road,
Park Wood Industrial Estate,
Maidstone, Kent ME15 9XT.
Telephone 0622 686811



FREE CAREER BOOKLET

Train for success, for a better job, better pay

Enjoy all the advantages of an ICS Diploma Course, training you ready for a new, higher paid, more exciting career.

Learn in your own home, in your own time, at your own pace, through ICS home study, used by over 8 million already!

Look at the wide range of opportunities awaiting you. Whatever your interest or skill, there's an ICS Diploma Course there for you to use.

Send for your FREE CAREER BOOKLET today—at no cost or obligation at all.

TICK THE FREE BOOKLET YOU WANT AND POST TODAY

ELECTRONICS
ENGINEERING

TV & AUDIO
SERVICING

ELECTRICAL
ENGINEERING

RUNNING YOUR
OWN BUSINESS

Name _____

Address _____



Dept EB144
ICS School of Electronics
180 Stewarts Road
London SW8 4UJ



01 622 9911
(all hours)

BI-PAK

VALUE PACKS

Pak	No.	Oty	Description	Price
VP1	300	Assorted Resistors Mixed Types	£1.00	
VP2	300	Carbon Resistors 1/2 Watt Pre-Formed	£1.00	
VP3	200	1/2 Watt Min Carbon Resistors Mixed	£1.00	
VP4	150	1/4 Watt Resistors 100 ohm - 1M Mixed	£1.00	
VP5	200	Assorted Capacitors All Types	£1.00	
VP6	200	Ceramic Caps Miniature - Mixed	£1.00	
VP7	100	Mixed Ceramic Disc. 1pf-56pf	£1.00	
VP8	100	Mixed Ceramic Disc. 68pf - 015pf	£1.00	
VP9	100	Assorted Polyester/Polystyrene Caps	£1.00	
VP10	60	C280 Type Caps Metal Foil Mixed	£1.00	
VP11	100	Electrolytics - All Sorts	£1.00	
VP12	80	Bead Type Polystyrene Min Caps	£1.00	
VP13	50	Silver Mica Caps Ass. 5.6pf - 150pf	£1.00	
VP14	50	Silver Mica Caps Ass. 160pf - 470pf	£1.00	
VP15	50	High Voltage Disc Ceramic 750v-8kv Mixed	£1.00	

BI-PAK'S OPTO SPECIAL

A selection of large and small sized LED's in various shapes, sizes & colours, together with 7 Segment Displays both anode & cathode plus photo transistors emitters and detectors. Cadmium Cell ORP12 and Germ. photo transistor OCP71 included. In all a total of 25 Opto Pieces valued over £12 Normal Price.

Order No. VP57
Our Super Value Price Just £5.00



SILICON BRIDGE RECTIFIERS

Comprising 4 x 1/2 Amp mounted on PCB rectifiers. VRM - 150 vts IFM - 1.5 Amps

Size: 1 inch square
10 off £1.00
50 off £4.50
100 off £7.50

ORDER NO: 4R1 B Rect.

VP38	100	Silicon NPN Transistors - All Perfect. Coded Mixed Types With Data And Eqvt. Sheet. No Rejects Fantastic Value £3.00
VP39	100	Silicon PNP Transistors - All Perfect. Coded Mixed Types With Data And Eqvt. Sheet. No Rejects Real Value £3.00

HYBRID LED COLOUR DISPLAYS



Red, Green, Yellow - 3/5/6 inch Mixed Types and colours NUMERIC & OVERFLOW Common Anode/Cathode. GaAsP/GaP. Brand New, Full Data incl. 10 pieces (our mix) £4.00 Normal Retail Value Over £10.00 Order No. VP58

IC BARGAINS

VP40	30	Assorted 74 Series TTL I.C's Gates, Flip-Flops & M.S.I.'s + Data Book. All New, Normal Retail Value Over £6.00. Our Price £2.50
VP41	30	Assorted CMOS I.C's CD4000 Series. Pack Includes 00/09/12/14/18/21/23/25/28/30/35/44/88 AY/AE Types Plus Data Sheet Value Over £8.00. Normal retail £2.50

YOU MAY ORDER any ONE TYPE of the above CMOS at £2.00 per 25 pieces. ORDER AS VP41 + type number required.

RATCHET SCREWDRIVER KIT

Comprises 2 standard screwdriver blades 5 & 7mm size, 2 cross point size 4 & 6. 1 Ratchet handle. 5-in-1 Kit £1.45 each. C/N 329B.

VALUE PACKS

Pak	No.	Oty	Description	Price
VP16	50	Wirewound Res. 9W (avg)	£1.00	
VP17	50	Metres PVC Covered Single Strand Wire Mixed Colours	£1.00	
VP18	30	Metres PVC Covered Multi Strand Wire Mixed Colours	£1.00	
VP19	40	Metres PVC Single/Multi Strand Hook-Up Wire Mixed	£1.00	
VP20	6	Rocker Switches 5 Amp 240V	£1.00	
VP21	20	Pcs. 1-2 & 4mm Plugs & Sockets Matching Sizes	£1.00	
VP22	200	Sq. Inches Total, Copper Clad Board Mixed Sizes	£1.00	

VALUE PACKS

Pak	No.	Oty	Description	Price
VP23	20	Assorted Slider Pots. Mixed Values	£1.00	
VP24	10	Slider Pots, 40mm 22K 5 x Log 5 x Lin	£1.00	
VP25	10	Slider Pots, 40mm 47K 5 x Log 5 x Lin	£1.00	
VP26	20	Small 125° Red LED's	£1.00	
VP27	20	Large 2" Red LED's	£1.00	

100

TRANSISTOR CLEARANCE

All Sorts Transistors. A mixed Bag NPN-PNP Silicon & Germ. Mainly Uncoded. You To Sort. Pack includes Instructions For Making Simple Transistor Tests. Super Value.

Order No. VP60

£1.00

Use your credit card. Ring us on Ware 3182 NOW and get your order even faster. Goods normally sent 2nd Class Mail. Remember you must add VAT at 15% to your order total. Postage add 75p per Total order.

Send your orders to Dept ETI 4
BI-PAK PO BOX 6 WARE, HERTS



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

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.

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.

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

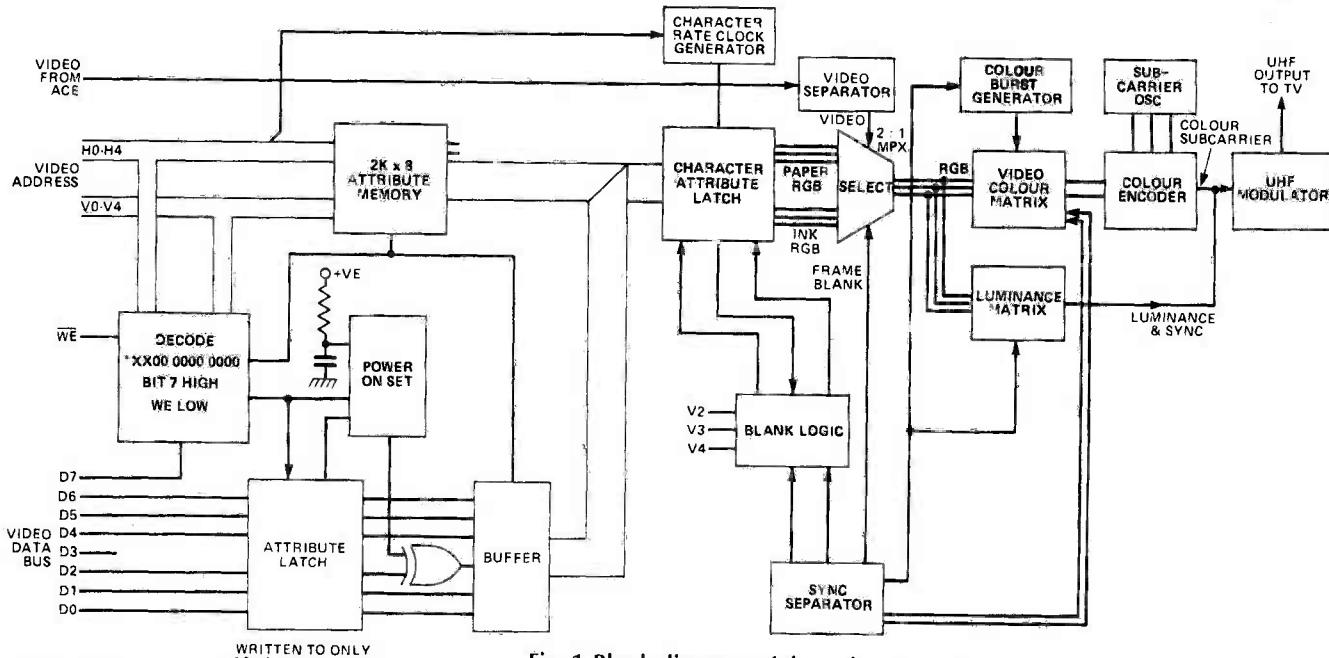


Fig. 1 Block diagram of the colour board.

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 $+90^\circ$ 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

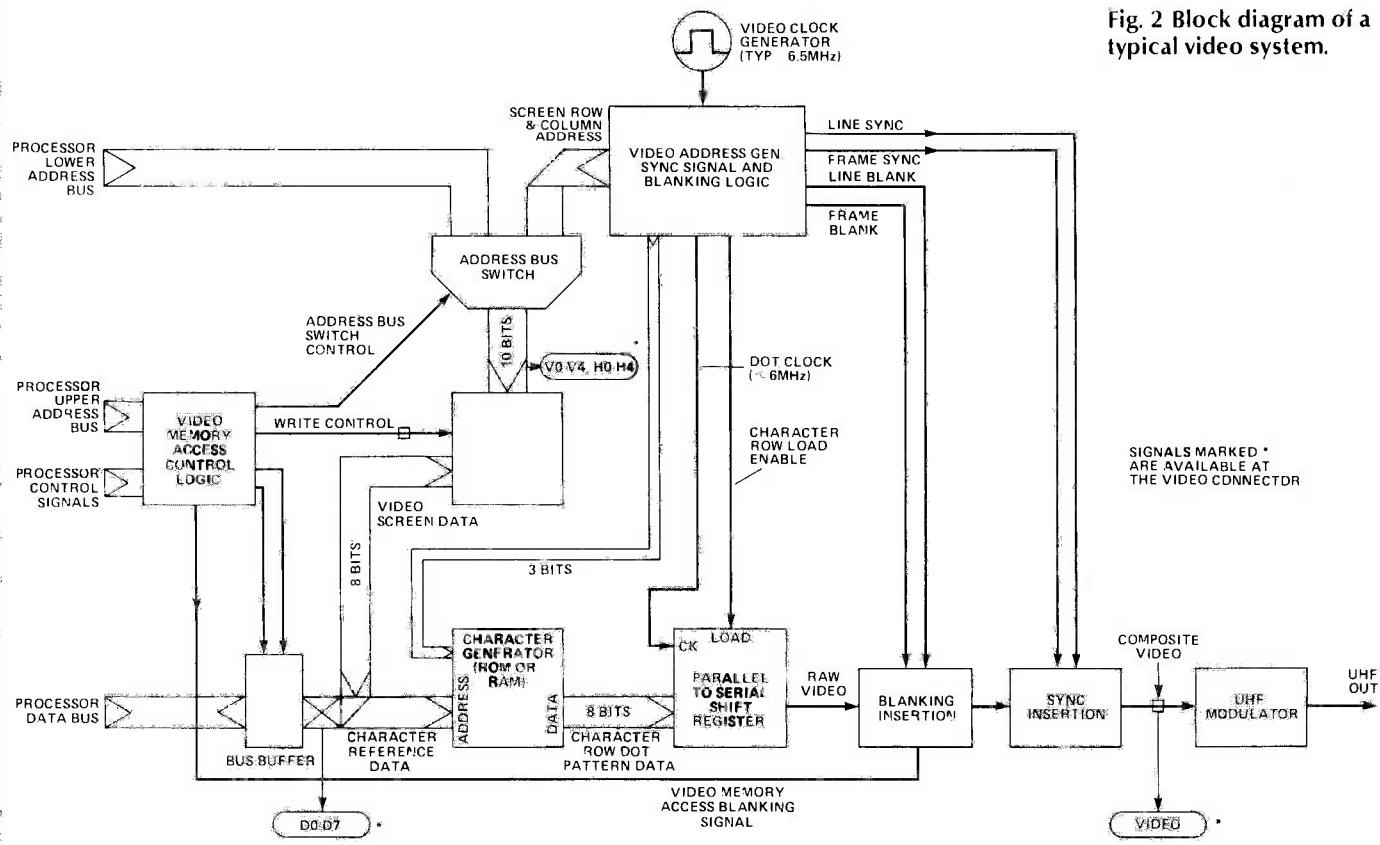
workings of micros from the hardware side, we present a short description of a typical black and white TV style video display.

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.



PROJECT : Adding Colour

For operation in the UK and several European countries, the line period is $64\mu s$ (15.625kHz) while the frame period is 20ms (50 Hz). The line blanking period is nominally $12\mu s$ 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 32×32 screen of which only 32×24 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.

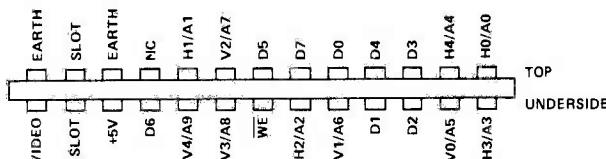


Fig. 3 Edge connector details that aren't in the manual!

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 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 WE will go low and data from latch IC4 (via tri-state buffer IC1) will be written into IC8. The 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.

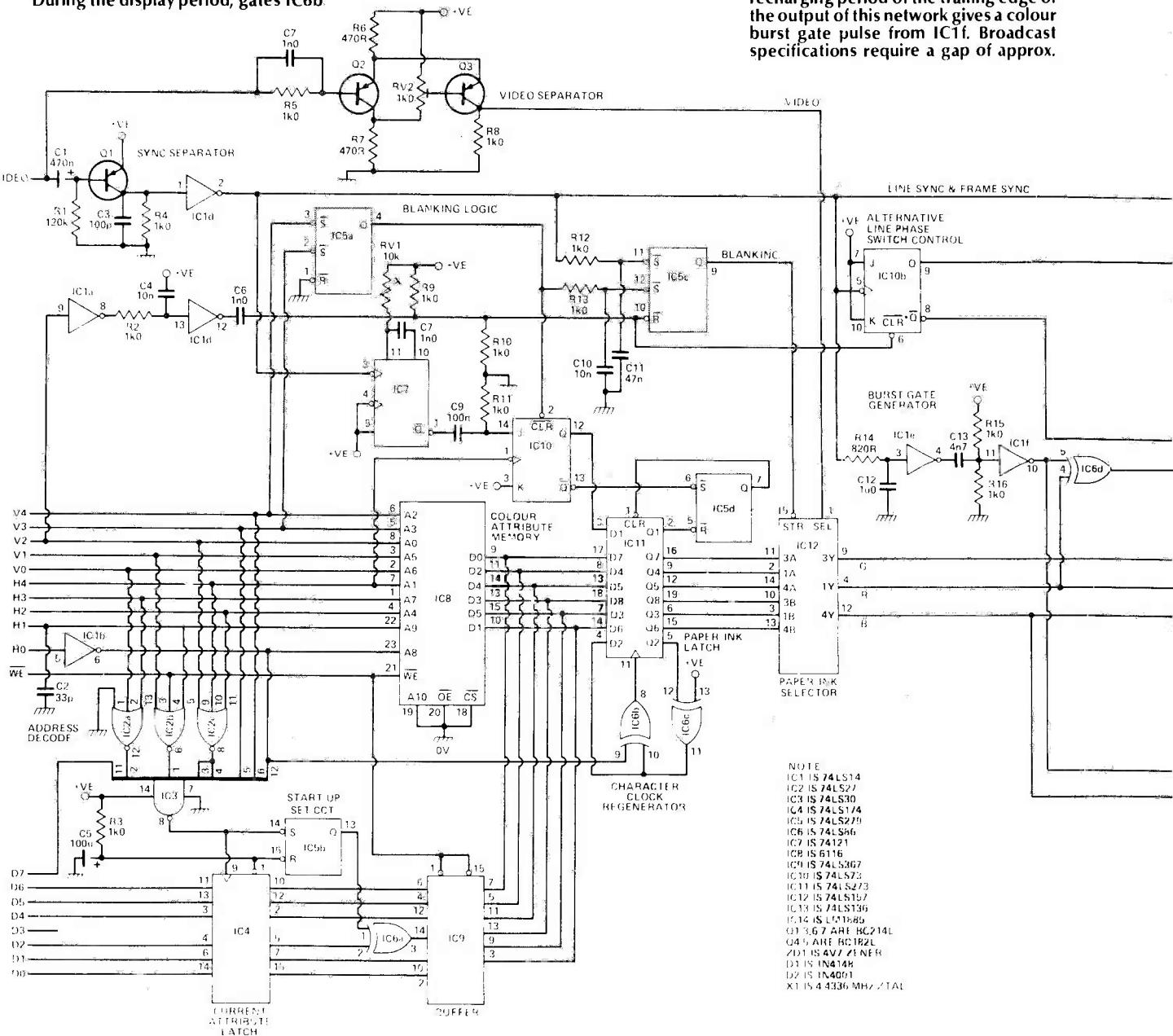
The outputs of IC11 consist of three ink bits and three paper bits for the character currently being displayed by the Ace character generator. Selection of ink or paper bits in data selector IC12 is controlled by Schmidt trigger Q2/3 from the Ace composite video signal. White areas select ink colours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

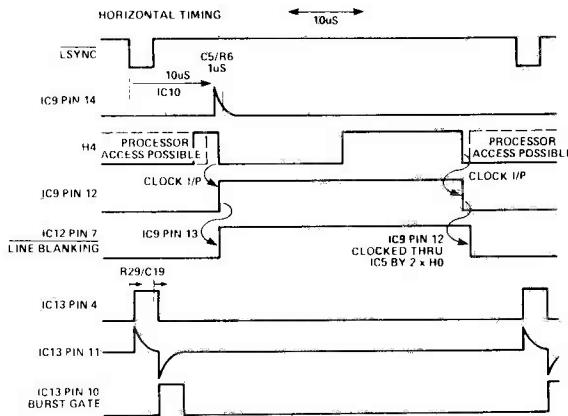
ing of IC10a, monostable IC7 and differentiator R11/C9 give a short window for triggering to occur. Latch IC5d and output Q1 of IC11 serve to delay the blanking signal for the same period that the data from the RAM is delayed.

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.



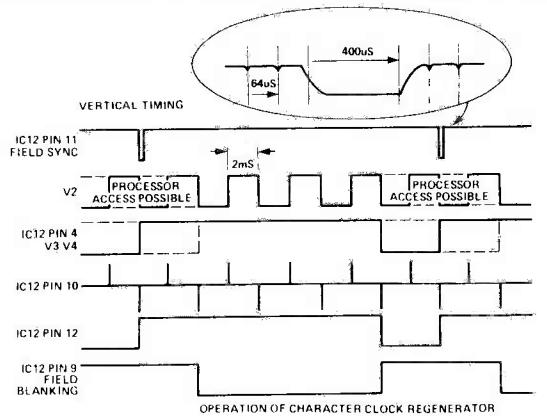
WORKS



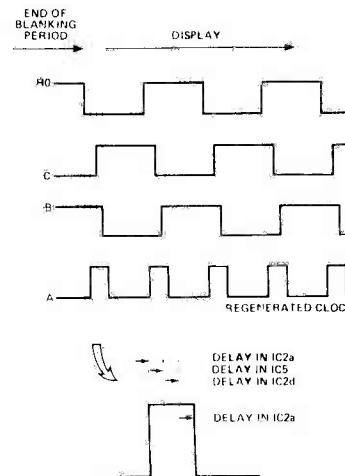
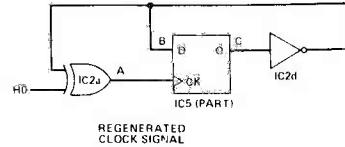
800ns between line sync and burst. This is provided by delay network R14/C12.

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



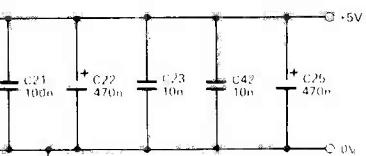
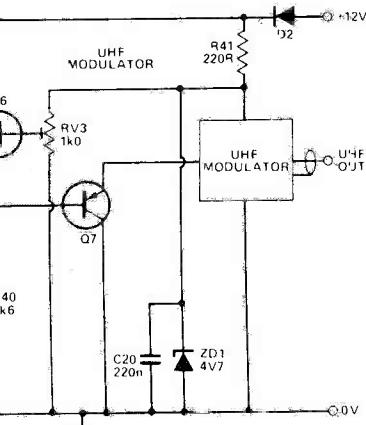
OPERATION OF CHARACTER CLOCK REGenerator



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 subcarrier. 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.



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

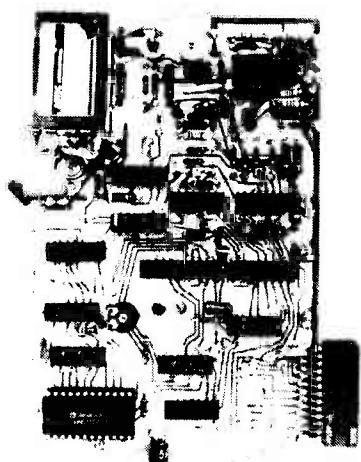
In order to use the colour facilities within FORTH programs, it is necessary to define the following words:

```
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
```

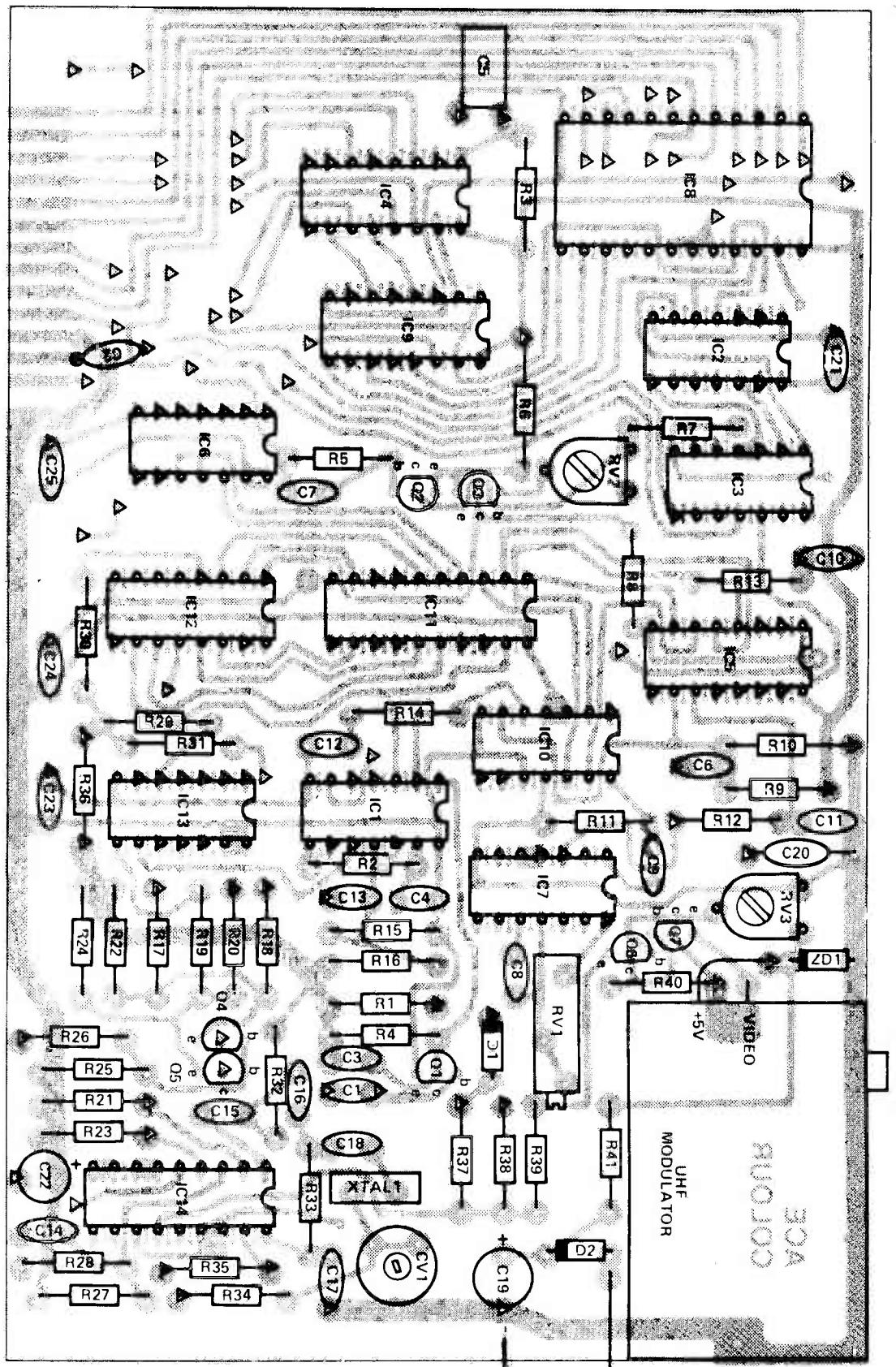
By way of explanation, INK and PAPER both expect a colour number on the stack. They pass this and a mask value to COMBINE which masks out the old colour and adds the new one. This is stored in the variable ATTRIB and also in the latch. Zero is then written to the latch for the reasons given earlier.

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.



PROJECT : Adding Colour



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.

SHUGART 801 FLOPPY DISC DRIVE 5" £100 ea.
TRANSMITTER DOT MATRIX PRINTER. Compact Serial Interface
 230V. Wht Info £85 ea.
TELETYPE A4RS3 (Printer, Keyboard, Punch & Reader.) £232
850 THERMISTOR
OLC 75 TELEPRINTER. Very good condition £25 ea.
9" MONITOR. Cased. Non Standard With Info £15 ea.
12" MONITOR. Cased. Non Standard With Info £15 ea.
12" MONITOR. Black & White. Video in £30 ea.
TV 16" 80" MONITOR. Black & White. Video in £30 ea.
BALOMETER OSCILLOSCOPE CD1400 Dual Beam 15MHz
 90 deg.
MICRO WOBBLER TOP 2105-220MHz With Manual £25 ea.
A.V.O. TRANSISTOR TESTER TTI 89 With Leads 20 ea.
ADVANCE SIGNAL GEN 8062B 15KHz-220MHz C/W/Mod
 £80 ea.

GEARLESS MOTOR 150W Input Imp. Size 25 inch/diameter
 1/4" shaft. 1000 rpm. £25 ea.
GEARED MOTOR 1/7-234V 50HZ Input 4" dia x 5" deep 1/4" shaft. New £85 ea. P&P £4.
240V/17 AC MOTOR (Turntable style) Size 82 x 75 x 28mm. Shaft 13x4mm £1.50 ea. P&P £2.
MOTOR 12V DC Input 3" dia x 4" deep. 1/4" shaft. New. £3.50
 each. P&P £3.
SYNCHRONOUS MOTOR 2 Phase 9 volt AC 375 RPM Good
 Quality. 30-40mm diameter Can be used as DC STEP-
 PING MOTOR. 8 STEPS PER REV. £1 each.

**STEPPING MOTORS AVAILABLE
 PLEASE ENQUIRE**

GEARED MOTOR 120V 50HZ 4 Watt 1 rpm. 2" dia x 1" deep. £1.50 each.

TONIN BNAIL TYPE BLOWER 230V 22 Watts Overall size 5x

1 1/2" x 4" each. P&P £2.

TRANSFORMERS - All Brand New. All 240V input.

Sec 255V 2VA 5A Size 3" x 2" x 1" £2.50 each.

Sec 115V 1A (Auto.) £1.25 each.

Sec 115V 1A (Auto.) £1.25 each.

TRANSFORMER D-220 - 240V Input Sec 0-12V & 0 24V 1 Amp/2 winding £2 each.

TRANSFORMER 120V Input Sec 100-10V 1A - 75p each.

Sub Min Transformer O-120V 240V Input Sec 12-0-12V 4VA - 75p each.

TOPOIDAL TRANSFORMER 0-15-230V Input Sec 13.5-0-13.5V 8VA. £1.50 each. 10 off £12.

TOPOIDAL TRANSFORMER 120-240V Input Sec 0-12V. 0-12V 10VA per winding Encapsulated £4 each. 10 off £35.

SUSI PULL TYPE TRANSFORMER 120-240V Input Sust. 500W Thyristor trigger. 20VA each. 10 off £1.80.

TRANSFORMERS brand new 120/240V input Secondary 15V 0.4A twice. PC mount £1.50 each. Sec 9V 0.3A twice. Sec 6V 0.6A each. £1.50 each. Sec 24V 0.1A twice. Sec 21V 0.1A each. Sec 12V 0.1A each. Sec 10V 0.1A twice £3 each. Many others available. Please enquire.

DUBLIER E.H.T. CAPACITOR 0.025 uF 5kV £1 each.

PARK DISCHARGE CAPACITOR mid 4kV. 1000pf each. P&P £2.

E.H.T. CAPACITORS 200pf, 500pf, 1000pf 8KV 20p each. 10 off £1.80.

ELECTROLYTIC CAPACITOR 15,000 mfd 25V 20p each. 10 off £1.80.

ILLUMINATED ROCKER SWITCH 2 pole 250V 8 Amp. Orange - 50p each. 10 off £4.

SLOTTED OPTO SWITCH with data - 50p each. 10 off £4.

SPECTRAL RELIANCE TEN TURN POT. 100 ohm. 500 ohm. Brand New. 75p each. 10 off £6.

SLIDER POTENTIOMETER Twin Gang. 200K. 2M - 35p each. 10 off £3 Single Gang 10K - 25p each. 10 off £2.
PAN HEAD MOUNTING FUSE HOLDER For 1/4" fuse - 20p each.
 10 off £2.
CINCH CONNECTOR STRIP 12 way 4BA Screw connection on both sides - 35p each. 10 off £3.
INFRA RED QUARTZ LAMP 230V 620W Watts. Size 13/8" x 1" dia - £1.50 each. 10 off £10.
PHOTOCELL TYPE MS15 - 50p each. 10 off £4.

VU METER Scale 0-5. Size 1 1/2" x 1/2" - 50p each. 10 off £4.

I.T.T. LOUD SPEAKER 2 1/4" dia. 50 ohm 0.2 Watt. New - 75p each. 10 off £6.50.

PCB KEYBOARD P&P - 50p each. 10 off £12.

KEYBOARD 12 Alins Red/Black switches Pushmatic 0.9-1" x 1" black size 1 1/2" x 2" high - 84 each. 5 off £18. P&P £3.

VARIAC 2 Amp Ex-equipment. Good condition - 50p each. P&P £4.

E.M.T. CABLE Overall 1.5mm - 10p per meter. 100 meters £7.50. P&P £4.

LED type TL209 Red with holder - 8p each. 10 off £70.

DC-DC COUPLES 20p each. 10 off £2. I.C.

SOCKET 16 pin 8p. 100 off £6.

EPROM Texas 2554 £3 each. REGULATOR TYPE 7812 - 50p each. 10 off £2.50.

MOSPOWER FET type VMP1 (TO 31) £1.50 each.

DISCOS 1N3410, 1N3083, 1544, BA13 - 100 off £1.50.

100 off £1.50. 1N3403, 1N3405, 1N3406 - 50p each.

TRANSISTORS - 2N3704 - 8p. 2N3984 - 50p. 2N5449 - 8p. BC107 - 8p. TIP640 - 50p.

BRIDGE RECTIFIER - CSC type BOSS - 20p each. 10 off £2.

TANTALUM BEAD CAPACITORS 0.1mf 35V. 10 off £1. 100 off £7.50.

CAPACITORS - 0.047µF 1000V. 0.047 12V. 0.001 200V. 10 off 50p. 100 off £2.

TRANSFORMER 240V Input Sec 2KV 10MA. Size 80 x 70x 110mm. 84 each. P&P £10.

BURGESS HEAVY DUTY MICROSWITCH with Lever & arm 75p each. 10 off £6.50.

HONEYWELL H/DUTY MICROSWITCH with Button 60p each. 10 off £6.

EXECUTIVE TELEPHONE-PUSH BUT-TON. Functions include 10 number memory; repeat dialling; internal Microphone & Speaker and separate handset etc. Will connect direct to British Telecom System. BRAND NEW. ONLY £25 ea. P&P £4.

**Minimum Order of Goods £3.
 Minimum P&P £1.80. VAT at 15%
 MUST be added to TOTAL OF GOODS
 & PACKING**

Many more components and test equipment available. S.A.E. or telephone for lists.

ELECTROVALUE

Your **SPECIALIST**
SUPPLIERS for **CAPACITORS**
 of all preferred types



CERAMIC PLATE

Above 1000pF, in E.6 values to 4700pF

C.333 100Vdc 1.8-4700pF - 10 types

B.37448 63Vdc 2.5mm PCM 0.01-0.68µF - 5 types

B.37449 63Vdc 5mm PCM 0.047, 0.68, 0.1µF

CERAMIC DISC 1nF-10nF, 300Vac

ELECTROLYTIC Axial in 48 values from 1 to 10000µF, 10 to 63Vdc

Canned in 9 values from 2000 to 22000µF, voltages to 350

Reversible from 2 to 1000µF Low Leak, Alimn. 0.1-100µF. 17 values, 6-50Vdc

Radial 15 values from 0.1-1000µF, 16-63Vdc

TANTALUM BEADS in 18 values from 0.1-100µF, 63-35Vdc

POLYSTYRENE (Siemens) 39 values 5pF to 18nF, 160Vdc.

The above ranges should meet the majority of current requirements. Mention E.T.I. when sending for our latest A-Z list showing very many more types.

BRITAINS LEADING QUALITY COMPONENT SUPPLIERS - SEND FOR FREE 36 PAGE A-Z LIST ATTRACTIVE DISCOUNTS-FREE POSTAGE-GOOD SERVICE & DELIVERY

ELECTROVALUE LTD

28 St Jude's Rd, Englefield Green, Egham, Surrey TW20 0HB (0784) 33603. Telex 264475. 680 Burnage Lane M/C (061-432 4945) (Callers only). EV Computing Shop, 700 Burnage Lane, Manchester (061-431 4866).

**ACCESS AND BARCLAYCARD
 Phoned Orders Welcome**

SPECIAL OFFER
 Order three books and get
 Understanding series
 FREE.

STEWART of READING
 110 Wykeham Road, Reading, Berks RG6 1PL
 Tel: 0734 68041
 Callers welcome 9am-5.30 pm Monday to Saturday inclusive

An in-depth series in understanding today's world of electronics.

From Texas Instruments.

The Understanding Electronics Series was specially developed and written to give you an in-depth knowledge of this world.

Each book is comprehensive, yet easy to understand. As informative for the electronics buff as for someone who's simply interested in what's going on today.

Together the library will give you the most complete range of titles available. Take advantage of our special offer and choose the book, or books you want from the titles below. You'll find whole new worlds of advanced technology unfolding before you.

L. Understanding Electronic Control of Energy Systems. 1st edition. Ref. LCB 6642. Covers motor, generator, power distribution, heating, air conditioning, internal combustion engine, solar and nuclear systems. Softbound 272 pages. £4.50.

2. Understanding Electronic Security Systems.

1st edition. Ref. LCB 720L. A complete guide covering the basics of hard wired, photoensitive, infrared, ultrasonic and microwave systems and their use in different applications. Softbound 128 pages. £2.95.

3. Understanding Solid State Electronics.

3rd edition. Ref. LCC 336L. The principles of solid state theory. It explains electrical movement, with intermediate tuition on the applications of solid state devices. Softbound 232 pages. £4.50.

4. Understanding Digital Electronics. 1st edition. Ref. LCB 331L. Describes digital electronics in easy-to-follow stages. It covers the main families of digital integrated circuits and data processing systems. Softbound 260 pages. £4.50.

5. Understanding Microprocessors. 1st edition. Ref. LCB 4023.

An in-depth look at the magic of the solid state chip. What they are, what they do. Applications of 8-bit and 16-bit microprocessors; and design from idea to hardware. Softbound 288 pages. £4.50.

6. Understanding Computer Science. 1st edition. Ref. LCB 547L.

This book tells you in everyday English how today's computer has been developed, what goes on inside it, and how you tell it what to do. Softbound 278 pages. £4.50.

7. Understanding Communications Systems.

1st edition. Ref. LCB 452L. An overview of all types of electronic communications systems. Softbound 282 pages. £4.50.

8. Understanding Calculator Maths. 1st edition. Ref. LCB 332L. Brings together the basic information - formulae, facts, and mathematical tools - you need to "unlock" the real power of the hand-held calculator. Softbound 230 pages. £4.50.

9. Understanding Optronics. 1st edition. Ref. LCB 547Z.

Optronics is the application of light and electronics to perform a wide range of useful tasks. From car headlights to missile guidance systems. Softbound 270 pages. £4.50.

10. Understanding Automotive Electronics.

1st edition. Ref. LCB 572L. Learns how electronics is being applied to automobiles. How the basic mechanical, electrical and electronic functions and the new microprocessors and microcomputers are being applied in innovative ways for vehicle drive, train control, motion control and instrumentation. Softbound 288 pages. £4.50.

11. Understanding Telephone Electronics.

1st edition. Ref. LCB 714L. The positive thrust of electronics is making the telephone an even more important communication link. Conventional telephone fundamentals, analog and digital electronics, principles, newer digital techniques and hardware implementation are covered in this book. Softbound 288 pages. £4.50.

12. Understanding Electronic Control of Automation Systems.

1st edition. Ref. LCB 664L. This book is about automation - explains in simple language the subject of electronic control of automation systems, and helps the reader understand the terms, principles, techniques and effort used to automate processes. Softbound 280 pages. £4.50.

How to order

Fill in the coupon below or if someone else has already used it, simply:

1. List reference numbers and quantities required

2. Calculate total order value. Add £1.50 for postage and packing.

3. Send the list, plus your cheque payable to Texas Instruments Ltd.

PO Box 50, Market Harborough, Leicestershire.

Allow 30 days for delivery.

To Texas Instruments Limited, PO Box 50, Market Harborough, Leics. Please send me the following publications:

REFERENCE NO.	QTY.	REFERENCE NO.	QTY.
1	7		
2	8		
3	9		
4	10		
5	11		
6	12		

Free title choice: Understanding _____

Enclose a cheque for £_____

Name _____

Company (if any) _____

Address _____

Please send me details of TI's range of Technical Books (please tick)

Registered office: Texas Instruments Ltd, Manton Lane, Bedford MK41 7PA
 Registered number: 574102 England.

ET13

TEXAS INSTRUMENTS 

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 pedigree, 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
FC	backwards to load A with high byte again
3E	Load A with code for letter O
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.

FEATURE

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 will 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 — INR 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

MIDWICH

COMPUTER COMPANY LIMITED

RICKINGHALL HOUSE, HINDERCLAY ROAD, RICKINGHALL, SUFFOLK IP22 1HH. TEL. DISS (0379) 898751.

BBC Microcomputers

Model B	348.25
Model B + Disc Int	433.21
NB Credit cards are not accepted in payment for BBC Microcomputers	

BBC Micro Econet

Full range of products available Installation service available

BBC Compatible Disc Drives

Cased drives, finished to match the BBC Micro are supplied complete with connecting cables, manual and utilities disc. All single cased drives may be expanded to dual configuration by the addition of the appropriate uncased mechanism.

Disc capacity	Single	Dual	Uncased
100K 40T	160.83	291.95	130.00
400K 40/80T D/S	264.35	479.15	215.00

Trade quantity discounts are available

BBC3 Disc Interface 84.95
Please send for our BBC Micro price list. Full range of accessories available.

Memories

	Regulators
2141-20	D1 0.92
4116-15	D2 1.05
4116-20	D2 0.88
4118-15	D1 3.75
4164-15	D2 4.33
4164-20	D2 3.95
4164-20	D2 6.60
4564-15	5.25
5516-25	7.73
6116-3	D1 3.72
6116-LP3	D2 4.67
2524-45	D2 3.50
2708-45	D2 3.25
2716-35	D1 4.50
2716-45	D1 3.50
2716-3	D1 4.50
2732-35	D1 4.58
2732-45	D1 3.75
2764-30	D1 3.92
2764-250NS TT	3.92
2784-250NS B	5.95
2564-30	D2 6.00
27128-30	D2 24.50

Buffers

	Regulators
81LS95	0.95
81LS96	0.95
81LS97	0.95
81LS98	0.95
8726A (8800AP)	0.78
8728A (8888)	0.78
8735 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
81LS10	D1 1.25
8281	D3 1.31
8640	D4 3.92
8643L	20.88
8645	D5 5.88
8650	D2 1.31
8662-AU	0.00
8671-AU	14.17
8688	D2 5.78
8675	7.13
86800	D7 4.73
86809	D6 9.96
86821	D3 1.88
86840	D3 1.88
86843L	20.88
86845	D5 5.88
86850	D2 1.31
86862	0.00
86871-AU	14.17
86888	D2 5.78
86975	7.13
86980	D7 4.73
86989	D6 9.96
86996	D3 1.88
86810	D1 1.80
86840	D4 5.50
86850	D2 1.83
MC66854P	7.75

	Regulators
8726A (8800AP)	0.78
8728A (8888)	0.78
8735 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78
8737A (8867)	0.78
8738 (8888)	0.78

	Regulators

<tbl_r cells="2" ix="5" maxcspan="1

NEW **INTERFACE E** – ONLY £55.00
Simply plug in and it's ready to use. All operating commands are held in an EPROM so LLIST, LPRINT and COPY can be used at any time without using up valuable user RAM. COPY will allow the reproduction of high resolution graphics with Epson (or derivatives) and Seikosha 80, 100 and 250 Series printers. Print width selection from 32 characters to full width depending on printer used.

INTERFACE S – ONLY £39.99

Visually identical to Interface E but without the EPROM. Interface S also recognises the LLIST & LPRINT commands and will allow print width selection from 32 characters to full width.

However, software routines will need to be loaded before use. Full screen dump to reproduce high resolution graphics is also possible and supporting software is supplied to operate this facility with Epson and Seikosha printers. The software routines that are necessary to initialise the interface are held in the printer buffer so valuable user RAM will not be used up. There is a growing range of Business/Utility software that includes these routines. Details available on request.

Either interface simply plugs into the ZX Spectrum expansion port or interface and is supplied fully cased with a one metre ribbon cable which connects to the printer of your choice. Full instructions are included and driving software is supplied with Interface S.

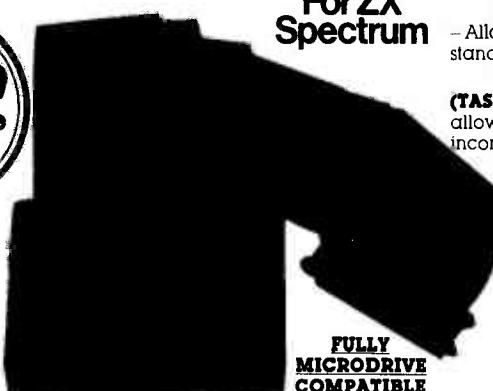
We recommend Epsons, NEC, TEC, Seikosha, OKI Microline, Tandy GP115, Star DP510, Shinwa, Brother HR15, etc.

At last you can have real print performance from your ZX Spectrum with the Kempston Centronics Interfaces.

THE INDUSTRY STANDARD INTERFACE

For ZX Spectrum

From
£39.99
Inclusive



FULLY
MICRODRIVE
COMPATIBLE

Interface S available from W H Smith and Spectrum Computer Centres

All products direct from:

KEMPSTON
MICRO ELECTRONICS LTD

Unit 30 Singer Way, Woburn Road
Industrial Estate, Kempston,
Bedford, MK42 7AF. Tel: (0234) 856633
Telex: 826078 KEMPMI G

All prices include VAT and P. & P.
Overseas orders please add £4.00 P. & P.
Please allow 21 days for delivery of interfaces
and software. Printers available within 48 hours.

TRADE ENQUIRIES WELCOME



Happy Memories

Part type	1 off	25-99	100 up
4116 200ns	1.25	1.15	1.10
4164 200ns	4.95	4.40	4.20
2016 150ns (6116)	3.85	3.45	3.30
6116 150ns Low power	Call	Call	Call
6264 150ns	28.00	25.00	24.00
2716 450ns 5 volt	3.85	3.45	3.30
2732 450ns Intel type	3.85	3.45	3.30
2532 450ns Texas type	3.85	3.45	3.30
2764 250ns	Call	Call	Call
27128 300ns	Call	Call	Call
Z80A-CPU	£2.99	Z80A-PIO	£2.99
6522 PIA	£3.70	7805 reg	£0.50
Z80A-CTC		7812 reg	£0.50

Low profile IC sockets:

Pins	8	14	16	18	20	22	24	28	40
Pence	12	13	14	16	18	22	24	27	38

Soft-sectored floppy discs per 10 in plastic library case:
5 inch SSSD £17.00. 5 inch SSDD £19.25. 5 inch DSDD £21.00.
5 inch SSQD £23.95. 5 inch DSQD £26.35.

74LS series TTL, large stocks at low prices with DIY discounts starting at a mix of just 25 pieces. Write or phone for list.

Please add 50p post & packing to orders under £15 and VAT to total.
Access & Visa welcome. 24hr phone service on (054 422) 618
Government & Educational orders welcome. £15 minimum.
Trade accounts operated, phone or write for details.

Happy Memories (ETI)
Gladestry, Kington, Herefordshire HR5 3NY
Tel: (054 422) 618 or 628

KEMPSTON CENTRONICS
INTERFACE COMPATIBLE
SOFTWARE UTILITIES.

FOR THE 48K SPECTRUM.

FINANCE MANAGER (OCP) – Menu driven program for all domestic and business accounting applications £19.95

ADDRESS MANAGER (OCP) – Simple index filing system ideal for names, addresses, etc. Various search facilities. £19.95

FULL SCREEN EDITOR/ASSEMBLER (OCP) – Allows you to write Z80 assembly code using standard mnemonics on full screen. £19.95

WORD PROCESSOR (TASWORD TWO) – (TASMAN) A professional word processor allowing 64 characters per line and incorporating all usual editing facilities. £13.90

OMNICALC (MICROSPHERE) – The only spreadsheet written entirely in machine code. The easy and fast way of solving any numerical problem. Ideal for cash flow forecasting to concrete stress analysis. £9.95

MASTERFILE (CAMPBELL SYSTEMS) – Filing and retrieval system for domestic or business use. Files can be loaded and saved independently. Microdrive compatible. £9.95

NOW WE CAN ALSO SUPPLY YOUR PRINTER.

We've looked at the printers currently available and have selected what we feel is best value for money in dot matrix and daisy wheel printers:

EPSON RX-80 FT – A dot matrix printer allowing full graphics dumping and a choice of printing styles. Speed: 100 C.P.S. Price £325 Inc. VAT and Delivery

BROTHER HR15 – A daisywheel printer ideal for letters, mail shots, documents, etc. Many typefaces available by changing daisywheel. Duplication facility but no graphics. Speed: Up to 18 C.P.S. Price £425 Inc. VAT and Del.

THEATRE & BAND LIGHTING

12 x 1K LESS THAN £200!

The days of hiring your electronics are over. You know we manufacture a range of power packs, desks, lanterns, stands, etc. NOW WE ARE PLEASED TO INTRODUCE THE APD SERIES OF MODULAR DIMMERS. Incorporating technology that allows the control of Inductive as well as resistive loads, you build a system exact to your requirements, and save a fortune in process. So where is the sense in hiring????

Contact our sales for free info:

The Sales Manager
MJL SYSTEMS LTD
45 Wortley Road
W. Croydon CR0 3EB
Surrey, U.K.

Tel: 01-689 4138
(Mon-Fri 9-5pm)

BUILD A BETTER AMPLIFIER!



How can you own a top class HiFi amplifier, of comparable standard to Naim, Meridians, Quads etc., for an outlay of less than £250? — Simple! Build it yourself — with a Crimson kit.

It is not necessary to spend a small fortune to obtain true HiFi performance. Crimson Kits offer all the features and sound quality of the most esoteric amplifiers available and their ease of assembly ensures that they work first time and continue to do so. Not only do Crimson Kits offer outstanding value, but they also have the flexibility to adapt to any user's needs. All the P.C.B.'s are ready assembled and tested (they are not "potted" as we believe disposable modules are rather extravagant!) therefore constructing a kit is pleasurable in itself and, once built, will give years of untroubled service. So, whether you use a simple record player or a compact disc, you can be sure to get the most from your system. E.T.I. said, in their review of the CK1010/1100: "I can say no more than that for £250 it is a bargain and one that will become the reference point for kit amplifiers from now on." Need we say more?

PRICES

CK1010 — STEREO PRE-AMPLIFIER (moving magnet, tape, tuner input)	takes power from any CK power amp or separate p.s.u. type P.S.K.	£92.00
CK1040 — STEREO POWER-AMPLIFIER 40 watts R.M.S./Chanel		£121.00
CK1080 — STEREO POWER-AMPLIFIER 80 watts R.M.S./Chanel		£134.00
CK1100 — STEREO POWER-AMPLIFIER 100 watts R.M.S./Chanel		£151.00
MC2K — Moving coil add on kit for CK1010		£25.00
P.S.K. — power supply for CK1010 (if not used with a CK power amp)		£20.00

CRIMSON also supply power amp, pre amp and electronic crossover modules, power supplies and hardware — too much to list here — but on receipt of an S.A.E. we will be happy to supply full details.

TO ORDER Send C.W.O. or quote your access card no (phone orders accepted) Crimson Products are also available from Bradley Marshall Ltd, 325 Edgware Road, London.

CES CRIMSON ELEKTRIK STOKE

MANUFACTURERS OF PROFESSIONAL, DOMESTIC & INDUSTRIAL AMPLIFICATION

PHOENIX WORKS, 500 KING STREET, LONGTON, STOKE-ON-TRENT, STAFFORDSHIRE. ST2 1EZ 0782 330520

MARCO TRADING

Resistor Kits — Each Value

Individually Packed
1/4W pack 10 each value E12-10R to 1M
610 pcs £4.80.

1/2W pack 10 each value E12-2R2 to 2m2
730 pcs £5.25!

0.1W Pre-Sets

7p ea: 65p/10: £5.50 per 100

Rotary Potentiometers

1K to 2m2 Log and Lin 32p ea, £3.10

Resistors

1/4W 1R 10M 2p ea: 15p/10 75p/100 £4.80/1000
1/2W 1R to 10M 2p ea: 15p/10 95p/100 £6.00/1000

Zener Diodes

400mW 2V7 to 7.5V. 8p ea: 75p/10. £3.50/50 £8/100
1.3W 2V7 to 20V 15p ea: £1.40/10. £12.50/100

L.E.D.s

Available in 3mm and 5mm

RED 10p ea: 85p/10 £8/100

YELLOW 13p ea: £1.20/10 £10/100

Supplied complete with clips

Diodes

Voltage Regulators

1N4001 5p 78L/05/08/12/15 30p

1N4007 7p 78M/05/08/12/15 50p

1N4148 4p 78/05/08/12/15/18/

1N5401 15p 24 55p

1N5408 20p 79/12/15/18/24 65p

Soldering Section

Antex 15W Iron £5.00

Antex 18W Iron £5.00

Antex 25W Iron £5.20

Antex Elements £2.00

Antex Bits £0.95

Antex Stands £1.90

De solder pumps £3.50

MULTIMETER SPECIAL

(Complete with re-chargeable batteries)

Russian type U4324 d.c.

Voltage: 0.6, 1.2, 2, 12, 30,
60, 120, 600, 1200. a.c.

Voltage: 3.6, 15, 60, 150,

300, 600, 900. d.c. intensity

m/a: 0.006, 0.6, 6, 60, 600,

3000. a.c. intensity m/a: 0.3,

3, 30, 300, 3000. d.c. resistance:

0.25, 5, 50, 500,

500.kOhm. a.e. level dB 10

to +12, 20.000 OPV.

£12 Inc p/p + VAT

I.C. SOCKETS

8 pin: 8p 70p/10

14 pin: 10p 65p/10

16 pin: 11p £1/10

18 pin: 14p £1.30/10

40 pin: 34p £3.10/10



Transformers (*p/p see below)

240v: 6-0-6/100mA 58p £5.20 for 10: £4.3 for 100

240v: 6-0-6/500mA 65p: £6.00 for 10: £4.8 for 100

Transistors

AC128 30p BC147 8p BC213 9p BT106 £1.50

AC169 45p BC157 10p BC214 9p BY238 68p

AD149 98p 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

Integrated Circuits

741 25 5/£1 TDA2020 £4.60 UPC1181H3 £1.80

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

This advert only a fraction of our range, send 65p for our latest 109 page fully illustrated catalogue (Incls 35p credit+). Complete with special offer lists etc etc. (*Transformers p/p 45p each £1.60/10, £4.50/100).

Please add 15% VAT and 45p P/P to the above prices.

Send orders to:

MARCO TRADING

Dept ET4, The Mailings, High Street, Wem, Shropshire SY4 5EN

Tel: 0939 32763

Visit our new 1000 sq ft retail shop at the above address.



C.E.L. D.I.Y. CAR ALARMS

Complete Voltage Sensitive/
Contact Car Security Systems

Assembled and tested: ST. £32.50

or

IR£39.00 + 23% V.A.T. (incl. P&P.)

Housed in Attractive Aluminium Box

- Voltage Drop Sensor
- Contact Sensor
- Immobilizes Ignition
- Optional 10 second delay
- Pulse horn or siren
- Resets automatically for next intruder
- Complete with all wires and fittings
- Simple installation instructions for D.I.Y. enthusiasts

Write or phone:-

Connaught Electronics Ltd

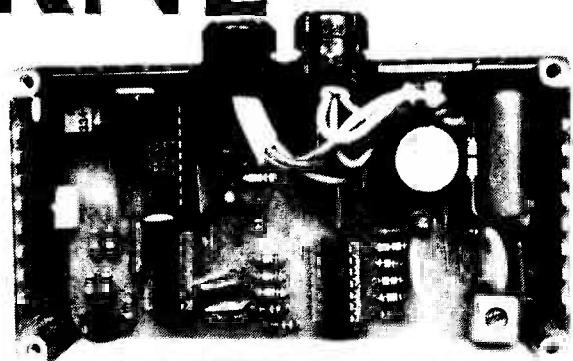
Unit 5, Industrial Estate

Dunmore Road, Tuam

Co. Galway, Ireland

Tel: (093) 28529 or (093) 28569

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 occurring as a result of noise.

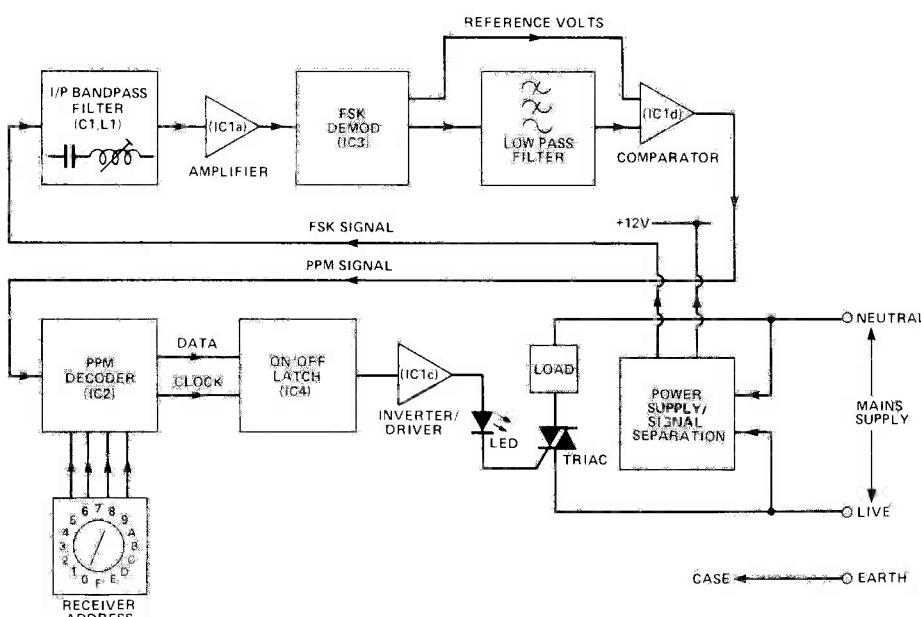


Fig. 1 Block diagram of the receiver unit.

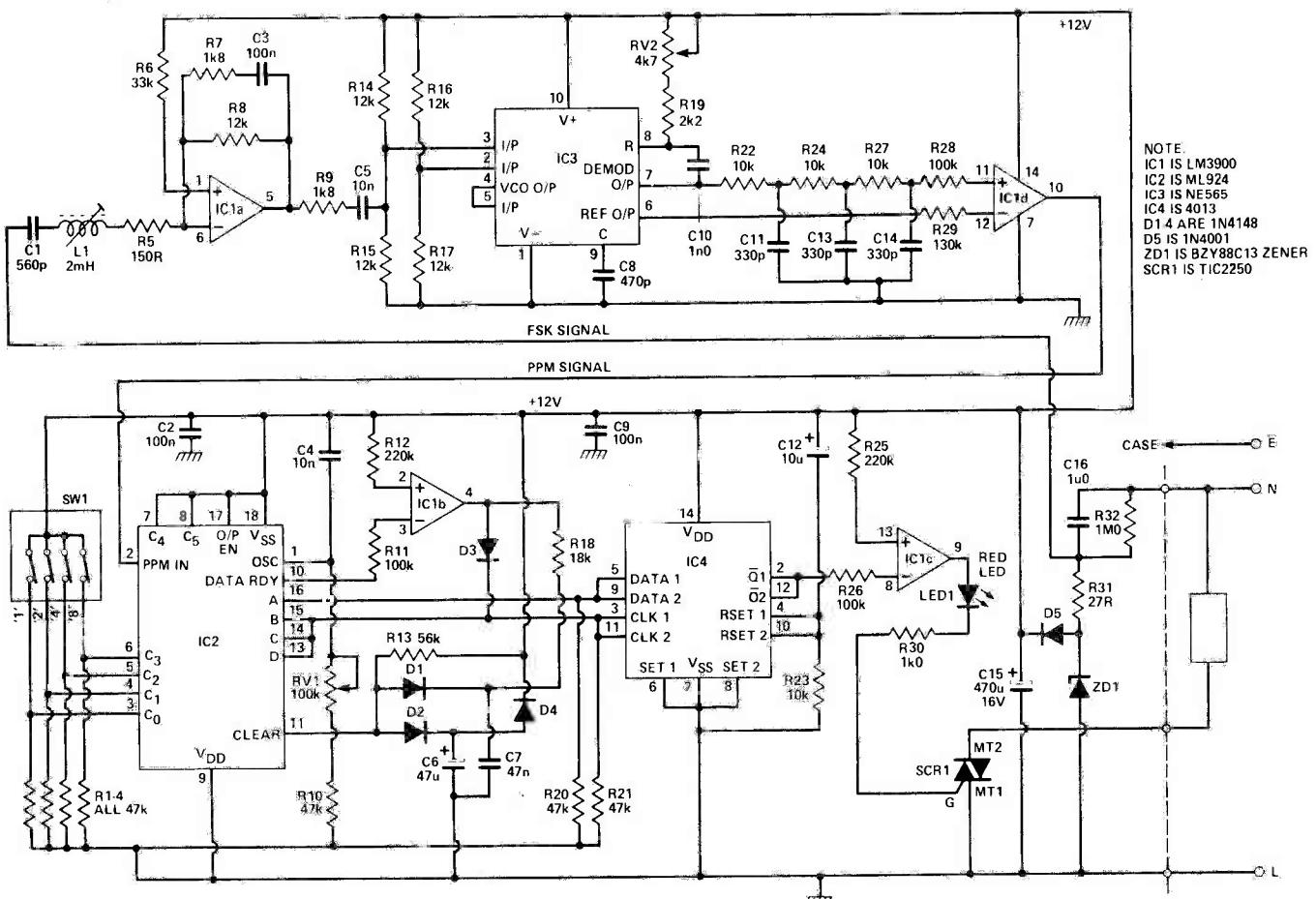


Fig. 2 Circuit diagram of the receiver.

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 resilience 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 sources 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.

(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

Pulse Position Modulation

In a PPM transmission, a 1 or 0 is transmitted not by the presence or 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, so that each word requires the transmission of 6 pulses to generate the 5 interpulse periods

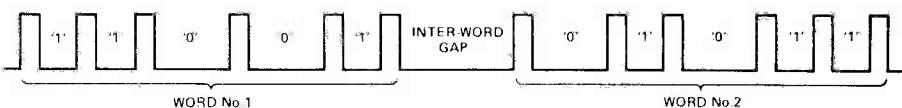


Fig. 3 Data format used in Pulse Position Modulation (PPM).

in several modes, one of which is this simple mode where the receipt of a valid message consisting of two identical words will result in the 5 bit data pattern appearing 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 device 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

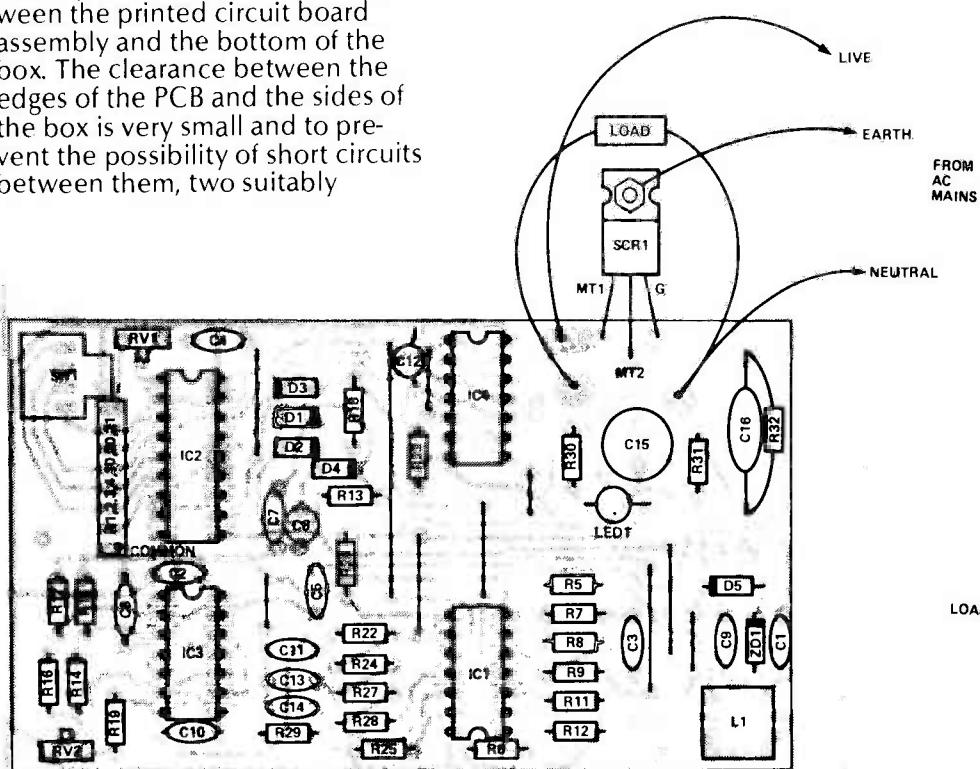


Fig. 4 Component overlay of the receiver PCB.

PARTS LIST — THE RECEIVER

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

PROJECT : Remote Control

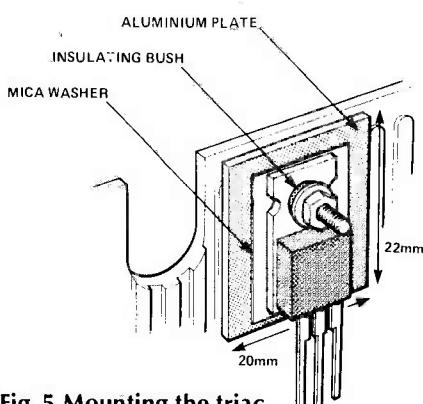


Fig. 5 Mounting the triac using a small aluminium plate.

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 aluminum 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.

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

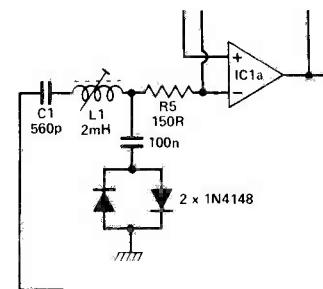


Fig. 7 A modification which will reduce the risk of spurious switching.

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 or the size of power triac that can be used is the gate current required to switch it on. This should be less than 300 millamps. 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 millamps.

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.

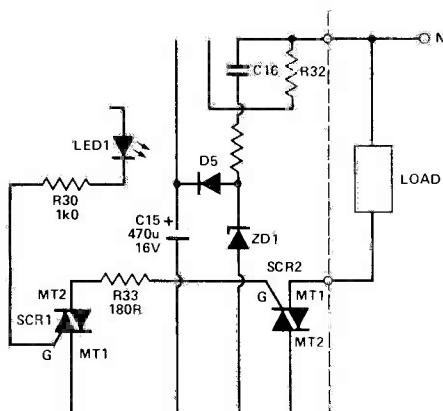
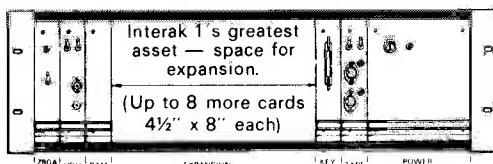


Fig. 6 The modification required to drive high power triacs.

Interak 1

A METAL Z80A COMPUTER

Colleges, Universities, Individuals: Build your own modular Z80A-based metal 19" rack and card Interak computer. Uses commonly available chips — not a single ULA in sight (and proud of it). If you can get your own parts (but we can supply if you can't) all you need from us are the bare p.c.b.s and the manuals.



(P.c.b.s range in price from £10.95 to £17.75 + VAT; manuals £1 - £5.)

The Interaktion User Group has 14K BASIC, Assembler, Fig Forth, Disassembler, Debug, Chess and a Book Library, Newsletters etc. No fears about this one going obsolete — now in its fifth successful year! Send us your name and address with a 21p stamp and we'll send you 40 pages of details (forget the stamp if you can't afford it!) You've already got a plastic computer for playing games, now build a metal one to do some real work: Interak, Interak, Interak!

Greenbank

Greenbank Electronics (Dept T4E), 92 New Chester Road, New Ferry, Wirral, Merseyside L62 5AG
Telephone: 051-645 3391

CLEF ELECTRONIC MUSIC

MICROSYNTH

2½ Octave Music Synthesizer with two Oscillators, two Sub-Octaves, Switched Routing and Thruwheel. A comprehensive instrument offering the full range of Synth Music & Effects

FULL KIT £137 Also available in 3 parts



PERCUSSION MICROSYNTH

Two Channel touch Sensitive unit plus Variable Angle LFO, phaser, internal and external triggering.

COMPONENT KIT £89



BAND-BOX PROGRAMMABLE BACKING TRIO

THREE PIECE BACKING BAND Generates the sounds of three instrumentalists to back Soloists

DRUMS + BASS + KEYBOARDS

Over 3,000 chord changes (60 scores) on 132 different chords — extendable to 200 scores. Master Rhythm also required.

FULL KIT £235 EXTENSION £82



88/72 NOTE PIANOS SPECIALISTS SINCE 1972

Using Patented electronic technique to give advanced simulation of Piano Key Inertia.



COMPONENT KITS including Keyboard

88 NOTE	£266
72 NOTE	£234

The above may also be purchased in four parts.

DOMESTIC KITS inc. Cabinet, P.A. & Spkr.

88 NOTE	£442
72 NOTE	£398

STAGE MODEL inc. Cabinet & Stand

72 NOTE	£383
---------	------

ALL PRICES INC. VAT, CARR. & TELEPHONE ADVICE

SAE for full Specs & MANF. PRICES VISA-ACCESS

TELE: 051-645 3391

MASTER RHYTHM PROGRAMMABLE DRUMS

Twenty-Four Rhythm programmable Drum Machine with twelve instruments. Eight sections are extended to 24/32 measures for two bar programming. Sequence operation and instrument tone adjust. COMPLETE KIT £79

STRING ENSEMBLE £198.50 ROTOR-CHORUS £98.00

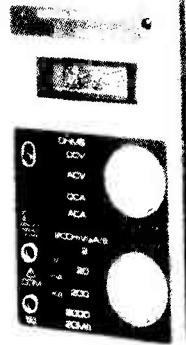
SQUARE FRONT KEYBOARDS 88 NOTE £60 49 NOTE £29

73 NOTE £50 30 NOTE £19 KEYSWITCH ITEMS ALSO AVAILABLE

THE 1984 GREENWELD CATALOGUE

NOW AVAILABLE

Its Bigger, Brighter, Better, more components than ever before. With each copy there's discount vouchers, Bargain List, Wholesale Discount List, Bulk Buyers List, Order Form and Reply Paid Envelope. All for just £1.00! Order now for early delivery!



TREAT YOURSELF TO A NICE NEW DIGITAL MULTIMETER!!

KD555C A DVM for the professional — this 3½ digit multimeter has overload protection, low battery and overrange indication. Full auto-polarity operation.

AC Volts: 0.2-700

DC Volts: 0.2-1000

AC Current: 200uA-10A

DC Current: 200uA-10A

Resistance: 200R-200M

Total 28 ranges for just £44.95

PUSH BUTTON BANKS

W4700 An assortment of latching and independent switches on banks from 2 to 7 way, CPCO to 6PCO. A total of at least 40 switches for £2.95; 100 £6.50; 250 £14.00; 1000 £45.00

"THE SENSIBLE '64"

David Highmore's new book on the Commodore 64 now available £5.95

TELESCOPIC AERIALS

As used in Sinclair microvision. 9 section 100-610mm. Only 95p

FERRIC CHLORIDE

New supplies just arrived — 500mg bags of granules, easily dissolved in 500ml of water. Only £1.15. Also abrasive polishing block 55p

CMOS PANEL

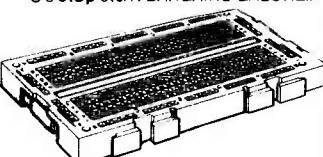
Z904 Panel 240 x 165 mm with 6 x 4099, 723 all in sockets, 14 x 8A 200V triacs, 45 small signal transistors, 14 R/C networks, 30 x 1N4001, sub-min relay, R's, C's, etc. 1£4.95

SEAT BELT ALARM

Originally for sale at £8.95, these well made units 70x50x25mm provide both audible and visual alarms. Uses 2 IC's PB2720 transducer, etc. . . Available ready built, with circuit and instructions for just £3.95. Also available as a kit, PCB + all components box, wire, etc, together with instructions. ONLY £2.95.

BULK BUYERS LIST

Send for our latest wholesale list — IC's from 5p, R's £2/1000, transistors 2½p, C's 0.8p etc. . . BARGAINS GALORE!!



VEROBLOC £1 off

Our biggest selling breadboard on offer at a special price of £4.10

NUT SCREWS WASHERS & BOLTS

Over 2 million in stock, metric, BA, self-tappers etc. SAE for list:

COMPUTER GAMES

Z901 Can you follow the flashing light/pulsating tone sequence of this famous game? Supplied as a fully working PCB with speaker (no case) plus full instructions. Only £4.95

Z902 Probably the most popular electronic game on the market — based on the old fashioned pencil and paper battleship game, this computerized version has brought it bang up to date! We supply a ready built PCB containing 76477 sound effect chip, TMS1000 micro-processor chip, R's, C's etc. Offered for its component value only (board may be cracked or chipped), it's only £1.95. Instructions and circuit 30p.

ALL PRICES INCLUDE VAT: JUST ADD 60p P&P

GREENWELD

443A Millbrook Road Southampton SO1 0HX

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 cancelled 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 warn-

ing 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.

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 μF , and T is time in minutes. This formula

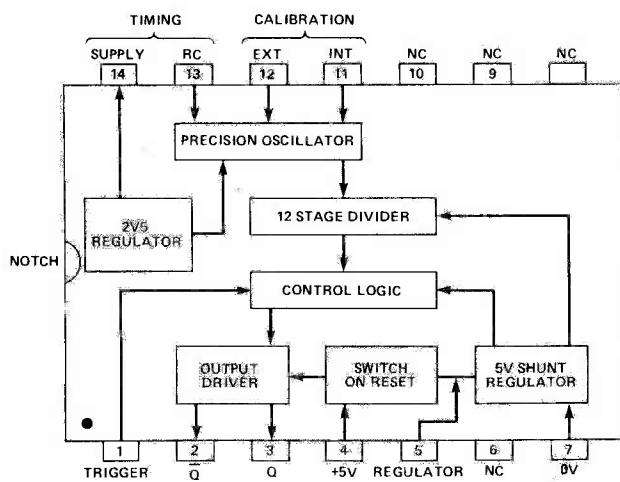


Fig. 1 Internal block diagram of the ZN1034E.

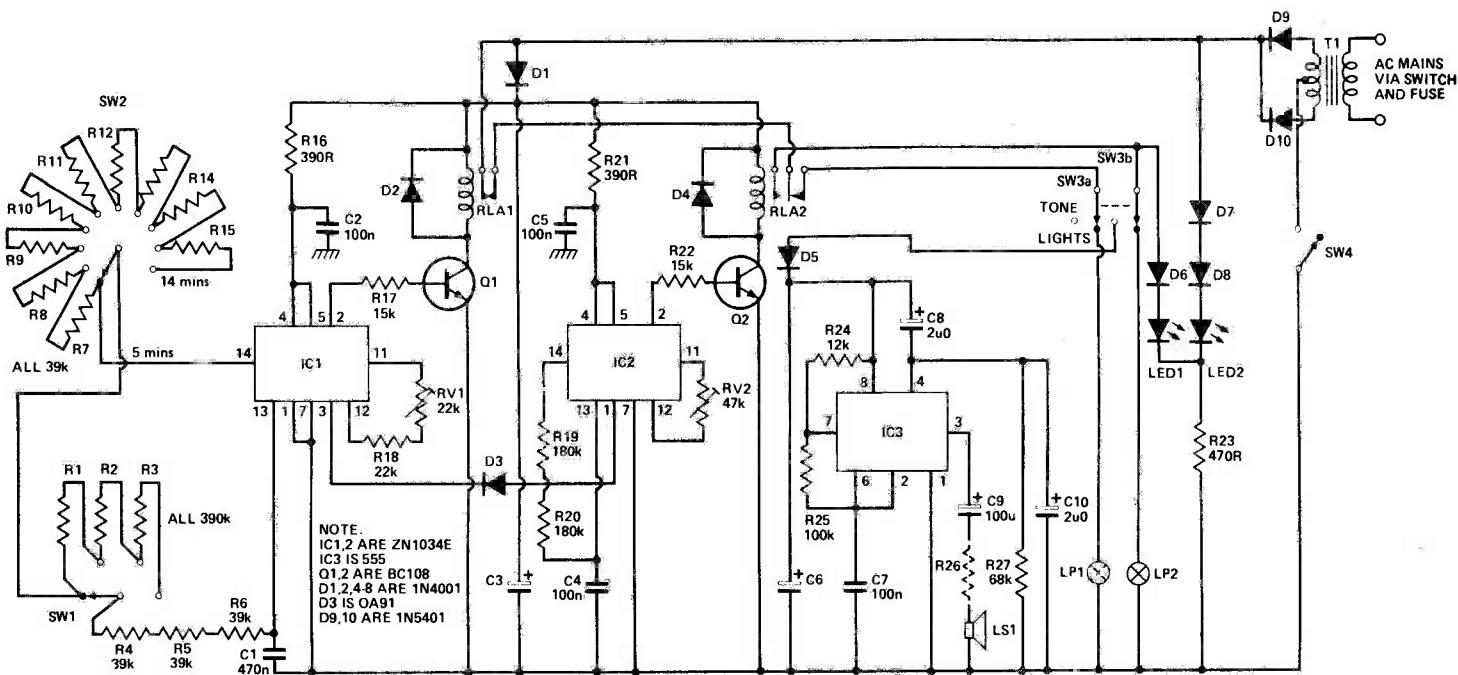


Fig. 2 Circuit diagram of the School Timer.

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 adjust-

ment 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 1/4W 5% unless otherwise stated)		SEMICONDUCTORS
R1, 2, 3	390k (see text)	IC1, 2 ZN1034E
R4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.	39k (see text)	IC3 555
R16, 21	390R	Q1, 2 BC108
R17, 22	15k	D 1, 2, 4, 5, 6, 7, 8 1N4001
R18	22k	D3 OA91
R19, 20	180k (see text)	D 9, 10 1N5401
R23	470R	LED1 0.2" red LED
R24	12k	LED2 0.2" green LED
R25	100k	
R26	see text	MISCELLANEOUS
R27	68k	SW1 1 pole, 4 way rotary switch
RV1	22k horizontal skeleton preset	SW2 1 pole, 10 way rotary switch
RV1	47k horizontal skeleton preset	SW3 DPDT switch, any type
C1	470n polycarbonate	SW4 SPST switch, any type
C2, 5, 7	100n	T1 9-0-9V, 2A mains transformer
C3	2200u 25v radial electrolytic	LS1 Eagle type TP26G or any speaker of 30 — 80 ohms
C6	2u0 16V radial electrolytic	RLA1, 2 miniature PC mounting relay, 12V 400R coil
C8, 10	100u 16V radial electrolytic	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.
C9		

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 ZN1034E 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 resis-

tance 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.

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.

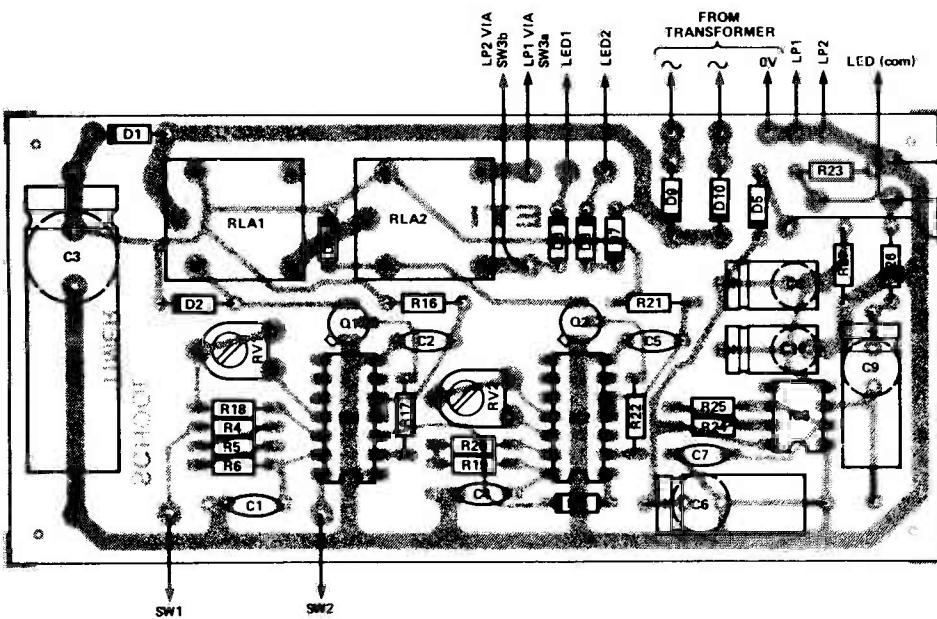


Fig. 3 Overlay diagram of the PCB.

SERVICE SHEET

Enquiries

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

- We undertake to do our best to answer enquiries relating to difficulties with ETI projects, in particular non-working projects, difficulties in obtaining components, and errors that you think we may have made. We do not have the resources to adapt or design projects for readers (other than for publication), nor can we predict the outcome if our projects are used beyond their specifications;
- Where a project has apparently been constructed correctly but does not work, we will need a description of its behaviour and some sensible test readings and drawings of oscilloscopes if appropriate. With a bit of luck, by taking these measurements you'll discover what's wrong yourself. Please do not send us any hardware (except as a gift);
- Other than through our letters page, Read/Write, we will not reply to enquiries relating to other types of article in ETI. We may make some exceptions where the enquiry is very straightforward or where it is important to electronics as a whole;
- We will not reply to queries that are not accompanied by an SAE (or international reply coupon). We are not able to answer enquiries over the telephone. We try to answer promptly, but we receive so many enquiries that this cannot be guaranteed.

• Be brief and to the point in your enquiries. Much as we enjoy reading your opinions on world affairs, the state of the electronics industry, and so on, it doesn't help our already overloaded enquiries service to have to plough through several pages to find exactly what information you want.

Subscriptions

The prices of ETI subscriptions are as follows:
UK: £14.35
Overseas: £18.15 Surface Mail
£37.15 Air Mail

Send your order and money to: ETI Subscriptions Department, P.O. Box 35, Wolsey House, Wolsey Road, Hemel Hempstead, Herts, HP2 4SS (cheques should be made payable to ASP Ltd). Note that we run special offers on subscriptions from time to time (though usually only for UK subscriptions, sorry).

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

Backnumbers

Below we list the backnumbers that are available from our backnumbers department. Please note that this list will be out of date if you use an old copy of the magazine. Backnumbers cost £1.50 (UK or overseas by surface mail) and are available from: ETI Backnumbers Department, P.O. Box 35, Wolsey House, Wolsey Road, Hemel Hempstead, Herts, HP2 4SS (cheques should be made payable to ASP Ltd).

Even if the copy of ETI you need is not listed, all may not be lost, because we run a photocopying service. For £1.50 (UK and overseas) we will photocopy an entire article (note that parts of a series of articles count as separate articles). Your request should clearly state what article you require and the month and year in which it appeared (the index for 1980 and 1981 was published in January 1982, the index for

1982 appeared in December 1982, and the index for 1983 in January 1984). Send your request to ETI Photocopies, Argus Specialist Publications Ltd, 1 Golden Square, London W1R 3AB (cheques should be made out to ASP Ltd).

June 77	April 81
February 78	May 81
July 78	June 81
September 78	September 81
October 78	October 81
November 78	November 81
December 78	December 81
March 79	January 82
April 79	February 82
May 79	March 82
June 79	May 82
August 79	June 82
September 79	July 82
November 79	August 82
April 80	September 82
May 80	October 82
July 80	November 82
August 80	December 82
September 80	March 83
October 80	April 83
November 80	May 83
December 80	June 83
January 81	July 83
February 81	August 83
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 telephone number).

We don't bother with the bureaucracy for Tech Tips — all you do is to send in your idea, stating clearly if you want an acknowledgement 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.

Trouble With Advertisers

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

1. Write to the supplier, stating your complaint and asking for a reply. Quote any reference number you may have (in the case of unsatisfactory or incomplete fulfilment of an order) and give full details of the order you sent and when you sent it.
 2. Keep a copy of all correspondence.
 3. Check your bank statement to see if the cheque you sent has been cashed.
 4. If you don't receive a satisfactory reply from the supplier within, say, two weeks, write again, sending your letter recorded delivery, or telephone, and ask what they are doing about your complaint.
- If you exhaust the above procedure and still do not obtain a satisfactory response from the supplier, then please drop us a line. We are not able to help directly, because basically the dispute is between you and the supplier, but a

letter from us can sometimes help to get the matter sorted out. But please, don't write to us until you have taken all reasonable steps yourself to sort out the problem.

We are a member of the mail order protection scheme, and this means that, subject to certain conditions, if a supplier goes bankrupt or into liquidation between cashing your cheque and supplying the goods for which you have paid, then it may be possible for you to obtain compensation. From time to time, we publish details of the scheme near our classified ads, and you should look there for further details.

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)

Gremlings 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.

Rapid Electronics

MIN D CONNECTORS

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



CONNECTORS

DIN Plug Skt	Jack	Plug Skt
2 pin	9p	2.5mm 10p 10p
3 pin	12p	10p 3.5mm 9p 9p
5 pin	13p	11p Standard 16p 20p
Phone 10p	12p	Stereo 24p 25p
1mm 12p	13p 4mm	18p 17p
UHF (CB) Connectors:		
PL259 Plug 40p.	Reducer 14p	
SO239 square chassis skt 38p.		
SO239S round chassis skt 40p.		
IEC 3 plug 250V/6A.		
Plug chassis m-unting	38p	
Socket free hanging		
Socket with 2m lead	120p	

SCRs	►C106D	30
	400V 8A	70
	400V 12A	95

SWITCHES

Submini 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. DPDT 48p.			
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.			

SOCKETS

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

COMPONENT KITS		
An ideal opportunity for the beginner or the experienced constructor to obtain a wide range of components at greatly reduced prices. 24W 5% Resistor kit. Contains 10 of each value from 4.7 ohms to 1M (total of 850 resistors).		
Ceramic Cap. kit. 5 of each value - 22p to 0.01uF (115 caps)		
Polyester Cap. kit. 5 of each value from 0.01 to 1uF (65 caps)		
Preset kit. Contains 5 of each value from 100 ohms to 1M (total of 65 presets)		
Nut and Bolt kit (total 300 items) 180p		
25.6BA 1/4" bolts		
50.6BA washers		
25.6BA 1/4" bolts		
50.6BA washers		

LINER

LM339	40	LM3911	120	NE566	140	TL064	96
LM348	60	LM3914	225	►NE567	100	TL071	30
LM358	50	LM3915	225	►NE570	370	TL072	45
LM377	170	LM13600	105	NE571	370	TL074	95
ICL7016	680	ICL7011	95	►PLM380	75	MC1496	68
ICL7111	95	ICL7621	180	►PLM381	120	MC3340	135
ICL741	25	ICL7622	180	ICL7622	180	►PLM10CN	350
ICL748	35	ICL8038	295	ICL8038	130	ML922	400
ICL9040J	350	ICL8211A	200	ICL8211A	200	ML924	90
ICL9040J	720	ICL9040J	785	ICL9040J	785	ML925	210
ICL9040J	1370	ICL9040J	220	ICL9040J	220	PL259	40
ICL9040J	270	ICL9040J	375	ICL9040J	375	PL259	45
ICL9040J	540	ICL9040J	540	ICL9040J	540	PL259	50
ICL9040J	1040	ICL9040J	1040	ICL9040J	1040	PL259	55
ICL9040J	1540	ICL9040J	1540	ICL9040J	1540	PL259	60
ICL9040J	2040	ICL9040J	2040	ICL9040J	2040	PL259	65
ICL9040J	2540	ICL9040J	2540	ICL9040J	2540	PL259	70
ICL9040J	3040	ICL9040J	3040	ICL9040J	3040	PL259	75
ICL9040J	3540	ICL9040J	3540	ICL9040J	3540	PL259	80
ICL9040J	4040	ICL9040J	4040	ICL9040J	4040	PL259	85
ICL9040J	4540	ICL9040J	4540	ICL9040J	4540	PL259	90
ICL9040J	5040	ICL9040J	5040	ICL9040J	5040	PL259	95
ICL9040J	5540	ICL9040J	5540	ICL9040J	5540	PL259	100
ICL9040J	6040	ICL9040J	6040	ICL9040J	6040	PL259	105
ICL9040J	6540	ICL9040J	6540	ICL9040J	6540	PL259	110
ICL9040J	7040	ICL9040J	7040	ICL9040J	7040	PL259	115
ICL9040J	7540	ICL9040J	7540	ICL9040J	7540	PL259	120
ICL9040J	8040	ICL9040J	8040	ICL9040J	8040	PL259	125
ICL9040J	8540	ICL9040J	8540	ICL9040J	8540	PL259	130
ICL9040J	9040	ICL9040J	9040	ICL9040J	9040	PL259	135
ICL9040J	9540	ICL9040J	9540	ICL9040J	9540	PL259	140
ICL9040J	10040	ICL9040J	10040	ICL9040J	10040	PL259	145
ICL9040J	10540	ICL9040J	10540	ICL9040J	10540	PL259	150
ICL9040J	11040	ICL9040J	11040	ICL9040J	11040	PL259	155
ICL9040J	11540	ICL9040J	11540	ICL9040J	11540	PL259	160
ICL9040J	12040	ICL9040J	12040	ICL9040J	12040	PL259	165
ICL9040J	12540	ICL9040J	12540	ICL9040J	12540	PL259	170
ICL9040J	13040	ICL9040J	13040	ICL9040J	13040	PL259	175
ICL9040J	13540	ICL9040J	13540	ICL9040J	13540	PL259	180
ICL9040J	14040	ICL9040J	14040	ICL9040J	14040	PL259	185
ICL9040J	14540	ICL9040J	14540	ICL9040J	14540	PL259	190
ICL9040J	15040	ICL9040J	15040	ICL9040J	15040	PL259	195
ICL9040J	15540	ICL9040J	15540	ICL9040J	15540	PL259	200
ICL9040J	16040	ICL9040J	16040	ICL9040J	16040	PL259	205
ICL9040J	16540	ICL9040J	16540	ICL9040J	16540	PL259	210
ICL9040J	17040	ICL9040J	17040	ICL9040J	17040	PL259	215
ICL9040J	17540	ICL9040J	17540	ICL9040J	17540	PL259	220
ICL9040J	18040	ICL9040J	18040	ICL9040J	18040	PL259	225
ICL9040J	18540	ICL9040J	18540	ICL9040J	18540	PL259	230
ICL9040J	19040	ICL9040J	19040	ICL9040J	19040	PL259	235
ICL9040J	19540	ICL9040J	19540	ICL9040J	19540	PL259	240
ICL9040J	20040	ICL9040J	20040	ICL9040J	20040	PL259	245
ICL9040J	20540	ICL9040J	20540	ICL9040J	20540	PL259	250
ICL9040J	21040	ICL9040J	21040	ICL9040J	21040	PL259	255
ICL9040J	21540	ICL9040J	21540	ICL9040J	21540	PL259	260
ICL9040J	22040	ICL9040J	22040	ICL9040J	22040	PL259	265
ICL9040J	22540	ICL9040J	22540	ICL9040J	22540	PL259	270
ICL9040J	23040	ICL9040J	23040	ICL9040J	23040	PL259	275
ICL9040J	23540	ICL9040J	23540	ICL9040J	23540	PL259	280
ICL9040J	24040	ICL9040J	24040	ICL9040J	24040	PL259	285
ICL9040J	24540	ICL9040J	24540	ICL9040J	24540	PL259	290
ICL9040J	25040	ICL9040J	25040	ICL9040J	25040	PL259	295
ICL9040J	25540	ICL9040J	25540	ICL9040J	25540	PL259	300
ICL9040J	26040	ICL9040J	26040	ICL9040J	26040	PL259	305
ICL9040J	26540	ICL9040J	26540	ICL9040J	26540	PL259	310
ICL9040J	27040	ICL9040J	27040	ICL9040J	27040	PL259	315
ICL9040J	27540	ICL9040J	27540	ICL9040J	27540	PL259	320
ICL9040J	28040	ICL9040J	28040	ICL9040J	28040	PL259	325
ICL9040J	28540	ICL9040J	28540	ICL9040J	28540	PL259	330
ICL9040J	29040	ICL9040J	29040	ICL9040J	29040	PL259	335
ICL9040J	29540	ICL9040J	29540	ICL9040J	29540	PL259	340
ICL9040J	30040	ICL9040J	30040	ICL9040J	30040	PL259	345
ICL9040J	30540	ICL9040J	30540	ICL9040J	30540	PL259	350
ICL9040J	31040	ICL9040J	31040	ICL9040J	31040	PL259	355
ICL9040J	31540	ICL9040J	31540	ICL9040J	31540	PL259	360
ICL9040J	32040	ICL9040J	32040	ICL9040J	32040	PL259	365
ICL9040J	32540	ICL9040J	32540	ICL9040J	32540	PL259	370
ICL9040J	33040	ICL9040J	33040	ICL9040J	33040	PL259	375
ICL9040J	33540	ICL9040J	33540	ICL9040J	33540	PL259	380
ICL9040J	34040	ICL9040J	34040	ICL9040J	34040	PL259	385
ICL9040J	34540	ICL9040J	34540	ICL9040J	34540	PL259	390
ICL9040J	35040	ICL9040J	35040	ICL9040J	35040	PL259	395
ICL9040J	35540	ICL9040J	35540	ICL9040J	35540	PL259	400
ICL9040J	36040	ICL9040J	36040	ICL9040J	36040	PL259	405
ICL9040J	36540	ICL9040J	36540	ICL9040J	36540	PL259	410
ICL9040J	37040	ICL9040J	37040	ICL9040J	37040	PL	

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 Praires 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 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 'electronics' — 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 thought 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 eversaw 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

IT LIVES AGAIN!

From the past it came, growing daily, striking terror into the hearts of lesser publications, and spreading its influence across the country in its quest to infiltrate every town, every home, every mind.

Not a horror story, but a success story. And if electronics theory strikes terror into you, then you need the help of **Electronics — It's Easy**. Originally a long-running series in Electronics Today International, **Electronics — It's Easy** was printed as a set of three books. They sold out. It was reprinted as a single volume. It sold out. Now this phenomenally successful publication is available again, in its third reprint. **Electronics — It's Easy** is a comprehensive and simply written guide which explains the theory (and the practice) of electronics step by step. Every aspect of the subject is covered, starting with the basic principles and working through to the how and why of today's technology.

You can obtain your copy of **Electronics — It's Easy** by mail order using the coupon below. Make cheques or postal orders payable to ASP Ltd, alternatively you may pay by Access or Barclaycard.

Send to: Sales Office (Specials).

513 London Road, Thornton Heath
Surrey CR4 6AR

Please send me copies of **Electronics — It's Easy**. I have enclosed £..... (£4.95 each including p&p).

NAME

ADDRESS

Please debit my account

My Access / Barclaycard No. is

Signature



ETI PCB SERVICE

The best way to get a really professional finish to your project is to use a professionally made PCB — look no further, here they are!

In order to ensure that you get the correct board, you must quote the reference number when ordering — if you don't, you may get sent the wrong board. The code can also be used to identify the year and month that a particular project was outlined in: the first two numbers are the year, the third is the month and the number after the hyphen indicates the particular project.

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

Our terms are strictly cash with order — we do not accept official orders. However, we can provide a pro-forma invoice for you to raise a cheque against, but we must stress that the goods will not be dispatched until we receive payment.

1979	<input type="checkbox"/> E/794-1 Guitar Effects Unit 3.04	<input type="checkbox"/> E/825-1 DV Meg..... 3.13	<input type="checkbox"/> E/836-1 to 3 PseudoROM (3 boards) 3.62
	<input type="checkbox"/> E/794-2 Click Eliminator 7.64	<input type="checkbox"/> E/826-1 Ion Generator (3 boards) 9.20	<input type="checkbox"/> E/836/4 Immersible Heater 2.30
	<input type="checkbox"/> E/796-1 Accented Beat Metronome 4.14	<input type="checkbox"/> E/826-4 MOSFET Amp Module.... 7.80	<input type="checkbox"/> E/836-5 Atom Keypad..... 5.18
1980	<input type="checkbox"/> E/808-3 Ultrasound Burglar Alarm 3.30	<input type="checkbox"/> E/826-5 Logic Lock 3.52	<input type="checkbox"/> E/837-1 Flash Sequencer 2.67
	<input type="checkbox"/> E/8010-1 Cassette Interface 3.37	<input type="checkbox"/> E/826-6 Digital PWM 3.84	<input type="checkbox"/> E/837-2 Trigger Unit Main Board... 2.67
	<input type="checkbox"/> E/8010-2 Fuzz/Sustain Box 3.76	<input type="checkbox"/> E/826-7 Optical Sensor 2.00	<input type="checkbox"/> E/837-3 Trigger Unit Transmitter... 1.66
	<input type="checkbox"/> E/8011-5 RIAA Preamp..... 2.22	<input type="checkbox"/> E/826-9 Oscilloscope (4 boards) 13.34	<input type="checkbox"/> E/837-4 Switched Mode PSU 16.10
	<input type="checkbox"/> E/8012-3 Four Input Mixer..... 3.04	<input type="checkbox"/> E/827-1 TV Bargraph Main..... 5.24	<input type="checkbox"/> E/838-1 Graphic Equaliser..... 9.10
1981	<input type="checkbox"/> E/811-1 LED Tacho 4.75	<input type="checkbox"/> E/827-2 TV Bargraph Channel..... 2.62	<input type="checkbox"/> E/838-2 Servo Fail-Safe (four-off) 2.93
	<input type="checkbox"/> E/811-2 Multi-Option Siren..... 3.68	<input type="checkbox"/> E/827-4 Hotwire 3.02	<input type="checkbox"/> E/838-3 Universal EPROM prog.... 9.64
	<input type="checkbox"/> E/812-2 IR Alarm (4 boards) 7.64	<input type="checkbox"/> E/827-5 Bridging Adapter 2.74	<input type="checkbox"/> E/839-1 NiCad Charger/Regen.... 3.77
	<input type="checkbox"/> E/812-5 Pulse Generator 4.11	<input type="checkbox"/> E/828-1 Playmate (3 boards)..... 8.28	<input type="checkbox"/> E/839-2 Digger 3.40
	<input type="checkbox"/> E/814-2 Drum Machine (2 boards) 6.44	<input type="checkbox"/> E/828-4 Kitchen Scales..... 2.12	<input type="checkbox"/> E/839-3 64K DRAM 14.08
	<input type="checkbox"/> E/814-4 Guitar Note Expander 3.68	<input type="checkbox"/> E/828-5 Sound Track..... 4.89	<input type="checkbox"/> E/8310-1 Supply Protector 2.19
	<input type="checkbox"/> E/816-8 Waa-Phase..... 1.76	<input type="checkbox"/> E/829-1 Auto Volume Control..... 2.12	<input type="checkbox"/> E/8310-2 Car Alarm 3.98
	<input type="checkbox"/> E/816-9 Alien Attack 4.00	<input type="checkbox"/> E/829-2 Dual Logic Probe 2.22	<input type="checkbox"/> E/8310-3 Typewriter Interface 4.17
	<input type="checkbox"/> E/817-1 System A-Input (MM or MC)..... 3.05	<input type="checkbox"/> E/8211-4 Pulse Generator 6.08	<input type="checkbox"/> E/8311-1 Mini Drum Synth 3.07
	<input type="checkbox"/> E/817-2 System A — Preamp..... 5.95	<input type="checkbox"/> E/8212-1 ELCB 2.77	<input type="checkbox"/> E/8311-2 Alarm Extender 3.21
	<input type="checkbox"/> E/817-3 Smart Battery Charger..... 2.27	<input type="checkbox"/> E/8212-2 Servo Interface (2 boards) 6.75	<input type="checkbox"/> E/8311-3 Multiswitch 3.59
	<input type="checkbox"/> E/818-3 Hand Clap Synth..... 4.57	<input type="checkbox"/> E/8212-4 Spectracolumn 5.54	<input type="checkbox"/> E/8311-4 Multiple Port 4.34
	<input type="checkbox"/> E/818-5 Watchdog Home Security (2 boards) 6.11	1983	<input type="checkbox"/> E/8311-5 DAC/ADC Filter 3.22
	<input type="checkbox"/> E/819-1 Mains Audio Link (3 boards) 8.45	<input type="checkbox"/> E/831-1 Fuel Gauge..... 3.45	<input type="checkbox"/> E/8311-6 Light Pen 4.60
	<input type="checkbox"/> E/819-4 Laboratory PSU..... 5.21	<input type="checkbox"/> E/831-2 ZX ADC 2.59	<input type="checkbox"/> E/8311-7 Logic Clip 2.51
	<input type="checkbox"/> E/8110-1 Enlarger Timer..... 3.91	<input type="checkbox"/> E/831-3 Programmable PSU..... 3.45	<input type="checkbox"/> E/8311-8 MC Head (JLLH)..... 3.17
	<input type="checkbox"/> E/8110-2 Sound Bender..... 3.05	<input type="checkbox"/> E/833-1 SoundBoard..... 12.83	<input type="checkbox"/> E/8312-1 Lightsaver 1.85
	<input type="checkbox"/> E/8111-1 Voice Over Unit..... 4.57	<input type="checkbox"/> E/833-2 Alarm Module 3.62	<input type="checkbox"/> E/8312-2 A-to-D Board 12.83
	<input type="checkbox"/> E/8111-2 Car Alarm..... 3.23	<input type="checkbox"/> E/833-3 ZX81 User Graphics 1.07	<input type="checkbox"/> E/8312-3 Light Chaser (2 bds) 7.54
	<input type="checkbox"/> E/8111-3 Phone Bell Shifter..... 3.40	<input type="checkbox"/> E/833-4 Logic Probe 2.50	<input type="checkbox"/> E/8312-4 ZX Alarm 6.04
	<input type="checkbox"/> E/8112-4 Component Tester..... 1.71	<input type="checkbox"/> E/834-1 Real Time Clock 8.74	1984
1982	<input type="checkbox"/> E/821-3 Guitar Tuner (2 boards) ... 6.38	<input type="checkbox"/> E/834-2 Thermometer (2 boards) 9.74	<input type="checkbox"/> E/841-1 Vector Graphics 8.27
	<input type="checkbox"/> E/822-1 Ripple Monitor 2.21	<input type="checkbox"/> E/834-4 Stage Lighting — Main ... 13.73	<input type="checkbox"/> E/841-2 Speech Board (Mini-Mynah) 10.97
	<input type="checkbox"/> E/822-2 Allez Cat Pest Repeller 1.93	<input type="checkbox"/> E/834-5 Stage Lighting — Display 3.45	MODULAR PREAMP:
	<input type="checkbox"/> E/822-5 Moving Magnet Stage..... 4.01	<input type="checkbox"/> E/835-1 Compressor/Limiter 6.19	<input type="checkbox"/> E/842-2 Disc input (mono) 3.73
	<input type="checkbox"/> E/822-6 Moving Coil Stage 4.01	<input type="checkbox"/> E/835-2 Single PSU 3.16	<input type="checkbox"/> E/842-3 Output stage (stereo) 3.73
	<input type="checkbox"/> E/823-4 Capacitance Meter (2 boards) 11.66	<input type="checkbox"/> E/835-3 Dual PSU 4.01	<input type="checkbox"/> E/842-4 Relay/PSU 3.73
	<input type="checkbox"/> E/824-5 Voltage Monitor 2.14	<input type="checkbox"/> E/835-4.2 NDFL Amp 7.88	<input type="checkbox"/> E/842-5 Tone, main (mono)..... 3.73
		<input type="checkbox"/> E/835-5 Balance Input Preamp.... 3.23	<input type="checkbox"/> E/842-6 Tone, filter (stereo) 3.73
		<input type="checkbox"/> E/835-6 Stage Lighting Autofade..... 6.19	<input type="checkbox"/> E/842-7 Balanced output (st) 3.73
		<input type="checkbox"/> E/835-7 Stage Lighting — Triac Board..... 4.74	<input type="checkbox"/> E/842-8 Headphone amp (st) 3.73
			<input type="checkbox"/> E/842-9 Mother board 9.01
			<input type="checkbox"/> E/843-1 Power Meter 5.81
			<input type="checkbox"/> E/843-2 Z80 DRAM 9.79
			<input type="checkbox"/> E/843-3 Obedient Die..... 3.76
			<input type="checkbox"/> E/844-1 School Timer 4.07

How to order: indicate the boards required by ticking the boxes and send this page, together with your payment, to: ETI PCB Service, Argus Specialist Publications Ltd, 1 Golden Square, London W1R 3AB. Make cheques payable to ETI PCB Service. Payment in sterling only please. Prices subject to change without notice.

Total for boards £.....
Add 45p p&p 0.45
Total enclosed £.....

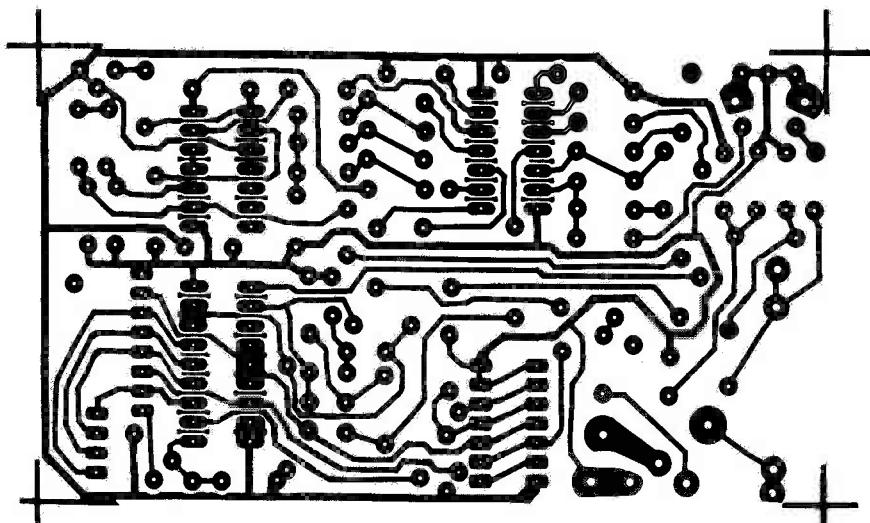
**PLEASE ALLOW
28 DAYS FOR
DELIVERY**

Signed

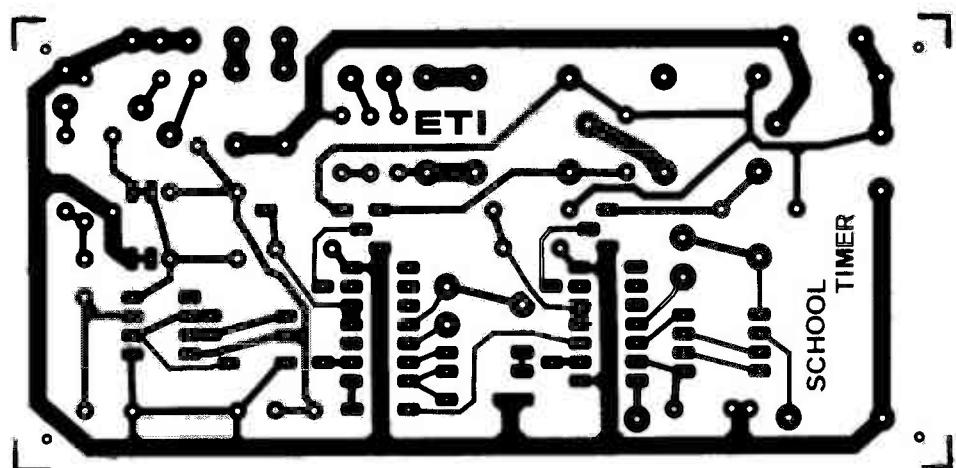
Name

Address

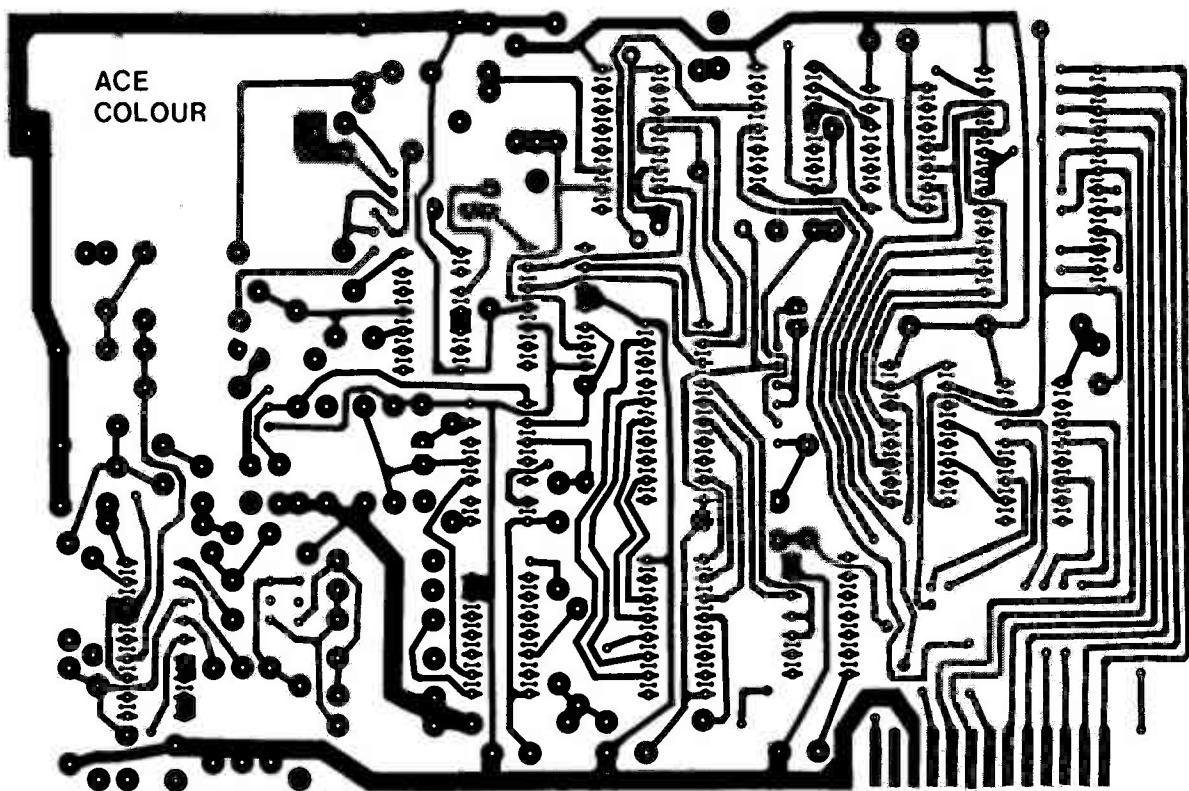
PCB FOIL PATTERNS



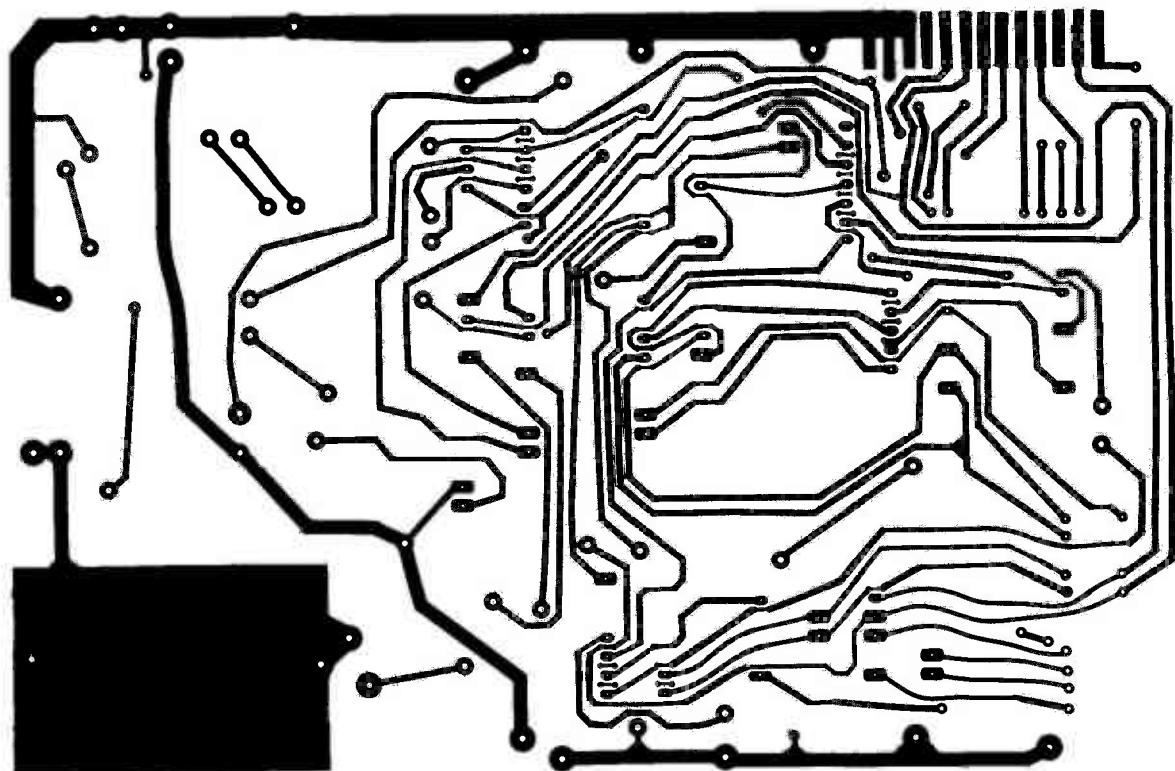
The Remote Controller PCB.



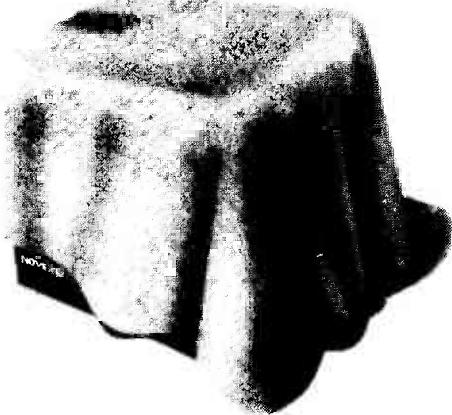
The School Timer.



The Ace Colour Board.



**Discover a full colour monitor
for less than £200
which is compatible with the
majority of small Micros**



£199.95 + VAT & CARRIAGE

- SUPERB GRAPHIC RESOLUTION
- UNIQUE GREEN TEXT OR FULL COLOUR OPTION
- COMPOSITE/RGB INPUTS
- SPECIFICALLY DESIGNED TO DISPLAY THE OUTPUT FROM MICRO COMPUTERS
- SOUND WITH BUILT IN SPEAKER AND VOLUME CONTROL
- ATTRACTIVELY DESIGNED METAL CASE IN BEIGE AND DARK BROWN
- FULL 12 MONTH GUARANTEE

The full range of NOVEX MONITORS are available through dealers nationwide.
Dealer enquiries welcome.

NOVEX®

© 1984 NOVEX LTD. TRADE MARK BY
DISPLAY DISTRIBUTION LIMITED. 36 Grosvenor Road,
Twickenham, Middlesex. Tel: 01 891 1923/1513 Telex 295083

Name _____
Address _____
City _____ Postcode _____

For further details and stockists of the NOVEX MONITOR
range please ring and return to:

FOR HI-FI & ELECTRONICS ENTHUSIASTS
CONCEPT ELECTRONICS LTD
51 Tollington Road, London N7 6PB

Mail order only

We are the specialist of electronic kits and rack mounting cabinets. A catalogue with complete range of products including pre-amp modules, power amp modules, pre and power amplifier modules, complete kits of amplifiers, equalizers, reverberation amplifiers (with cases), alarm clocks, appliance timers, CB amplifiers, test equipment, control modules, music generator, battery fluorescent light and high quality rack mounting cabinets etc. with illustrative pictures now available at the cost of 35p + 25p p&p.

Professional rack mounting cabinet

Panel Size	Rear Box	Price
W H (inch)	W H D	AL STEEL
19 x 5	17 x 4.5 x 10	27.54 23.54
19 x 4	17 x 3.5 x 10	25.24 21.24
19 x 3.5	17 x 3 x 10	24.09 20.09
19 x 3	17 x 2.5 x 10	24.09 —
19 x 2.5	17 x 2 x 10	22.94 18.94
19 x 6	17 x 5.5 x 12	28.89 24.89
19 x 5	17 x 4.5 x 12	27.54 23.54
19 x 4	17 x 3.5 x 12	25.24 21.24
19 x 3.5	17 x 3 x 12	24.09 20.09
17 x 3.5	15.5 x 3 x 9	21.79 17.79
17 x 2.5	15.5 x 2 x 9	20.84 16.84
17 x 4	15.5 x 3.5 x 12	25.24 21.24
17 x 3	15.5 x 2.5 x 12	24.09 20.09

Please add £2.50 p/p per item

★ Wholly made of black anodised aluminium sheets ★ Suitable for high quality amplifiers and many other purposes ★ Top, side and rear cover removable for access ★ Separate front mounting plate ★ Heavy gauge front panel is of brushed aluminium finish enhanced with two professional handles ★ With ventilation slits and plastic feet.

The low cost steel version is also available. The size and features as well as the front panel is the same as the aluminium cabinets except the rear box is manufactured from steel painted in black.

CONTROL MODULES



- TY-7 Electronic touch switch
£2.90 Kit £4.50 Ass.
TY-11 Light activated switch
£2.20 Kit £3.50 Ass.
TY-18 Sound activated switch
(Clap switch) £4.50 Kit £5.95 Ass.
TY-36 Sound activated switch
(voice-switch) £5.50 Kit £7.50 Ass.
TY-41 Infra-red remote control
(Receiver and transmitter)
£17.20 Kit £21.95 Ass.

HI-FI AMPLIFIER MODULES



- TA-323A 30W + 30W stereo amplifier
£18.95 Kit £23.95 Ass.
TA-820 80W + 80W stereo amplifier
£27.50 Kit £33.50 Ass.
TA-920 70W + 70W stereo amplifier
£35.50 Kit £42.50 Ass.

MASTER ELECTRONICS NOW!

The PRACTICAL way!

YOUR CAREER..YOUR FUTURE..YOUR OWN BUSINESS..YOUR HOBBY
THIS IS THE AGE OF ELECTRONICS!
the world's fastest growth industry...

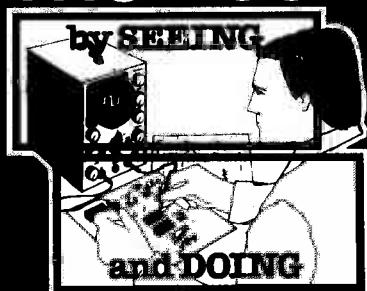
Our new style course will enable anyone to have a real understanding of electronics by a modern, practical and visual method. No previous knowledge is required, no maths, and an absolute minimum of theory.

You learn by the practical way in easy steps, mastering all the essentials of your hobby or to start, or further, a career in electronics or as a self-employed servicing engineer. All the training can be carried out in the comfort of your own home and at your own pace.

A tutor is available to whom you can write personally at any time, for advice or help during your work. A Certificate is given at the end of every course.

You will do the following:

- Build a modern oscilloscope
- Recognise and handle current electronic components
- Read, draw and understand circuit diagrams
- Carry out 40 experiments on basic electronic circuits used in modern equipment using the oscilloscope
- Build and use digital electronic circuits and current solid state 'chips'
- Learn how to test and service every type of electronic device used in industry and commerce today. Servicing of radio, T.V., Hi Fi, VCR and microprocessor computer equipment



British National Radio & Electronics School Reading, Berks. RG1 1BR

FREE!

COLOUR
BROCHURE

Post now to:

British National Radio & Electronics School Reading, Berks. RG1 1BR

Please send your brochure without any obligation to

NAME _____

ADDRESS _____

ETI/4/842

BLOCK CAPS PLEASE

I am interested in:

- COURSE IN ELECTRONICS as described above
 RADIO AMATEUR LICENCE
 MICROPROCESSORS
OTHER SUBJECTS
please state below



OR TELEPHONE US
0734 51515 OR
TELEX 22758
(24 HR SERVICE)

Lineage:

35p per word (minimum 15 words)

Semi Display: (minimum 2 cms)

£10.00 per single column centimetre

Ring for information on series bookings/discounts

All advertisements in this section must be prepaid.

Advertisements are accepted subject to the terms and conditions printed on the advertisement rate card (available on request)



01-437 0699

Send your requirements to:
Debbie Miller
ASP Ltd.,
1 Golden Square,
London W1.

APPOINTMENTS

TRAINEE ASSISTANT FILM RECORDISTS

Would you like to specialise in sound with the BBC TV's Film Department in West London?

Trainee Assistant Film Recordists work in Sound Transfer and Dubbing areas. Prospects exist for moving on to location recording work after several years.

Applicants, who should be at least 18 years of age, must possess a minimum of 'O' level standard of education or equivalent, including Physics and Mathematics, together with a knowledge of electronics. They must be able to demonstrate a practical interest in sound.

Normal hearing and colour vision are essential and applicants must hold a current driving licence or be prepared to obtain one within a reasonable period.

Successful applicants will start their three year training period in September 1984 at a salary of £5,809 (currently under review). An additional allowance is paid for shift work. Relocation expenses considered.

Contact us immediately for application form (quote ref. 1143/ETI and enclose s.a.e.): BBC Appointments, London W1A 1AA. Tel. 01-927 5799.

Preliminary interviews are expected to be held in June.

We are an Equal Opportunities employer

**VIDEO ENGINEER**

for repair company wanted. Experienced on J.V.C, Sony, Akai and all other Video machines essential. Three years experience necessary. Salary negotiable, in W1 Area. Phone 01-636 2520

**TO FIND
THE
RIGHT
PERSON
USE
ETI**

WIRES 'N CABLES

**THE SCIENTIFIC
WIRE COMPANY**

811 Forest Road, London E17

01-531 1588

ENAMELLED COPPER WIRE

SWG	1lb	8oz	4oz	2oz
8-34	3.63	2.09	1.10	88p
35-39	3.82	2.30	1.26	93p
42-43	5.20	2.91	2.25	1.60
44-47	8.56	5.80	3.49	2.75
48	15.96	9.93	6.48	3.69

SILVER-PLATED COPPER WIRE

14-30	9.09	5.20	2.93	1.97
-------	------	------	------	------

TINNED COPPER WIRE

14-30	3.97	2.41	1.39	0.94
-------	------	------	------	------

Prices include P&P and VAT. Orders under £2 add 20p. Dealer inquiries welcome.

PLANS 'N DESIGN

AMAZING ELECTRONIC plans, lasers, gas, ruby, light shows, high voltage teslas, van de graph surveillance devices, ultrasonics, pyrotechnics, new solar generator, 150 more projects, catalogue. S.A.E. Plancentre, Bromyard Road Industrial Estate, Ledbury HR8.

WANTED

TURN YOUR SURPLUS transistors, IC's etc into cash. Contact Coles Harding & Co., 103 South Brink, Wisbech, Cambs. Tel: 0945 584188. Immediate settlement.

SOFTWARE
APPLICATIONS**CORTEX-FORTH**

Full fig-forth with extensions for power tran cortex computer. Supports disc & cassette, 40 page manual, 16K supplied in two 2564 Eproms. Replaces 1st two Basic Eproms.

£35 Inclusive

LOMBARD SYSTEMS
18 Lombard Street, Liddington Bedford MK43 0RP

REPAIRS

MICRO-COMPUTER repairs. ZX Spectrum, VIC 20, C64 Pets, Commodore computers, printers and floppy disk. Phone Slough (0753) 48785. Monday to Saturday.

FOR SALE

100W AMPLIFIER
— £9.95 built

Or use the same board for 50W, 150W, 200W into 4 or 8 ohms etc., by using alternative output transistors and P.S.U. SAE for full details to:

ESS AMPLIFICATION
Innovation House
Guildhall Road, Hull

ELECTRONIC ORGAN KEY-BOARDS and other parts being cleared out as special offer. Elvins Electronic Musical Instruments, 40A Dalston Lane, London E8. 01-986 8455.

POWERTRAN Digital Delay Line. Upto 1.6mS delay. Kit cost over £170. Fully built and tested to a high standard. Give away at £100. Also Clef Electronic Band-Box and Master Rhythm unit. Kit cost over £300. Built and tested as above. £180 o.n.o. Phone Medway 64900 after 7.15 evenings only.

VERORACKS and cabinets. 19 inch 3u and 5u. Larger ones available. New and unused. Yateley (0252) 871048.

FREE parcel of L.E.D.'s, decoders, components worth £10! Send only 80p postage! D. Horsley, 113 Clare Rd, Braintree, Essex.

ALARMS

EQUIPMENT

ALARMS

FREE BOOKLET
on
BURGLAR ALARMS
with
LOWEST U.K. DIY PUBLISHED PRICES
PHONE OR WRITE FOR YOUR COPY
051-523 8440
AD ELECTRONICS
217 WARBRECK MOOR
AINTREE, LIVERPOOL L9 0HU

A1 INTRUDER ALARMS**Wholesale Alarm Suppliers**

Latest D.I.Y. & Wholesale Published Catalogue.
Write off for your copy

86 Derby Lane, Old Swan, Liverpool 13
Tel: 051 228 3483 or 051-220 0590



BURGLAR Alarm Equipment. Please visit our 2,000 sq. ft. showrooms or write or phone for your free catalogue. C.W.A.S. Ltd., 100 Rooley Avenue, Bradford BD6 1DB. Telephone 0274 308920.

ULTRASONIC BURGLAR ALARM housed in attractive teak finish loudspeaker cabinet. Keyswitch operated, gives full room coverage on mains battery with piercing auto-resetting alarm and timed exit and entry delays. Full kit only £29.95 or £38.50 ready built. Safewise Installations, 6 Southern Street, Manchester M3 4NN. 061-835 1015. Access and Barclaycard.

SECURITY Alarm Systems

FREE COMPREHENSIVE CATALOGUE!

- LOWEST DISCOUNT PRICES
- HIGHEST QUALITY EQUIPMENT
- FULLY ILLUSTRATED
- MICROCHIP CIRCUITRY
- QUICK DESPATCH SERVICE
- FULL INSTRUCTIONS

SEND SAE OR PHONE

C TEC SECURITY Dept E 1,
60 Market St, Wigan WN1 1HX
Telephone (0942) 424444

Trade Enquiries Welcome

TO FILL
THIS SPACE
PHONE
DEBBIE
01-437 0699

COMPUTER ADD-ONS**Microtan 65 Eprom Switching Board**

Perm any 4 from 16. Software controlled. Bareboard + instructions £19.95 post-free. Also available 64 x 25 colour VDU card, 3 pass assembler, word processor etc. Large SAE for details

M.P.D., 7 Cedar Close,
Graham, Huntingdon
PE18 0DZ.

LARGE STOCK OF BURGLAR ALARM EQUIPMENT. As used in the trade. JN Security Centre, 176 Sydenham Rd, London SE26 5J2. 01-778 1111. Showrooms open 6 days.

CONSTRUCTING AN AUDIO MIXER?

To achieve a high quality finish you need commercially produced printed panels — sub-frames — main frames etc designed and manufactured specifically for this purpose.

PARTRIDGE ELECTRONICS

THE MIXER PEOPLE

56 Fleet Road, Benfleet, Essex, SS7 5JN, England.
(Large S.A.E. please)

TANGERINE OWNERS. We have available an independent switch selectable RAM card to free the EPROM space on Tanex P.C.B. on built. S.A.E. for details. Ralph Allen Eng, Forncett-End, Norwich. Tel (095389) 420.

FREE PROTOTYPE of the finest quality with every P.C.B. artwork designed by us. Competitive hourly rates and high standard of work. Halstead Designs Limited. Tel: halstead (0787) 477408.

RACAL UNIVERSAL Counter Timer. Eight digit IIM112 perfect. Cost £860. Bargain £160. Cooke, Shillingford, Oxford. Phone Warborough 8491.

AERIAL AMPLIFIERS improve weak television reception. Price £6.70. S.A.E. for leaflets. Electronic Mailorder, Ramsbottom, Lancashire, BL0 9AGH.

PRINTED CIRCUIT BOARDS made to your drawings. Artwork carried out. One offs and small quantities acceptable. Ask for quote. Fennel Industrial Electronics (0203) 382296. 35 Fife Street, Nuneaton, Warwickshire.

EQUIPMENT
TO SELL?
PHONE
DEBBIE ON
01-437 0699

RCB's

Printed Circuit Boards to your specification from artwork through to finished board.

QUICK DELIVERY - COMPETITIVE PRICES

DRYFOTON BOARD ELECTRONICS LIMITED

35 Grosvenor Road, Twickenham, Middlesex
TEL: 01-891 1923/1513 Telex: 295093

BOOKS & PUBLICATIONS

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

COMPUTERS

MICROTAN 65. Fully expanded tanex. 12 Slot M/Board, PSU, mounted in vero case, full keyboard with case, complete manuals, all in mint condition, £200. Tel: Wimslow (Cheshire) 530054.

KITS

TELEPHONE MONITOR KIT, connects between telephone line and your cassette recorder and automatically records all phone usage. Complete kit including case and PCB only £9.95. Dept. ETX, Unitech (Midlands), FREEPOST, Erdington, Birmingham B24 8BR.

SERVICES**MENDASCOPE LTD**

Repair & recalibrate
Oscilloscopes

All makes, all models

Scopex, Saffan, older TEK & TQ
Otter House, Weston Underwood
Olney, Bucks MK46 5JS
Belford (0234) 712445
For the complete service

KITS

TIME WRONG?

MSF CLOCK is ALWAYS CORRECT — never gains or loses. SELF SETTING at switch-on. 8 digits show Date, Hours, Minutes and Seconds, auto GMT/BST and leap year also parallel BCD for computer, receives Rugby 60KHz atomic time signals, built-in antenna 1000km range, £72.70.

OSCILLATOR, 10Hz-200KHZ, £21.60.

Each fun-to-build kit includes all parts, printed circuit, case, by-return postage etc, list of other kits.

CAMBRIDGE KITS
45(TD) Old School Lane, Milton, Cambs

VHF TRANSMITTER MODULE

Kit, size 2 inches by 1/2 inch. Hyper-sensitive pickup. Hi-fi quality reception on domestic VHF/FM Radio. Sub-min components for exceptional transmission stability. 70-150MHz, range dependent on voltage (6-18V). Includes ultra-sensitive microphone, illustrated plans etc. NB new price reduced to £6.95, post paid, send cash/cheque/PO to Modulex, P.O. Box 102, Dartford, Kent DA1 2PW.

Build your own high performance AUDIO SIGNAL GENERATOR

£25.00 incl. case (p.p.£1)

Spec:

Very low distortion (only .02%)
Output 1v into 600 Ohms.
(Attenuated)

10Hz — 100Khz. Sine-Square
(A Linsley-Hood design)

TELERADIO ELECTRONICS

325 Fore Street, Edmonton

London N9 0PE

Ready made £30.00

BULK COMPONENTS

Resistors — Ideal for making into packs or just to increase stocks at a very low price. We're selling new full lead length resistors in original boxes/packets/reels. Because most are packed in thousands (some are 100's) you'll need to buy a large quantity to get a reasonable mix. You'll get carbon/film/oxide mixed tolerances 1% to 20% in 1/8W, 1/4W & 1/2W, 20,000 £26; 50,000 £60; 100,000 £110; 1 million £250; 1 million £950. All prices inclusive. SAE for samples.

We also stock capacitors, semiconductors, veroboard etc in bulk. SAE for latest list.

**PC ELECTRONICS 1, THORNHILL,
ROMSEY RD., WHITEPARISH,
SALISBURY, WILTS SP5 2SD**

BUMPER BOX OF BITS

WOW! We've got so many components in stock, we can't possibly list them all — So buy a box. In it you'll find resistors, capacitors, displays, switches, panels with transistors, diodes, IC's etc. coils, pots... and so on. All modern parts — guaranteed at least 1000 items, minimum weight 10lbs. ONLY £8.50 inc. 48 page catalogue 50p.

ELECTRONICS WORLD
1e Dews Road, Salisbury,
Wiltshire SP2 7SN

EQUIPMENT

WEST HYDE

THE UK'S LEADING STOCKIST
OF CASES, PANELWARE
AND ACCESSORIES

Large Stocks — Fast Deliveries

SEND £2 FOR COMPREHENSIVE,
ILLUSTRATED CATALOGUE —
Includes £2 Worth of Vouchers

UNIT 9, PARK ST. IND. ESTATE
AYLESBURY BUCKS HP20 1ET
Telephone: (0296) 20441

IRISH READERS

MAIL ORDER COMPONENTS

Top quality components

Great prices

Return-of-post service

Write or phone for free price list

WAVEFORM ELECTRONICS
12 Effra Road, Rathmines, Dublin 6.
Phone (01) 987507

Mail order only please

ELECTROMART

MERSEYSIDE

PROGRESSIVE RADIO
93 Dale Street. Tel 051 236 0982
47 Whitechapel, Tel 051 236 5489
Liverpool 2
THE ELECTRONICS SPECIALISTS'
Open: Tues-Sat 9.30-5.30

S. WALES

**STEVE'S ELECTRONIC
SUPPLY CO. LTD.**
45 Castle Arcade, Cardiff
TEL: 0222 41905
Open: Mon-Sat 9.5-30
For components to computers

LANCASHIRE

ETESON ELECTRONICS
E-E•Poulton-le-Fylde, Blackpool
Tel: (0253) 885107
Open: 9.30am-12.30 1.30-5.30. Closed Wed & Sun.
Electronic Component Specialists.

Please include my business details in the next available issue of ELECTRONICS TODAY
INTERNATIONAL:

BUSINESS NAME:

ADDRESS:

TEL. NO.:

OPENING HOURS:

RETAIL WHOLESALE

MAIL ORDER

(Please tick)

CONTACT: (FOR OFFICE USE ONLY)



HAM RADIO TODAY

NEEDS



We require an organised, literate and technically competent radio enthusiast for duties as **Editorial Assistant**. These duties will include all aspects of magazine production: subbing, writing and communicating with design and print departments. It would help if you have previous experience, but if you haven't, don't let that stop you applying!

Applicants should be cheerful in the face of adversity, enjoy writing and be able to handle a typewriter. A willingness to learn is essential. A current amateur radio licence is highly desirable. We are willing to consider applications for both full-time and part-time employment.

If you are interested, please apply with full CV to Ron Harris, Managing Editor, Argus Specialist Publications Ltd, 1 Golden Square, London W1R 3AB.

ADVERTISER'S INDEX

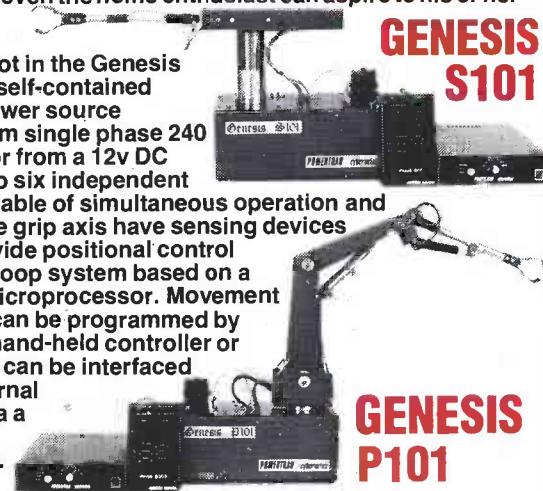
Audio Electronic	31
Bimsales	34
Bi-pak	40
B.K. Electronics	16
Black Star	34
B.N.R&E.S.	70
Cambridge Learning	26
Clef products	58
Concept Electronics	70
Connaught Electronics	52
Cricklewood Electronics	12
Crimson Elektrik	52
Crofton Electronics	70
Delta Tech	18
Display Electronics	14
Electrovalue	48
Greenbank Electronics	58
Greenweld Electronics	58
G.S.C.	7
Happy Memories	51
Hawk Electronics	40
ICS	40
ILP	38
Kelan Engineering	18
Kempston	50
L B Electronics	18
Maplin	OBC
Marco Trading	52
Midwich Computers	51
MJL Systems	51
Parndon Electronics	34
Powertran	IFC,10,IBC
Radio Society Great Britain	32
Rapid Electronics	64
Riscomp	31
R.T.V.C.	26
Stewarts of Reading	48
Technomatic	8,9
Texas Instruments	48
T K Electronics	32
Watford Electronics	4,5

Low-price robots from POWERTRAN

- hydraulically powered
- microprocessor controlled

The UK-designed and manufactured range of Genesis general purpose robots provides a first-rate introduction to robotics for both education and industry. With prices from as low as £470, even the home enthusiast can aspire to his or her own robot.

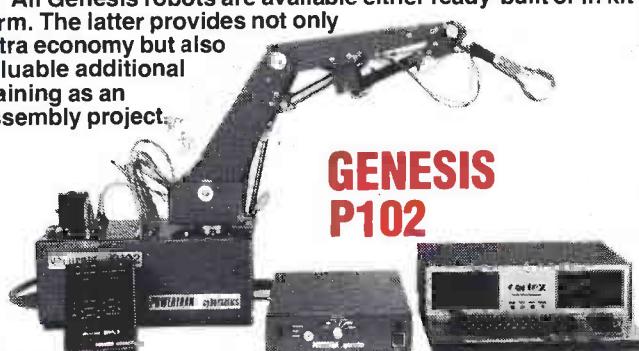
Each robot in the Genesis range has a self-contained hydraulic power source operated from single phase 240 or 120v AC or from a 12v DC supply. Up to six independent axes are capable of simultaneous operation and all except the grip axis have sensing devices fitted to provide positional control by a closed loop system based on a dedicated microprocessor. Movement sequences can be programmed by means of a hand-held controller or the systems can be interfaced with an external computer via a standard RS232C link.



**GENESIS
S101**

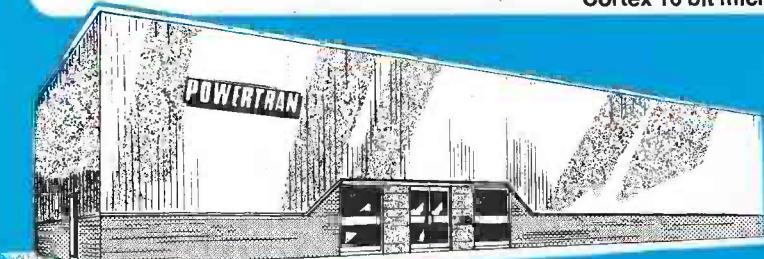
The top-of-the-range P102 has dual speed control, enhanced memory and double acting cylinders for increased torque on the wrist and arm joints. There is position interrogation via the RS232C interface, increasing the versatility of computer control and inputs are provided for machine tool interfacing.

All Genesis robots are available either ready-built or in kit form. The latter provides not only extra economy but also valuable additional training as an assembly project.



**GENESIS
P102**

Cortex 16 bit microcomputer



PORTWAY INDUSTRIAL ESTATE, ANDOVER, HANTS SP10 3ET. TEL (0264) 64455

ALL PRICES ARE EXCLUSIVE OF VAT AND APPLY TO THE U.K. ONLY - ALLOW 21 DAYS FOR DELIVERY. OVERSEAS CUSTOMERS - PLEASE CONTACT OUR EXPORT DEPARTMENT FOR THE NAME AND ADDRESS OF YOUR LOCAL DEALER.



HEBOT II
Turtle-type robot

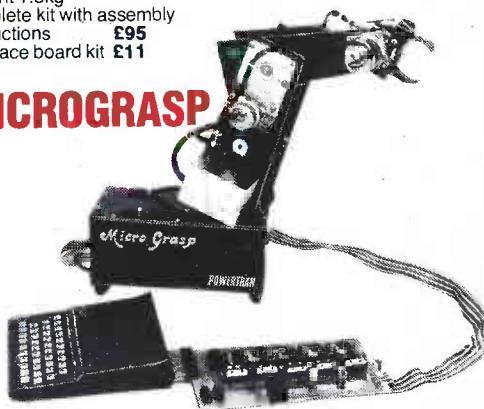
For a little over £100, Herbot II takes programming off the VDU and into the real world. Each wheel is independently controlled by a computer, enabling the robot to perform an almost infinite number of moves. It has blinking eyes, a two-tone bleep and a solenoid-operated pen to chart its moves. Touch sensors, coupled to its shell return data about its environment to the computer enabling evasive or exploratory action to be calculated.

The robot connects directly to an I/O port or, via the interface board, to the expansion bus of a ZX81 or other microcomputer.

HEBOT II

Weight 1.8kg
complete kit with assembly instructions £95
Interface board kit £11

MICROGRASP



A real, programmable robot for a little over £200! Micrograsp has an articulated arm jointed at shoulder, elbow and wrist positions. The entire arm rotates about its base and there is a motor driven gripper. All five axes are motor driven and four of these are servo controlled giving positive positioning. The robot can be controlled by any microcomputer with an expansion bus – the Sinclair ZX81 being particularly suitable.

MICROGRASP

Weight 8.7kg, max. lifting capacity 100g
Robot kit with power supply £160.00
Universal computer interface board kit £54.00
23 way edge connector £3.00
ZX81 peripheral/RAM pack £3.50

GENESIS S101

Weight 29kg, max. lifting capacity 1.5kg
4-axis model (kit form) £470
5-axis model (kit form) £525
5-axis complete system £817

GENESIS P101

Weight 34kg, max lifting capacity 1.8kg
6-axis model (kit form) £750
6-axis complete system (kit form) £1050

GENESIS P102

Weight 36kg, max lifting capacity 2kg
6-axis system (kit form) £1350
Powertran Cortex microcomputer self-assembly kit £295.00

POWERTRAN
cybernetics Ltd.



Full-travel, full size KEYBOARD

**Simply plugs into
expansion port on your
SPECTRUM**

- * Single-key selection of all major multi-key functions.
- * Plugs directly into Spectrum expansion port and extends port for other peripherals.
- * Can accept Atari-type joysticks (optional extra).
- * Absolutely no soldering or dismantling of Spectrum.
- * Available in kit-form or ready-built.

The kit is sold in three parts — the Keyboard Main Kit which allows you to make your own arrangements for connection to the Spectrum — the Adaptor Kit which contains the extension board and socket for the expansion port and the cable between the



**KIT ONLY
£39.95
READY-BUILT
£44.95**

Case included in both prices

Order As	LK29G (Keyboard Main Kit)	Price £28.50
	LK30H (Adaptor Kit)	Price £6.50
	XG35Q (Case)	Price £4.95

Full construction details in Projects Book 9.

Also available ready-built for direct connection and including case.

Order As	XG36P (Spectrum Keyboard)	Price £44.95
----------	---------------------------	--------------

extension board and the keyboard — and the Case Kit which includes all the necessary mounting hardware.

Maplin's Fantastic Projects

Full details in our project books. Price 70p each.

In Book 1 (XA01B) 120W rms MOSFET Combo-Amplifier • Universal Timer with 18 program times and 4 outputs • Temperature Gauge • Six Vero Projects.

In Book 2 (XA02C) Home Security System • Train Controller for 14 trains on one circuit • Stopwatch with multiple modes • Miles-per-Gallon Meter.

In Book 3 (XA03D) ZX81 Keyboard with electronics • Stereo 25W MOSFET Amplifier • Doppler Radar Intruder Detector • Remote Control for Train Controller.

In Book 4 (XA04E) Telephone Exchange for 16 extensions • Frequency Counter 10Hz to 600 MHz • Ultrasonic Intruder Detector • I/O Port for ZX81 • Car Burglar Alarm • Remote Control for 25W Stereo Amp.

In Book 5 (XA05F) Modem to European standard • 100W 240V AC



Inverter • Sounds Generator for ZX81 • Central Heating Controller • Panic Button for Home Security System • Model Train Projects • Timer for External Sounder.

In Book 6 (XA06G) Speech Synthesiser for ZX81 & VIC20 • Module to Bridge two of our MOSFET amps to make a 350W Amp • ZX81 Sound on your TV • Scratch Filter • Damp Meter • Four Simple Projects

In Book 7 (XA07H) Modem (RS232) Interface for ZX81/VIC20 • Digital Enlarger Timer/Controller • DXers Audio Processor • Sweep Oscillator • CMOS Crystal Calibrator.

1984 CATALOGUE

A massive 480 big pages of description, pictures and data and now with prices on the page. The new Maplin catalogue is the one book no constructor should be without. Now includes new Heathkit section. On sale in all branches of W.H. Smith. Price £1.35 — It's incredible value for money. Or send £1.65 (including p & p) to our mail-order address.

Great Projects From E&MM

Our book "Best of E&MM Projects Vol. 1" brings together 21 fascinating and novel projects from E&MM's first Year.

Projects include Harmony Generator, Guitar Tuner, Hexadrum, Syntom, Auto Swell, Partylite, Car Aerial Booster, MOS-FET Amp and other musical, hi-fi and car projects. Order As XH61R. Price £1.

In Book 8 (XA08J) Modem (RS232) Interface for Dragon and Spectrum • Synchime • I/O Ports for Dragon • Electronic Lock • Minilab Power Supply • Logic Probe • Doorbell for the Deaf.

In Book 9 (XA09K) Keyboard with electronics for ZX Spectrum • Infrared Intruder Detector • Multimeter to Frequency Meter Converter • FM

Radio with no alignment • Hi-Res Graphics for ZX81 • Speech Synthesiser for Oric • VIC Extendiboard • ZX81 ExtendRAM • Dynamic Noise Limiter for Personal Cassette Players • TTL Levels to Modem/RS232 Converter • Logic Pulser • Pseudo-Stereo AM Radio • Ni-Cad Charger Timer • Adder-Subtractor • Syndrums' Interface • Microphone Pre-Amp Limiter.

THE MAPLIN MODEM KIT

Exchange programs with friends, leave or read messages from the various Billboard services, talk to computer bureaux, or place orders and check stock levels on Maplin's Cashtel



service. A Maplin Modem will bring a whole new world to your computer and vastly increase its potential.

Now you can exchange data with any other computer using a 300 baud European standard (CCITT) modem and because the Maplin Modem uses this standard, you could talk to any one of tens of thousands of existing users.

Some computers need an interface and we have kits for the ZX81, VIC20/Commodore 64, Dragon and Spectrum and shortly Atari, whilst the BBC needs only a short program which is listed in Projects Book 8.

A Maplin Modem will add a new dimension to your hobby.

Order As LW99H (Modem Kit) excluding case. Price £44.95
YK62S (Modem Case) Price £9.95.

Full construction details in Projects Book 5.

Post this coupon now for your copy of the 1984 catalogue. Price £1.35 + 30p post and packaging. If you live outside the U.K. send £2.20 or 11 International Reply Coupons. I enclose £1.65

Name

Address

ETI/4/84



Despatch by return of post where goods available.

MAPLIN

ELECTRONIC
SUPPLIES LTD

Mail Order: P.O. Box 3, Rayleigh, Essex SS6 8LR. Tel: Southend (0702) 552911 • Shops at: 159-161 King Street, Hammersmith, London W6. Tel: 01-748-0926. • 8 Oxford Road, Manchester. Tel: 061-236-0281. • Lynton Square, Perry Barr, Birmingham. Tel: 01-356-7292. • 282-284 London Road, Westcliff-on-Sea, Essex. Tel: 0702 554000. • 46-48 Bevois Valley Road, Southampton. Tel: 0703 25831. All shops closed all day Monday.

All prices include VAT and carriage. Please add 50p handling charge to orders under £5 total value (except catalogue).