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KIT PRICES

Input channel Output channel Auxiliary channel Blank Panel

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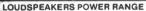
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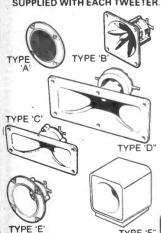
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400V: 11F. Ind. 2nd. 2nd. 4nf. 6ns 11p; 10n. 15n. 18n. 22n 12p; 33n. 47n. 68n 18p; 150n 20p; 220n 30p; 330n 42;
470n 52p; 680n 11fe 88p; 2uz 82p.
100V: 10nf. 12n. 9sn. 11p; 150n 22on 17p; 330n. 470n 30p; 680n 38p; 1uf 48p 42p; 1u5 45p; 2uz 48p; 4u7
48p.
100V: 11nf 17p; 10nf 30p; 15n 40p; 22n 36p; 33n 42p; 47n. 100n 42p.

POLYESTER RADIAL LEAD CAPACITORS: 280V 10n, 15n, 22n, 27n 8p; 33n, 47n, 68n, 100n 7p; 150n, 220n 10p; 330n, 470n 13p; 680n 19p; 1u5 40p; 2u2 48p.

TANTALUM BEAD CAPACITORS 35V: 0.1uF, 0.22, 0.3315p0.47, 0.68, 1.0, 1.5 16p; 2.2, 3.3 18p; 47, 6.8 22p 10 28p; 16V; 2.2, 3.3 16p; 47, 6.8, 10 18p; 15, 36p; 2.30p; 3.3, 47, 50p; 10075p; 10V; 15, 22, 26p; 33, 47, 35p; 100 85p; 6V: 100 42p. POTENTIONETERS: Rotary, Carbon, Track 0.25W Log & Lin values. 500 . 1K & 2K (Linear only) Single Gamp 5 5K 2m Single Gamp Log & Lin 5K M Single Gamp D.P Switch 5K 2m Double Gamp MYLAR FILM CAPACITORS 100V: 1nF, 2, 4, 4nF, 10 6p; 15nF, 22n, 30n, 40n, 47n 7p; 56n, 100n, 200n 9p; 50V: 470nF 12p. \$LIDER POTENTIOMETERS 0.25W log and linear values 60mm 5K 500K single gang

CERAMIC CAPACITORS 50V; Range 0 5pF to 10nF 4p. 15nF, 22nF 33nF; 47nF 5p. 100nF/300V 7p. 200nF/6V 8p.

POLYSTYRENE CAPACITORS: 10pF to 1nF 8p; 15nF to 12nF 10p

SILVER MICA (Values in pF) 2. 3.3. 47, 6.8, 8.2, 10, 12, 15, 18, 22. 27, 33, 39, 47, 50, 56, 66, 75, 82, 85, 100, 120, 150, 180pF 18p sech 200, 220, 250, 270, 390, 330, 380, 380, 390, 470, 800, 820 21p each 100, 1200, 1800, 2200 30p each 3300, 4700pF 80p

MINIATURE TRIMMERS Capacitors 2.6pF, 2.10pF 22p; 2.25pF, 5.65pF 30p; 10.88pl 36p. 225p RANGE 2 2-10M 2 2-4M7 2 2-10M 100 + 1p 1p 4p 4p 6p Val E24 E12 E12 E24 0.25W 0.5W 1W

2% Metal Film 1% Metal Film

1702CP 1802CP 1702CP 1802CP 1144.300n 2144.300n 2145.300n 2145.300 DIODES BRIDGE RECTIFIERS 75 SERIES 96 80 150 125 125 125 126 99 56 140 360 150 86 52 70 65 1A/50V 1A/100V 1A/400V 2A/50V 2A/50V 2A/400V 6A/100V 6A/400V 10A/200V 10A/200V 10A/500V 25A/500V 8Y164 VM18 DIL 18 20 25 34 30 40 46 66 83 96 126 215 296 240 396 56 75114/5 75121/2 75150 75154 75158 75182/4 75188/9 75322 75324 75365 75450 75451/2 75454 75491/2 ZENERS 5A/40V 5A400V 5A600V 8A300V 12A100V 12A400V 12A800V BT108 BT116 C106D TIC44 TIC45 TIC47 2N5064 2N4444 32 40 48 80 90 78 188 150 180 38 24 29 36 32 38 130 Range: 2V7 to 39V 400mW 8p each Range: 3V3 to 33V 1 3W 15p each TRIACS

DIAC

3A200V 3A400V 8A100V 8A400V 12A100V 12A400V 16A100V 16A400V 16A800V 25V500V 25A800V

SIEMENS oct Type Miniature poly Conscitors

2607 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n 18n, 22n, 27n, 33n, 39n, 47n 39n, 56n 82n, 100n

TRANSISTORS

AC1887 AC1881 AC

BC189C BC170 BC171/2 BC177/8 BC177/8 BC177/8 BC181 BC182/3 BC184 BC183L BC183L BC184L BC188 6/7 BC12

100V 100n, 120n 150n, 180n 220n, 270n 330n, 390n 470n, 560n 180n

30p 30p 78p 89p

45p

7p 12p 12p

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BC2196.
BC2197.
BC2196.
BC2196 BP 2598
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BP 2578
BP 2588
BP 2578
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BP 3587
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RF CHOKES Miniature PCB type 1uH. 2u2, 4u7 10u, 22u, 33u, 47u, 100u, 220u, 330u, 470u **30**g 1mH, 1m5, 2m2, 4m7, 10mH 3

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VARICAPS

	and the same						
SWITCHES (OGGLE: 2A 250V		MITCHES 10p; 8 way 85p; 10 way 125p	VEROBOARD 0.1in	VA Board 1959 DIP Board 3659	IDC CONNECTORS FCB. Plugs Female Female	PANEL METERS	RELAYS Miniature enclosed PCB mount
3PST 33p 3PDP 44p	(SPOT) 4 way 190p ROTARY	SWITCHES	2½ x 3¼ 85p — 2½ x 5 100p	Vero Strip 95p	PCB Plugs Female Fomela with talch Header Card Pine Plns Plug Edge Strt Angle Connect	FSD 60 x 46 x 35mm	5INGLE POLE Changeover RL-91 205 Coil: 12V DC, (10V5 to
SUB-MIN TOGGLE	1 pole/2 to 12 way, 2 pole/	le Stop type) 2 to 6 way; 3 pole/2 to 4 way:	3% x 3% 100p 3% x 5 115p	PROTO DECs	10 way 80p 99p 05p 120p 16 way 130p 150p 110p — 20 way 145p 166p 125p 185p	0-50mA 0-100mA	19 5V), 10A at 30V DC or 250V AC 195p DOUBLE POLE Changeover, 8A 30V QC or 250V AC
3PST on/off 84p 3PDT c/over 80p 3PDT centre off 85p	4 pole/2 to 3 way	45p	3% x 17 390p 4% x 17 495p	Veroblock 405p S-Dec 350p Eurobreadboard 520p	26 way 175p 200p 150p 340p 34 way 205p 224p 160p 320p	0-500mA 0-1mA 0-5mA	RL-100 53 Coil, 6V DC (5V4 to 9V9) 190p RL6-111 205 Coil, 12V DC (10V7 to 19V5) 195p
3PDT blessed both	ROTARY: Mains DP 250V 4 A	ump on/off 66p	Pkt of 100 pins 55p Spot face cutter 150p Pin insertion tool 185p	Bimboard 1 575p Superstrip SS2 1350p	40 way 220p 280p 180p 340p 50 way 235p 270p 200p 386p	0-10mA 0-50mA	RL6-114 740 Coil, 24V DC (22V to 37V) 200p
DPDT 6 tags 75p DPDT centre off 86p	ROTARY: (Mak-a-switch)	-	VERO WIRING PEN		60 way 230p 406p	0-100mA 0-500mA	
OPDT blassed both ways 145p	Accommodates up to 6 wafers	ing assembly has adjustable stop. (max, 6 pote/12 way + DP switch).	+ spool 340p Spare spool 75p	DALO ETCH RESIST PEN	EURO CONNECTORS	0.aA 0.2A	
OPDT 3 pestions on/on/on 185p S-sole 2 way 205p	Mechanism only	90p	Combs Sp	Plus spare lip 100p	Gold Flashed Female Socket Male Plug Contacts Strt. Angle Strt. Angle Pins Pins Pins Pins	0.25V 0.50V AC 0.300V AC	AMPHENOL PLUGS
SLIDE 250V:		read) to fit the above switch pole/6 way; 3 pole/4 way; 4 pole/3	FERRIC CHLORIDE 1 Ib bag Anhydrous	ULTRASONIC TRANSDUCER	DIN41617 31 way 170p 175p	"S" 490p each	Centronics Parallel 36 Way solder 530 Centronics Parallel 36 Way IDC 495
GPDT 1A 14p GPDT 1A c/oll 15p	way; 6-/2 ay Mains DP 4A 5witch to fit	65p 45p	195p +50p p&p	40KHz 325 pr	DIN41612 2 x 32 A + 8 275p 320p 220p 286p		Centronics 36 Way IDC Female 520p
PUBHBUTTON SA	Spacers 4p Screen 6p.		COPPER CLA	Double S.R.B.P.	DIN41612 2 x 32 A + C 295p 340p 240p 300p DIN41612 3 x 32		
## 10mm Button PDT latching 99p	ROCKER: 5A/250V SPST ROCKER: 10A/250V SPDT	26p 38p	glass sided	S/Speed . sided 9.5" x 8.5"	A+B+C 360p 385p 280p 395p	CRYSTALS	
POT letching 145p POT moment 99p	ROCKER: 10A/250V DPDT c/ ROCKER: 10A/250V DPST wi	off 95p	6" x 6" 100p 6" x 12" 175p	125p 110p 225p		32.768KHz 100 100KHz 235	BUZZERS
PDT moment 145p	THUMBWHEEL Mini front me		DILL SOCKETS	EDGE	Solder IDC 14 pin 40p 90p	. 200KH2 265 455KH 370	miniature, solid-state 6V 9V & 12V 70p PIEZO TRANSDUCERS PB2720 55p
ush to Make 15p	Decade Switch Module B.C.D. Switch Module	220p 278p	Low: Wire	.1 .156 2 x 15 way — 140p	14 pin 40p 90p 16 pin 48p 105p 24 pin 86p 178p price per foot	1MHz 275 1.008M 275	
	Mounting Cheeks (per pair)	75p	Prof Wrap 8 pm 8p 25p	2 x 18 way 180p 145p 2 x 22 way 180p 200p	26 pln 140p - Grey Color 40 pin 250p 255p 10 way 15p 28p	1.28MHz 390 1.6MHz 395 1.8NHz 395	
	JUMPER LEADS (R	ibbon Cable Assembly)	14 pm 10p 35p 16 pm 10p 42p 18 pm 16p 52p	2 x 23 way 175p — 2 x 25 way 225p 220p 2 x 26 way 190o —	16 way 25p 40p 20 way 30p 50p	1.8432M 200 2.0MHz 225	'
	Length 14 pin	16 pn 24 pin 40 pin	20 pm 20p 60p 22 pm 22p 65p	2 x 30 way 245p — 2 x 36 way 295p —	ZIF DHL 24 way 40p 86p 80CKETS 34 way 80p 85p 24 pin 575p 40 way 70p 90p	2.4576M 200 3.278M 150	LOUDSPEAKERS
271	Single ended DIP (Header 24 inches 145p	Plug) Jumper 185p 240p 380p	24 pin 25p 70p 28 pin 28p 80p	2 x 40 way 315p - 2 x 40 way 315p -	24 pin 575p 40 way 70p 90p 28 pin 750p 50 way 100p 135p 40 pin 875p 64 way 120p 160p	35794M 96 36864M 300 4,0MHz 150	2in, 31-iin, 21-iin, 3in 80p 21-iin 40 - 64 or 80 80p
PROJECTS We stock	Double ended DIP (Header 6 inches 185p 12 inches 198p	Plug) Jumper 205p 300p 485p 215p 315p 480p	40 pm 30p 90p	2 x 75 way 550p —		4.032MHz 290 4.032MHz 290 4.80MHz 200	
most of	24 inches 210p 36 inches 290p	215p 315p 480p 236p 345p 540p 370p 480p 525p				4 19430M 200 4.433619M 100	
the parts			ANTEX SOLDERING IF C-15W 495p CS17W	495p SIL		5.0MHz 160 5.185MHz 300	
	20 pin	Socket Jumper Leads 36" 26 pln 34 pin 40 pin 200e 260e 300e	G18W 520p XS25W Spare tips, assorted sizes Spare elements	525p SOCKET 85p 0.1" pitch 225p 20 way	'D' CONNECTORS	5.24288M 390 6.0MHz 140 6.144MHz 150	ASTEC UHF MODULATORS Standard 6MHz 325p
	Single ended 160p Double ended 290p	200p 260p 300p 480p 525p	Spare elements Iron Stand with sponge	225p 20 way 175 85p	9 15 25 37 Wey way way way	6.5536MHz 225 7.0MHz 180	Wideband 8MHz 480p
TRANS	FORMERS	VOLTAGE RE	GIII ATOPR	SOLDERCON PINS	Male Solder lugs 80p 105p 160p 250p Angle pins 150p 210p 250p 355p	7.168MHz 250 7.7328MHz 250	
. IKANSI		1A TO220 Pla		Ideal for making SIL or Dit. Sockets	PCB pins 120p 130p 195p 295p Female	7.68MHz 200 8.0MHx 150 8.089333M 385	
0-3V; 6-0-6V; 9-0-9V; 12-0-12 30 mounting. Miniature, Split		5V 7805 40p 12V 7812 40p	7905 45 p 7908 60 p	100 pins 75p 500 pins 350p	Solder lugs 105p 160p 200p 335p Angle pins 165p 215p 290p 440p	8,86723M 175 9,00MHz 200	* SEIKOSHA GP-700
VA: 2x6V-0.25A; 2x9V-0.15A; VA: 2x6V-0.5A; 2x9V-0.3A; 2x	2x12V-0.12A; 2x15V-0.1A 200p	15V 7815 40p 18V 7818 40p	7912 45 p 7915 45 p		PCB pins 150p 180p 240p 420p COVERS 80p 75p 75p 90p	10.0MHz 175 10.24MHz 200	The Colour Printer that has broken all price barriers.
tenderd Split Bobbin type: MA: 2x6V-0.5A; 2x9V-0.4A; 2x		24V 7824 40 p	7918 45 p 7924 45 p	ALUM BOXES 3×2×1" 85p	IDC 25 way 'D' Plug 365p ; Socket 450p	10.7 MHz 180 12.0 MHz 175	A 7 colour graphic printer at
120V-0.3A	x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 320p (35p p8p) 1.2A; 2x12V-1A; 2x15V-0.8A;	100mA TO92 Plastic package 5V 78LO5 30p 6V 78LO6 30p	79LO5 60p	4 x 2½ x 2" 100p 4 x 2½ x 2½" 103p 4 x 4 x 2" 106p	25 way 'D' CONNECTOR (R\$232)	12.528M 300 14.31814M 170 16.0MHz 200	the price of a standard Dot matrix printer. Its unique 4
#20V-0.6A	365ø (60p p8p) x12V-2A: 2x15V-1.5A; 2x20V-1.2A;	8V, 78L08 30p	79L12 60p	4 x 4 x 2 ½" 120p 5 x 4 x 1½" 99p	18" long, Single end, Male 475p 18" long, Single end, Female 510p	18.0MHz 180 18.432M 150	hammer method enables text &high res graphics to be drawn
#28V-1A; 2x30V-0.8A pacinity wound for Multirail co	520p (60p p&p) omputer PSUs	. 15V 78L15 30p	79L15 . 80p	5 x 4 x 2½" 120p 5 x 2¼ x 1½" 90p	36" long, Double Ended, M/M 995p 36" long, Double Ended, F/F £10	19.966MHz 150 20.0MHz 200	in 7 basic colours or 30 shades.
6VA: Outputs +5V/5A: +12V, I 1A	820p (60p p8p)	ICL7660 248p RC4194 375p	TAA550 50p TDA1412 150p	5 x 24 x 27 130p 6 x 4 x 2" 120p	36" long. Double Ended, M/F 995p	24.0MHz 170 24.930MHz 325	7 x 8 matrix. Up to 106 char, per line at 50 CPS. Variable line
#80V-1A	220V-2.5A; 2x25V-2A; 2x30V-1.5A; 920p (75p)	RC4195 160p LM309K 135p LM317K 320p	78H05 + 5V/5V 580p 78H12 +12V/5A 580p 78HG + 5V to + 25V	6×4×3" 160p 7×5×3" 180p 8×6×3" 210e	● SPECIAL OFFER ●	26.69M 150 27.648M 170 27.145M 180	spacing to 1/120". Tractor or Friction feed, Centronix inter-
		LM317KP 450p LM323K 450p	5A 500p 79HG + 225V to 24V	10 x 4 x 3" 240p 10 x 7 x 3" 275p	2764 1250n 1+ 50+ 425p 375p	38 6667M 175 48,0MHz 170	face standard.
SP charge to be added over a	nd above our normal postal charge	LM337 175p LM723 Var 36p	51 685 p	12 x 5 x 3" 280p 12 x 8 x 3" 295p	27128 - 250n 1+ 50+ £21 £18	100.0MHz 295 116.0MHz 300	Special Introductory Offer: Only £399
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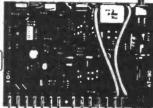
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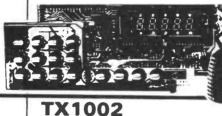
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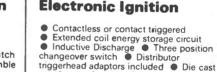






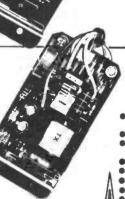
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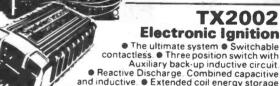
weatherproof case Clip-to-coil or remote mounting facility Fits majority of 48 6 cyl. 12V. neg. earth vehicles Over 145 components to assemble.





SX2000 Electronic Ignition

- The brandleading system on the market today
- Unique Reactive Discharge
- Combined Inductive and Capacitive Discharge Contact breaker driven
- Three position changeover switch Over 130 components to assemble
- Patented clip-to-coil fitting
- Fits all 12v neg. earth vehicles



Auxiliary back-up inductive circuit.

Reactive Discharge Combined capacitive and inductive. Extended coil energy storage circuit. Magnetic contactless distributor triggerhead. Distributor triggerhead adaptors included.

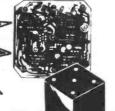
Can also be triggered by existing contact breakers.

Die cast waterproof case with clip-to-coil fitting Fits majority of 4 and 6 cylinder 12y neg. earth yehicles. majority of 4 and 6 cylinder 12v neg. earth vehicles.

Over 150 components to assemble

All SPARKRITE products and designs are fully covered by one or more World Patents

FREE" MAGIDICE KIT WITH L ORDERS OVER £45.00



MAGIDICE **Electronic Dice**

- Electronic Dice

 Not an auto item but great fun
 for the family

 Total random selection

 Triggered by waving of hand
 over dice

 Bleeps and flashes during a 4 second
 tumble sequence

 Throw displayed for 10 seconds
 Auto display of last throw 1 second in 5

 Muting and Off switch on base

 Hours of continuous use from PP7 battery

 Over 100 components to assemble

SPARKRITE 82 Bath Street

	SELF ASSEMBLY KIT
SX 1000	£12.95
SX 2000	£19.95
TX 1002	£22.95
TX 2002	£32.95
AT 80	£32.95
VOYAGER	£64.95
MAGIDICE	£9.95

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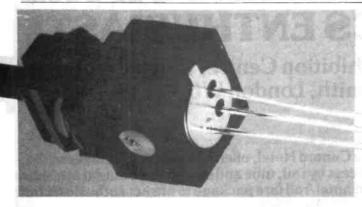
Project Special

As the majority of our readers will be all too aware, the dear old British summer doesn't last that long, and it'll be all too soon before the evenings start to close in, the clocks go back, and thoughts turn back to project work. Well, the November issue of ETI will provide plenty to keep you busy, because in our usual winter effort to lure readers away from the competition (what competition?) we shall be publishing *ten* projects in just the one issue. No silly plastic give-aways from us, we'll just simply deliver where it counts — the contents!

Projects will include a simple design for an active loudspeaker, which, while perhaps not offering the

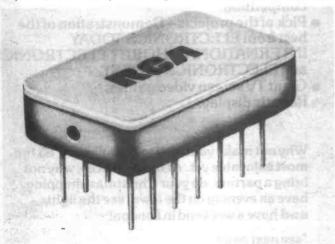
ultimate in audio performance, will certainly be very cost effective and relatively easy to build; a drum synthesiser module so that you can build up a small kit by using several all set to produce different noises; an add-on unit that will help to make many home-made alarms legal; an analogue amplifier/filter module for use with computer ADCs and DACs; and much, much more that we're still working feverishly on!

Add to this the fact that the next issue of ETI will be over 100 pages in size, and it looks as though there's only one possible choice of magazine for you to buy next month.



Optical Fibres

We've heard all about the industrial and communications use of optical fibres — now ETI takes a look at the home use of them, with, as you would expect from us, a practical guide showing how it's done.





Audio Design

John Linsley Hood continues his examination of some of the problems in audio designing with a look at distortion, and this is followed up by some practical designs for moving magnet and moving coil magnet pick-up amplifiers.

ALL THIS AND MORE IN THE NOVEMBER ISSUE OF ETI, ON SALE OCTOBER 7TH. PLACE YOUR ORDER NOW, OR RISK MISSING OUT!

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

Now's the time to catch up with out on Breadboard. 82.

THE PREMIER SHOW FOR THE **ELECTRONICS ENTHUSIAST!**

Cunard International Exhibition Centre, Cunard Hotel, Hammersmith, London W6

Improved Venue

We have transferred BREADBOARD to the Cunard Hotel, offering improved facilities to the visitor, including car parking and ease of access by rail, tube and car, all in a modern attractive setting. See below for our arranged reduced hotel/rail fare package to attract enthusiasts from all parts of the country.

Planned Features include

- Lectures: covering aspects of electronics and Amateur Radio Action Centre. computing.
- Electronics/Computing Advice Centre.
- Demonstration: electronic organs/synthesisers.
- Holography presentation.
- Practical demonstration: 'How to produce printed circuit boards'.
- Computer Corner 'Try before you buy'.

- Computer controlled model railway competition.
- Pick of the projects Demonstration of the best from ELECTRONICS TODAY INTERNATIONAL, HOBBY ELECTRONICS and ELECTRONICS DIGEST.
- Giant TV screen video games.
- Robotic display.

FRIDAY November 25th 10am - 6pm **SATURDAY** November 26th 10am - 6pm SUNDAY November 27th 10am - 4pm

Why not make your visit to Breadboard'83 the most enjoyable yet. At these *prices, why not bring a partner, do your Christmas shopping. have an evening on the town, see the lights, and have a weekend in London!

*see next page

HOLIDAY WEEKEND PACKAGE

- ★ Accommodation in a first class hotel with private bath, direct dial telephone, radio and colour television.
- * Return 2nd class rail travel from local British Rail station to London.
- ★ Ticket to Breadboard '83.
- ★ Breakfast at the hotel.
- ★ Prices quoted are inclusive of service and VAT.

Please note this offer closes on 1st November 1983.

REGION	SIN	GLE	TWIN	
	1 Night	2 Nights	1 Night	2 Nights
Beds, Berks, Bucks, Essex, Herts, Kent, Surrey and Gtr London	£29.25	£54.25	£47.75	£84.75
Cambs, Hants, Northants, Oxon, Suffolk, Sussex, Wilts	£32.50	£57.50	£57.25	£94.25
Avon, Derbyshire, Dorset, Glos, Gwent, Herefordshire & Worcs, I.O.W., Leics, Lincs, Norfolk, Notts, Somerset, Staffs, Warwickshire, West Midlands	£35.75	£59.75	£59.75	£96.75
Cheshire, Devon, Glams, Humber, Lancs, Gtr Manchester, Merseyside, Powys, Shropshire, West & South Yorks	£40.25	£64.25	£67.50	£104.50
Cornwall, Cumbria, Dyfed, Glwyd, Gwynedd, North Yorks	£44.25	£69.25	£75.00	£112.00
Borders, Cleveland, Durham, Dumfries & Galloway Northumberland, Tyne & Wear	£48.50	£73.50	£83.25	£120.25
Central, Lothian, Strathclyde	£51.75	£76.75	£89.50	£126.50
Fife, Tayside	£55.00	£80.00	£95.00	£132.00
Grampian, Highland	£58.25	£83.25	£101.50	£138.50

BOOKING FORM

Name:	Cheques should be made payable to
Address:	ASP Ltd. and sent to ASP Exhibitions, 145 Charing Cross Road, London WC2H 0EE
tel:	I enclose cheque value £
Date of arrival: 25th Nov 26th Nov	OR please debit my Access/B'card number:
Number of nights: 1 night \square 2 nights \square	
Room(s) required: single \square twin \square	
BR departure station:	
Region:	Signature

₹Rapid ₹Electronics

MAIL ORDERS: Unit 1, Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4 5RD. **TELEPHONE ORDERS:** Colchester (0206) 36412.





ACCESS AND BARCLAYCARD WELCOME

LINEAR			LM339 LM348	45 60	LM3911 LM3914	120 175	NE566 ▶NE567	140	TL064 TL071	98 30
555CMOS 80	ICL7106	790	LM358	50	LM3915	195	▶NE570	370	TL072	50
566CMOS 150	ICL7611	95	LM377	170	LM13600	105	NE571	370	TL074	95
709 25	ICL7621	180	►LM380	65	MC1496	68	▶RC4136	55	▶TL081	25
▶741 14			►LM381	120	MC3340	135	▶RC4558	60	TL082	45
748 35	ICL7622	180	LM382	120	►MF10CN	350	SL480	170	TL084	95
9400CJ 350	ICL8038	295	LM384	130	ML922	400	SL490	250	TL170	50
AY-3-1270 720	ICL8211A	200	LM386	65	ML924	195	SL76018	150	UA2240	120
AY-3-8910 370	ICM7224	785	LM387	120	ML925	210	.▶SN76477	380	ULN2003	85
	ICM7555	80	LM393	100	ML926	140	SP8629	250	ULN2004	90
AY-3-8912 540	▶LF351	45	LM709	25	ML927	140	TBA120S	70	XR2206	290
CA3046 60	LF353	85	LM711	60	ML928	140	TBA800	75	ZN414	100
►CA3080 65	LF356	90	LM725	350	ML929	140	TBA810	96	ZN423	135
CA3089 190	LM10	360	LM733	75	MM5387A	465	TBA820	70	ZN424	135
CA3090AQ 375	LM301A	25	LM741	14	NE529	225	TBA950	220	ZN425E	350
CA3130E 85	LM311	70	LM747	60	NE531	150	TDA1008	320	ZN426E	330
▶CA3140E 36	LM318	120	LM1458	40	NE544	205	▶TDA102		ZN427E	650
CA3161E 100	LM324	40	LM2917	200	▶NE555	16	TDA1024	125	ZN428E	480
CA3189 290	LM334Z	100	LM3900	45	▶NE556	45	TL061	40	ZN459	285
►CA3240E 110	LM335Z	125	▶LM3909	70	NE565	110	TL062	60	ZN1034E	200
			PEM3505	70	142.000		1 LU62	60	ZI41034E	200
		DCE1	7 '40	BE337	40 44	DCLIES	60 277		o 2N30EE	E0

						70							
				BC517	40	BF337	40	MPSU56	60	ZTX108	8	2N3055	50
TRAN	SIST	ORS		BC547	7	BFR40	23	TIP29A	30	ZTX109	12	2N3442	120
	_			BC548	10	BFR80	23	TIP29B	55	ZTX300	14	▶ 2N370:	26
AC125	35	8C149	9	BC549	10	▶BFR81	20	TIP29C	37	ZTX301	16	2N3703	9
	25	BC157	8	BC558	10	BF X29	25	TIP30A	35	ZTX302	15	▶2N370	
AC127	25	BC158	10	BCY70	18	BFX84	25	TIP30B	50	ZTX304	17	2N3705	9
▶AC128	20	BC159	8	BCY71	18	BFX85	25	TIP30C	37	ZTX341	30	2N3706	9
	25	BC160	45	BCY72	18	BFX86	28	TIP31A	35	ZTX500	15	2N3707	10
AC187	22	BC168C	10	BD115	55	BFX87	25	TIP31C	37	ZTX501	15	2N3708	10
AC188	22	BC169C	10	8D131	35	BFX88	25	TIP32A	35	ZTX502	15	2N3709	10
AD142 1	20	BC170	8	BD132	35	BFY50	23	TIP32C	37	ZTX503	18	2N3772	170
AD149	80	BC171	10	BD133	50	BFY51	20	TIP33A	50	ZTX504	25	▶2N3773	
AD161	40	8C172	8	BD135	40	BFY52	23	.TIP33C	75	2N697	20	▶ 2N3815	
AD162	40	BC177	18	BD136	30	BFY53	32	TIP34A	60	2N698	40	2N3820	40
AF124	60	BC178	18	BD137	30	BFY55	32	TIP34C	85	2N706A	20	2N3823	65
AF126	50	BC179	18	8D138	30	BFY56	32	TIP35A	105	2N708	20	2N3866	90
AF139	40	BC182	10	▶BD139	35	BRY39	40	TIP35C	125	2N918	35	2N3903	10
AF186	70	▶BC1821	L 8	▶BD140	35	BSX20	20	TIP36A	125	2N1132	22	2N3904	10
AF 239	75	BC183	10	BD204	110	BSX29	35	TIP36C	135	2N1613	30	2N3905	6
BC107	10	BC183L	10	BD206	110	BSY95A	25	TIP41A	45	2N2218A		2N3906	10
BC107B	12	BC184	10	BD222	85	BU205	160	TIP42A	45	2N2219A		2N4037	45
▶BC108	10	BC1841	L 7	BF180	35	BU206	180	TIP120	90	2N2221A		2N4058	10
BC108B	12	BC212	10	BF182	35	BU208	170	TIP121	90	2N2222A		2N4060	10
BC108C	12	BC212L	10	BF184	25	MJ2955	99	TIP122	90	2N2368	25	2N4061	10
▶BC109	10	BC213	10	BF185	25	MJE340	50	TIP141	98	2N2369	16	2N4062	10
8C109C	12	BC213L	10	BF194	12	MJE520	65	TIP142	98	2N2484	25	2N5457	36
BC114	18	BC214	10	BF 195	12	MJE521	95	TIP147	110		45	2N5458	36
BC115	22	▶BC214		BF196		MJE3055	70	TIP2955	60	2N2904	20	2N5459	30
BC117	18	BC237	8	BF 197	12	MPF102	40	TIP3055	55	2N2904A	20	2N5485	36
BC119	35	BC238	14	BF198	10	MPF104	40	TIS43	40	2N2905	22	2N5777	45
BC137	40	BC308	12	BF199	18	MPSA05	22	TIS44	45		22	2N6027	30
BC139	40	8C327	14	BF200	30	MPSA06	25	TIS90	30	2N2906	25	40360	40
BC140	28	BC328	14	▶BF2448		MPSA12	30	TIS91	30		25	40361	50
BC141 ·	30	BC337	14	BF245	30	MPSA55	30	VN10KN		2N2907	25	40362	50
BC142	25	BC338	- 14	BF256B	45	MPSA56	30	VN46AF			25	40408	70
BC143	25	BC477	30	BF257	32	MPSU05	55	VN66AF		2N2926	9		
BC147	8	BC478	30	BF258	25	MPSU06	55	VN88AF		▶2N3053			
BC148	В	BC479	30	BF259	35	MPSU55	60	ZTX107	8	2N3054	55		
			_							COLUMN TO SECURE			

CABLES		
20 metre pack single cor		
ing cable ten different co	οl	
Speaker cable		10p/m
Standard screened		16p/m
Twin screened		24p/m
2.5A 3 core mains .		23p/m
10 way rainbow ribbon		65p/m
20 way rainbow ribbon		120p/m
10 way gery ribbon .		38p/m
20 way grey ribbon		80p/m
	۰	

78L05 78L12 78L15 7805 7812 7815 LM309K LM317K LM317T LM323K

OPTO

▶1N4001 1N4002 1N4006 1N4007 1N5401 1N5404 1N5406 400mWzen

3mm red	7	5mm red	7
3mm green 10	5mm green 10		
3mm yellow10	5mm yellow10		
Clips to suit - 3p each,			
Rectangular	TIL32	40	
Pred	12	TIL78	40

P∃mm vellow10 ° Emm vellow10
Clips to suit · 3p each.
Rectangular 11L32 40
Pred 12 11L73 40
Pred 17 11L73 40
Pred 17 PH111 60
yellow 17 ORP12 85
PTIL38 40 TIL100 90
2N5777 45 Dual colour 60
Seven segment displays:
Com cathode DL704 0.3" 95 DL707 0.3" 95
PENDS00 FNDS07 0.5" 100
TIL313 0.3"15 TIL312 0.3"115
LCD: 3½ digit 580p. 4 digit 620p.

e pack single core connect- tent different colours, 65p cable . 10p/m d screened . 16p/m d screened . 24p/m ore mains . 23p/m rainbow ribbon . 38p/m grey ribbon . 38p/m grey ribbon . 80p/m	PP3 battery clips Red or black crocodile clip Black pointer control knol Pr Ultrasonic transducers 64 Electronic buzzer 12V Electronic buzzer 12V Electronic buzzer 164mm 64 ohm speaker 20mm panel fuseholder
30 79L05 65 30 79L12 65 30 79L15 65 30 79L15 65 35 7905 40 35 7912 40 35 7915 40 30 LM723 35 270 SPECIAL OFFERI 120 78PO5 10A +5V 350 only 3900 each,	ROTENTIOMETERS Rotary. Carbon track Log 1K - 2M2. Single 32p. Ster Single switched 80p. Side travel single Log or Lin 5K 63p each. Preset submin. hor. 100 of 7p each. Cermet precision multiturr %" 100 ohms to 100K - 88
	TRIACS 400V 8A

HARDWARE	
PP3 battery clips Red or black crocodile clips Black pointer control knob Pr Ultrasonic transducers B6V Electronic buzzer P12V Electronic buzzer P12V Electronic buzzer P8E2720 Piezo transducer B64mm 64 ohm speaker B64mm 86 ohm speaker 20mm panel fuseholder	. 60 350 60 65 75 70 25

63p each. Preset submin. hor. 100 ohms -1M 7p each. Cermet precision multiturn, 0.75W %" 100 ohms to 100K - 88p each.

95 25

TRIACS 400V 8A 400V 16A 400V 4A 50 BR100

Grey Ribbon cable. Price | 10 way . 38 34 way | 16 way . 55 40 way | 20 way . 80 50 way | 24 way . 110 60 way

JUMPER LEADS

HARDWARE	
P3 battery clips	6
Red or black crocodile clips	. 6
Black pointer control knob	. 15
r Ultrasonic transducers	350
6V Electronic buzzer .	60
▶12V Electronic buzzer .	65
PB2720 Piezo transducer .	75
64mm 64 ohm speaker .	70
64mm 8 ohm speaker	70
Omm panel fuseholder .	25

Omm panel fuseholder .	25
▶64mm 8 ohm speaker .	70
64mm 64 ohm speaker .	70
PB2720 Piezo transducer .	75
▶12V Electronic buzzer .	65
6V Electronic buzzer .	60
r Ultrasonic transducers	350
Black pointer control knob	. 15
Red or black crocodile clips	. 6
P3 battery clips	6
HARDWARE	

HARDWARE	
P3 battery clips led or black crocodile clips lack pointer control knob r Ultrasonic transducers 64 Electronic buzzer r12V Electronic buzzer r12V Electronic buzzer PBB720 Piezo transducer 64mm 64 ohm speaker 64mm ban speaker 0mm panel fuseholder	6 . 6 . 15 350 60 65 75 70 70 25

HARDWARE .	CAPACITORS
PP3 battery clips	Polyester, radial leads. 250v. C280 ⁻¹ type: 0.01, 0.015, 0.022, 0.033 - 6p; 0.047, 0.068, 0.1 - 7p; 0.15, 0.22 - 9p; 0.33, 0.47 - 13p; 0.68 - 20p; 1u - 23p. Electrolytic, radial or axial leads: 0.47/63V, 1/63V, 2.2/63V, 4.7/63V, 0.10/25V - 7p; 22/25V, 47/25V - 8p; 100/25V - 9p; 220/25V - 14p; 47/25V - 30p;
POTENTIOMETERS Rotary. Carbon track Log or Lin 1K - 2M2. Single 32p. Stereo 85p. Single switched 80p. Slide 60mm travel single Log or Lin 5K - 500K 630 aech	2200/25V - 50p. Teg end power supply electroly tics: 2200/40V - 110p; 4700/40V - 160p 2200/63V - 140p; 4700/63V - 230p Polyester, miniature Siemens PCB: 1n, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 7p; 22n, 33n, 47n, 6sn, 8p; 100n, 9p; 150n, 11p; 220n, 13p; 330n, 20p;

CAPACITORS

2200/25V · 50p.	
Tag end power supply ele	ctrolytics:
2200/40V - 110p, 4700/4	10V - 160p
2200/63V - 140p; 4700/6	33V - 230p
Polyester, miniature Siem	ens PCB:
1n, 2n2, 3n3, 4n7, 6n8, 10	n. 15n. 7p
22n, 33n, 47n, 68n, 8p; 10	DOn. 90:
150n, 11p; 220n, 13p; 33	On. 20p:
470n 26p; 680n, 29p; 1u 3	33p. 2u2
50p.	
Tentalum bead:	

30p.
Tantalum bead:
0.1, 0.22, 0.33, 0.47, 1.0 @ 35V -
12p. 2.2, 4.7, 10 @ 25V - 20p;
15/16V - 30p; 22/16V - 27p; 33/
16V - 45p; 47/6V - 27p; 47/16V -
70p; 68/6V - 40p; 100/10V - 90p.
Cer. disc. 22p-0.01u 50V, 3p each.
Mullard miniature ceramic plate:
1.8pf to 100pf 6p each.
Polystyrene, 5% tol: 10p-1000p, 6p
1500-4700, 8p;6800 0.012u, 10p.
Trimmers Mullard 808 series: 2-10

pF, 22p; 2-22pF,		
BRIDGE RECTIFIERS	2A 200V 2A 400V 6A 100V	40 45 80

BRIDGE RECTIFI	ERS	2A 200V 2A 400V 6A 100V	40 45 80
1A 50V 1A 400V	20 35	6A 400V 9 VM18 DIL 200V	

JUMPER LEADS	1.8pF to 100pF 6p each.
Length 14pin 16pin 24pin 40pin Sgle ended DIP(header plug) jumper 24 ins. 145 165 240 380 Dble ended DIP(header plug) jumper	Polystyrene, 5% tol: 10p-1000p, 6p; 1500-4700, 8p; 6800 0.012u, 10p. Trimmers. Mullard 808 series: 2-10 pF, 22p; 2-22pF, 30p; 5.5-65pF, 35p
6 ins. 185 205 300 465 12 ins. 195 215 315 400 24 ins. 210 235 345 540 36 ins. 230 250 375 595 25 way D Connector jumpers 18 ins. long single ended mate 495p. 18 ins. long single ended f/mate \$25p,	BRIDGE 2A 200V 40 RECTIFIERS 6A 100V 95 1A 50V 20 VM18 DIL 0.9A 1A 400V 95 50 VM 1A 400V 95 50 VM 1B DIL 0.9A 1A 400V 35 200V 50
COMPUTER CONNECTORS ZX81 2 x 23 way edge connector	IDC CONNECTORS
wire wrap suitable for ZX81 add-ons	PCB Socket Edge Conn. Straight 10 way 90 85 120 10 way 145 125 195 20 way 145 125 195
Grey Ribbon cable. Price per metre 10 way . 38 34 way . 150 16 way . 55 40 way . 170 20 way . 80 50 way . 198	26 way 175 150 240 34 way 205 170 320 40 way 220 190 340 50 way 235 200 395

BOXES

BC140 BC141 BC142 BC143 BC147 BC148	28 30 25 25 8 8	BC BC BC	328 337 338 477 478 479	14 14 14 30 30 30	► BF244E BF245 BF256B BF257 BF258 BF259	30 45 32 25 35	MPSA 12 MPSA 55 MPSA 56 MPSU 05 MPSU 06 MPSU 55	30 30 30 55 55 60	TIS91 VN10KI VN46AI VN66AI VN88AI ZTX107	F 75 F 85 F 95
Plugs se Right a Socket Right a Covers	oider i			15 was 85p 180p 130p 210p 90p	25 way 125p 240p 195p 290p	37 was 170p 350p 290p 440p *		LELLE		Antex 2.3 ar CS 17 Antex

DIN	Plug	Skt	Jack	Plua	Skt
2 pin	90	90	2.5mm	10p	100
3 pin	120	10o	3.5mm	9p	90
			Standar		
			Stereo		
			4mm		
UHF (CB) (Conn	ectors:		
PL 259	Plug	40o	Reduce	er 14s	•
			nassis skt		
			hassis sk		

SPDT 80p. SPDT centre off 90p. DPDT 90p. DPDT centre off 100p. Standard toggle: SPST 35p. DPDT48p Miniature DPDT slide 12p. Push to make 14p. Push to thesk 22p. Rotary type adjustable stop. 1912W, 256W, 364W all 55p each. DIL switches: 4SPST 80p 6 SPST 80p. 8SPST	MICRO 66 66 2114L2 75 6 2716 205 6 2732 290 6 2732 290 6 2764 290 6 4116P 20 70 6 5101 L-1 220 6
SWITCHES Submin toggle: SPST 55p. SPDT 60p. DPDT 65p. Miniature toggle:	system; ten TTL c nels are used to sel phones, SP0256 990c
PL259 Plug 40p. Reducer 14p. S0239 square chassis skt 38p. S0239S round chassis skt 40p. IEC 3 pin 250V/6A. Plug chassis mounting . 38p. Socket free hanging . 60p. Socket with 2m leed . 120p.	Now your comput The GI SP0256 sp is able through sto synthesize speech. (extended phonen unlimited vocabul Easily interfaced w

Now your computer can talk. The GI SP0256 speech processor is able through stored program to synthesize speech. Allophone (extended phoneme) system gives unlimited vocabulary. Essily interfaced with any digital system; ten TTL compatible signals are used to select the allophones. SP0256 990p. Data: 50p.									
2114L2 75 2716 205 2532 290 2732 290 2764 540 4116P20 70 5101L-1 220	6116P3 320 6502CPU 325 6522 VIA 295 6532 570 6551 ACIA 650 6800 CPU 250 6800 CPU 250 6809 CPU 620 6810 RAM 115 6821 PIA 110 6840 360 6850 110								

VOICE SYNTHESISER!

►C106D 400V 8A 400V 12A

Antex CS 17W Soldering i 2.3 and 4.7mm bits to suit CS 17Wor XS 25W elemen Antex XS 25W 3.3 and 4.7mm bits to suit	t .	495 210 525 85
Solder pump desoldering t Spare nozzle for above 10 metres 22swg solder		70 100

TO Metres 225Wg S	Oldei	_	. 100
VERO			
VEROBLOC ◀ . Size 0.1 matrix:	,		350
2.5 x 1			22 75
2.5 x 5			85
3.75 x 5 VQ board	i		95 160
Veropins per 100: Single sided			50
Double sided . Spot face cutter .	-		105
Pin insertion tool Wiring pen and spo			162 310
Spare spool 75p		nbs	. 6

8228 8251 8253 8255 8259 MC1488 MC1489 Z80A CPU Z80A PIO Z80A SIO Z80A DMA

ohm - 1 ½W 5% ohm to	Carbo OM . Carbo 4M7 . metal	n film Et	1p each 12 series 2p each	Alfac tran type (e.g. Dalo etch Fibre glas Fibre glas Ferric Chi	DIL pads resistant s board 3. s board 8	s – plea etc.) pen .75 x 8" x 12"	ise s	
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4002	12	4021	40	404		4066	22	4
4006	50	4022	45	404		4067	225	4
4007	14	4023	16	404		4068	14	4
4008	36	4024	33	404		4069	13	4
4009	24	4025	12	404		4070	13	4
4010	24	4026	75	404		4071	13	41
4011	10	4027	20	404		4072	13	4
4012	15	4028	40	405		4073	13	4
4013	20	4029	45	405		4075	13	4
4014	45	4030	14	405		4076	45	4
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404	7 35	4070	13	4098	70	4515	115	4556	35
404		4071	13	4099	70	4516	55	4559	390
404	9 21	4072	13	40106	40	4518	40	4560	140
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LS01	11	LS27	12	LS85	48	LS136	26	LS164	40	LS242	55	LS368	29
LS02	11	LS30	12	LS86	16	LS138	30	LS165	55	LS243	55	LS373	58
LS03	.12	LS32	13	LS90	24	LS139	30	LS166	60	LS244	55	LS374	60
LS04	12	LS37	14	LS92	25	LS145	70	LS170	75	LS245	70	LS375	43
LS05	12	LS38	15	LS93	24	LS147	150	LS173	60	LS247	48	LS377	60
LS08	12	LS40	13	LS95	38	LS148	75	LS174	45	LS251	28	LS378	
LS09	12	LS42	28	LS96	95			LS175					57
						LS151	38		45	LS257	32	LS390	45
LS10	12	LS47	35	LS107	40	LS153	38	LS190	35	LS258	32	LS393	40
LS11	12	LS48	45	LS109	21	LS154	75	LS191	35	LS259	55	LS399	156
LS12	12	LS51	14	LS112	21	LS155	33	LS192	35	LS266	20	LS541	78
LS13	19	LS55	14	LS113	21	LS156	36	LS193	36	LS273	58	LS670	135
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7410 13 7438 24 7476 25 74107 22 74156 36	74180 38
7411 15 7440 14 7480 45 74109 24 74157 28	74181 100
7412 17 7442 30 7482 65 74121 24 74160 55	74182 55

SOCKETS	Low	Wire
	profile	wrap
8 pm	6p	25p
14 pin	8p	35p
16 pin	9p	42p
18 pin	12p	52p
20 pin	13p	60p
22 pin	16p	70p
24 pin	18p	70p
28 pm	23p	80p
40 pin	25p	98p
Soidercon pin	s 60P/100	

COMPONENT KITS

	or the beginner or the ex of components at great!	xperienced constructor v reduced prices, %W 5%
Resistor kit. Contains	10 of each value from 4.	
of 650 resistors)		530
	each value - 22p to 0.01	
	each value from 0.01 to	
Preset kit. Contains 5 c	of each value from 100 o	ohms to 1M (total
65 presets		425
Nut and Bolt kit (total	300 items): 180p	
25 6BA ¼" bolts	50 6BA washers	50 6BA nuts
25 6BA 1/2" bolts	25 4BA 1/4" bolts	50 6BA washers
50 6BA nuts	25 6BA 1/2" bolts.	

6852 6875 6880 81LS95 81LS96 81LS97 8080A 8085AC 8156 8212 8216 8224

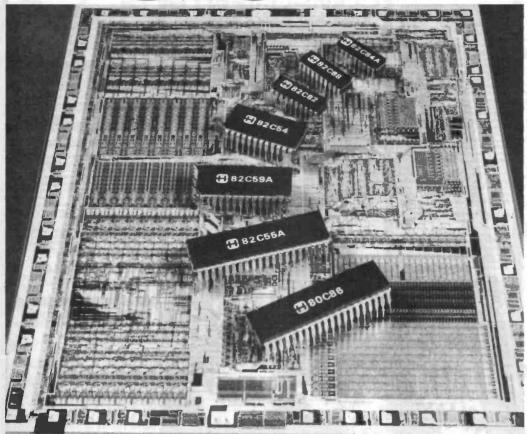
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DIGEST



16-Bit CMOS Micro

Harris Semiconductor has announced its 80C86 high performance CMOS 16-bit microprocessor and a family of peripheral devices. Intel Corporation, developer of the industry standard HMOS 8086, will also manufacture the new CMOS devices.

The Harris 80C86 is a completely compatible CMOS alternative for the Intel HMOS 8086. This includes pin-for-pin replacement, TTL level input/output specifications, performance parity at a 5 MHz system frequency

and complete software compatibility. The Harris CMOS 80C86 will operate with existing assembly and high level language programs.

The 80C86 features a standby power supply current of 500 microamperes maximum guaranteed over the full operating temperature and voltage ranges. The operating current 10 mA/MHz maximum dramatically lower than the HMOS 8086 which operates at 340 mA maximum at 5 MHz. With CMOS, operating power is reduced as the system's frequency is reduced. The static design of the 80C86 and all other members of the family allows system design

at lower frequencies (down to DC) to further reduce operating power. For maximum power reduction, the system clock can be stopped with all power requirements falling to the standby level (500 µA for the 80C86, 10 µA for other family members).

The Harris 80C86 is available now with a 5 MHz operating frequency. The 80C86-2, an 8 MHz system frequency compatible version, will be introduced later.

The 80C86 is packaged in the industry standard 40 pin 0.6" centre ceramic and plastic dual-in-line (DIP) packages. Harris/MHS Semiconductor, Harris Systems Ltd, 153 Farnham Road, Slough, Berks, tel 0753 34666.

Mr Kit Fix-It

There's a new service for all our not-so-nimble fingered readers, being offered by WEB Logic Systems Ltd. They will, for a fee (nothing in this life is completely free) build or repair your kit for you.

WEB say that they will also consider repairing any magazine project provided that it's built on a proper PCB, as published with the magazine article. What they suggest doing in either case is ringing them and talking over what's involved, and how much it's likely to cost. Alternatively, if you can't phone, they suggest sending the project in with all the information you have (instruction booklet or full magazine article, etc) and authorisation to debit your credit card by up to so much.

WEB say that they will have a

go at — and, more importantly, they have the equipment for — pretty well anything, because they've been offering a similar service to industrial clients for a while now. They expect to be able to turn most jobs around within five days of receipt of the gear.

Further information can be had from WEB Logic Systems Ltd, Gainsborough House, 15 High Street, Harpenden, Herts AL5 2RT, tel 05827 62119.

Breadboard '83

Preadboard '83 will be held on the 25th, 26th, and 27th November at the Cunard International Hotel, Hammersmith. This should make it a lot easier for many people to get to since Hammersmith has good rail and bus connections and the hotel is within a few hundred yards of two NCP car parks.

Breadboard has always had a friendly atmosphere regardless of where it has been held, and moving to the carpeted splendour of the Cunard Hotel should not only preserve this atmosphere but also ensure less wear on the feet!

The dates for the exhibition have been moved nearer to Christmas in response to popular demand... this way, the exhibitors are happy because the vistors are likely to spend more, and the visitors are better placed to drop hints to their loved ones about what they would like in their Christmas stockings instead of socks, after-shave, or cheap perfume!

At last year's exhibition the lectures proved a popular feature, so much so that at times the lecture room threatened to burst at the seams! This year we will again have a broad range of topics, so check well in advance and make sure you're there early to ensure a place.

Model railway enthusiasts will be interested in our computer controlled layout competition. The rules are very simple, amounting to little more than a restriction on the size of the layout.

Bearing in mind the crowds at last year's Computer Corner, the 'advice'/'hands on' area will be larger so as to be able to cope with all those would-be purchasers of computers.

For the benefit of those who live a long way from Hammersmith, we have arranged a special package deal that will include rail travel, first class hotel, breakfast, ticket to Breadboard, and various optional extras (tickets to shows, discount vouchers, etc). You can go to the exhibition while your boy/girl friend, husband/wife or whatever does the Christmas shopping and then meet up afterwards.

Breadboard will continue as an exhibition for the enthusiast (or would-be enthusiast!) in the world of electronics. There will be no three ring circuses, fashion shows or the like, just components, magazines, books, equipment, projects, and all the assorted peripherals in which you the reader (enthusiast?) are interested.

HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall paying and on the property of lighting.

TDR300K Remote Control E14.30 Dimmer

MK6 Transmitter for above £ 4.20

TD300K Touchdimmer £ 7.00

Touchswitch £7.00 TDE/K

Extension kit for 2-way switching for TD300K £ 2.50

Rotary Controlled LD300K £3.50



ELECTRONIC LOCK KIT XK101

This KIT contains a purpose designed lock IC. 10-way keyboard, PCBs and all components to construct a Digital Lock, requiring a 4-key sequence to open and providing over 5000 different combinations. The open sequence may be easily changed by means of a prewired plug. Size: 7 x 6 x 3 cms. Supply: 5V to 15 V d.c. at 40uA, Ouput: 750mA max. Hundreds of uses for doors and garages, car anti-theft device, electronic equipment, etc. Will drive most relays direct. Full instructions supplied. ONLY £10.50

Electric lock mechanism for use with latch locks and above kit £13.50

"OPEN-SESAME"

The XK103 is general purpose infra-red transmitter receiver with one momentary (normally open) relay contact and two latched transistor outputs. Designed primarily for controlling motorised garage doors and two auxiliary outputs for drive garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.

lights, IV, closing curtains, etc. Ideal for aged or disabled persons. The Kit comprises a mains powered receiver, a four button transmitter, complete with pre-drilled box, requiring a 9V battery and one opto-solated solid state switch kit for inter-facing the receiver to mains appliances. As with all our kits, full instructions are

ONLY £23.75

XK113 MW RADIO KIT

Based on ZN414 IC, kit includes PCB, wound pased on Investigative, it includes PCs, would aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5.5 × 2.7 × 2cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. £5.00

3-NOTE DOOR CHIME

Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 × 71 × 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK 102. £5.00

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MINI KITS

MK1 ELECTRONIC THERMOSTAT Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater (1KW). Mains powered. £4.00

(TKW). Mains powered. E4.00 MK2 SOLID STATE RELAY Switches 240V ac motors, lights, heaters from logic/computer circuits. Zero voltage switching, opto-isolated. Supplied without triac

Supplied without triac 22.80 MK4 PPO-PORTION TO TEMPERATURE CONTROLLER
Uses "burst fire" technique to maintain temperature to within 0.5°C. Ideal for photography, incubators, wire making, etc. Max. load 3KW 1240V ac). Temp. range up to 50°C. E5.55 MK5 MAINS TIMER Mains powered timer enabling a load up to 1KW at 240V ac to be switched

up to 1KW at 240V ac to be switched on (or off) for a variable time from 20 mins. to 35 hrs. Longer or shorter periods possible with minor component changes. £5.00 MK15 OUAL LATCHED SOLID STATE RELAY

STATE RELAY
Comprises two MK2s with latch circuit
enabling the MK12 kit to control two
mains loads independently. Two
output triacs pot supplied: (See
remote control kits.)

£4.50

NEW! MK19 DC CONTROLLED AUDIO AMPLIFIER

AUOIO AMPLIFIER
May be used with virtually any stereo
audio amplifier to control bass,
volume, treble and balance remotely
either using a wire link or the MK11
infra red receiver. A 1 of 10 decoder
with LEDS is also included for remote control kits.) £10.70

COMPONENTS a wide range in stock including:

LM3911 1.20 LM3914 2.10 LM3915 2.20 LM13600 REGU 4511 .55 LATORS 4514 1.15 78L05, 12, 15 .26 79L05, 12 ORUS 15, 60 2114 .80 7805 .40 2114 .80 7905 .40 2732 4.80 LM317T 1.80 MICROS

TDA 1024 1,20 TDA 2020 285 TDA 4290 TL061 40 11,062 60 TL064 98 TL071 30 TL072 50 TL074 95 TL084 95 TL084 95 TL084 95 TL084 95 TL084 95 TL170 50 TL507C LM 13600 L LS7220 2.75 LS7225 2.05 LS7225 2.05 MF10C 3.00 MI.922 4 10 MI.924 1.95 MI.925 2.10 MI.925 2.10 MI.929 1.40 MI.929 AD590 3.30 AY-3-1270 7.00 ICL7107 9 00 ICL7126 TL507C 1.80 UA2240 1.20 ULN2003 .80 ULN2004 B.00 3.10 CMOS 555 ULN2004 85 ZN414 .98 ZN425 3.40 ZN427 5.70 ZN428 4.10 ZN1034E 1.80 LM339 50 LM348 63 LM358 45 LM377 1 45 LM380 80 LM381 1.15 LM382 1.00 LM386 75 LM1458 35 LM1630 TRIACS

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04006LT .85 MOC3020 1.10 Diac .18

LM338K 4.60 LM723 .40

CMOS

Red 9p Green or Yellow 12p Flashing Red - 49p Flashing Continuous Red 52p Tri Colour 5mm Round Sop Rectangular Rectangular 55p

Z80A cpu 2.85 Z80A ctc 2.80

2.50 8035L 5.50

280A p

This kit enables you to control up to 16 different appliances anywhere in the house from the confort of your armaniar. The transmitter injects coded pulses into the mains which are decoded by receiver modules connected to the same mains supply and used to switch on the appliance addressed. The transmitter also includes a COMPUTER interface so you can programme your favourite micro (sg. 2X81) to switch lights, heating, electric blankst, make your morning coffee, etc., automatically without rewiring your house. JUST THINK OF THE POSSIBILITIES. The kin includes all PCBs and components for one transmitter and two receivers, plus a pre-drilled box for the transmitter. Order as XK112. £42.00 Additional Receivers XK111 £10.00

REMOTE CONTROL KITS

Supplied with nano-new pressure 24.
MK7 INFRA REO RECEIVER
Mains powered with trisc output to switch up
500W et 240V sc. Range approx. 20 ft. on/off

DISCO LIGHTING KITS

DL 1000K
This value for money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control. £14.60

DLC 1000K.

A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum.

Optional opto input DLA1 Allowing audio ("beat") — light 60p

DI.3000K
This 3 channel sound to light kit features
zero voltage switching, automatic level
control and built min. No connections to
speaker or amprequired. No knobs to adjust
- simply connect to mains supply and
lamps. (IKW channel)
Only £11.95

LCD 31/2 DIGIT MULTIMETER 18 renges including DC voltage (200 mv-1000 v) and AC voltage, DC current (200 mA-10 A) and resistance (0-2 M) + NPN & PNP transistor gain and diode check. Input impedance 10M. Size 155x08/21 mm. Requiree PP3 9 bettery.

Test leads included ONLY \$23.60

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This kit enables you to control up to 16 differen

DLZ1000K

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master

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MICROPROCESSOR CONTROLLED **MULTI-PURPOSE TIMER**

Now you can run your central heating, lighting, hi-fi system and lots now you can run your central heating, lighting, hi-fi system and lots now with just one programmable timer. At your selection it is lesigned to control four mains outputs independently, switching on and off at pre-set times over a 7 day cycle, e.g. to control your central leating (including different switching times for weekends), just connect it to your system programme and set it and forget it—the lock will do the rest.

FEATURES INCLUDE:

- EATURES INCLUDE:

 /mm LED 12 hour sollary

 Day of week, am pm and output status indicators

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 30 60Hz mans operation

 Battery backup saves stored programmes and continues time keeping during power failures. Blattery not supplied:

 Battery backup saves stored programmes and continues time keeping during power failures. Blattery not supplied:

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 Battery backup saves stored programme time sets.

 Powerful Everyday 'Innicion enabling output to switch every day but use only one time set.

 Useful 'sleep' function turns on output for one hour after a specify function. Turns on output for one hour after a specify function.

 Direct switch control enabling output to be turned on immediately or after a specified time interview.

 20 function keypad for programme entry.

 Programme verification at the touch of a button.

 Plassic box with attractive screen printed front panel 15 10 5.5cm.

box, assembly and programming instructions) Order as CT6000

XK114 OPTIONAL RELAY KIT Kit includes one relay. PCB to accommodate up to four relays, terminal blocks, etc.; to fit inside: CT6000 box: Provides up to

£3.90 Additional relays £1.65 eac

Now only £39.00

(Kit includes all components, PCB, 24 HOUR CLOCK/ APPLIANCE TIMER KIT

Switches any appliance up to 1kW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triecs, PCBs and full instruction

CT1000KBasicKit £14.90 CT1000K with white box (56.131×71mm) £17.40 (Ready Built) £22.50



NOOM 45 1404 x 8 hase septer 20 ft on 28.00 (RC 500K - pecial price for MK6-MK7 momentary control. (RC 500K - pecial price for MK6-MK7 MK9 4-MK7 KEYBOARD For use with MK 18/MK 12 transmitter receiver where only 4 channels are required 1.30 MK10 16-WAY KEYBOARD MK11 10 themal > 3 anasopue of priced provided to 10 million of 10 million 10 million of 10 million 10

DVM/ULTRA SENSITIVE

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THERMOMETER KIT
This new design is based on
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Multi-Purpose Scope

Brown Boveri claim to have scored a world first with their M2050 Digital Scope Multimeter. Measuring a mere 257 × 169 × 88 mm this (almost) pocket sized instrument combines a 3½ digit, 32 range digital multimeter, a digital oscilloscope featuring a 128 × 64 dot matrix flat screen display, and a transient recorder with two independent 512 × 8 bit memories.

The M2050 will operate for up to eight hours on its internal NiCad batteries and when switched off will retain information stored in the transient recorder memory for up to three months. One set of input range switching serves both the multimeter and the oscilloscope and the two outputs are displayed simultaneously. The multimeter features AC, AC/DC, and DC operation, will operate down to 15 Hz, and has a true RMS option available on the AC and AC/DC ranges. The oscilloscope has comprehensive triggering facilities, a choice of eight timebases ranging from 100 uS/div to 6 minutes/div, and a roll facility which allows slowly changing inputs to be displayed without irritating flicker. The transient recorder has a maximum sampling rate of 500 kHz and features a save facility which prevents accidental overwriting of stored data.

The manufacturers claim that combining three instruments in this way reduces costs by eliminating unnecessary duplication of common circuitry and speeds up measurement by removing the need to connect up several (often incompatible!) instruments. Aside from such obvious advantages as saving space in the lab and enabling the service engineer to make more sophisticated on-the-spot measurements, suggested applications include the measurement and recording of such variables as temperature and pressure in the

The instrument is available as described for £975, or with the addition of a hard copy output for £1150, from John Minister Instruments, 137-139 Sandgate Road, Folkestone, Kent CT20 2DE, tel 0303 41598.

Portable Computer

Immediate Business Systems have introduced NOMAD, a portable computer the size of a book yet half the weight and which offers the power of a desktop computer.

Nomad provies up to 256Kbytes of non-volatile bubble memory and has been specifically built for outdoor and harsh environment applications, so it is totally waterproof and shock resistant and can operate within temperature ranges of -30°C to +70°C.

Using Microsoft M-BASIC 80 software, Nomad can be programmed directly on its full alphanumeric keyboard, or can loaded with software developed on any CP/M-based microcomputer. Nomad has a two-line 80 character display panel, but can also be connected an inbuilt interface (V24-V28/RS232) to drive a visual or display unit printer. Rechargeable batteries make the Nomad totally portable for in the field computing, and the use of a Z80 microprocessor provides fast processing and conservation of power.

Nomad is ideally suited for all applications where portable data processing is required, including such computer-unfriendly environments as oil exploration, steelworks, coal mines, construction, military, etc. Immediate Business Systems plc, 3 Clarendon Drive, Wymbush, Milton Keynes MK8 8DA, tel 0908 568192.

Superbrush

The Superbrush is a compact tool which will clean and polish a variety of surfaces including, but not limited to, metallic materials. Applications include PCB track cleaning, switch and battery contact cleaning, rust removal, etc.

The brush length is controlled by a knurled cap to give a cleaning action ranging from fine

Computer Drive Amplifier

Following the launch of its first computer-drive New Class A amplifier, the SU-V303, Technics have now introduced two further models, the SU-V505 and the SU-V707. Unfortunately, they forgot to send us any bumf on the SU-V707 so we can only tell you about SU-V505!

The SU-V505 incorporates a number of special features. The Computer Drive New Class A system is designed to eliminate transient crossover distortion: sensors feed information on signal level and transistor temperature to a microprocessor which then calculates the optimum bias. To combat electromagnetically induced distortion, all the high current circuitry is placed in what Technics call a concentrated power block, effectively isolated from the rest of the amplifier. Other features claimed for the amplifier include the use of linear feedback (no, we don't know what it is either) as opposed to mere negative feedback and a computer controlled protection system. Output is 2 x 60 W into 4 or 8 ohms, both channels driven, with distortion at no more than 0.004% (still rather worse than our own NDFL amp . .).

Available in either black or silver finish, the SU-V505 sells for £177.95 and is available through Technics' nationwide dealer network. National Panasonic (UK) Ltd, 300-318 Bath Road, Slough, Berkshire, tel Slough 34522.

emery cloth to coarse sandpaper. Twist the cap to expose a long brush length for a fine abrasive action, retract the brush until the bristles just protrude for a coarse action.

Recommended retail price of the Superbrush is £2.29 and inquiries are welcomed from stores and distributors as well as end users. Eraser International Ltd, Portway Industrial Estate, Andover, Hants. SP10 3LU.

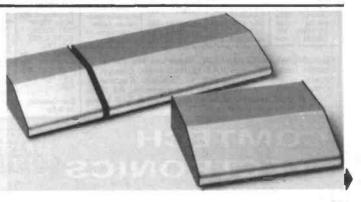
Desk-Top Cases

A new, lightweight case intended primarily for desk-top applications is now available from West Hyde.

Attractively styled with smooth contours, the Empress case is manufactured from 2mm aluminium and has a black and natural anodised finish. It has a sloping top surface at the front

which places switches, knobs and meters at an ideal angle. The four sizes available all have a common profile, so that two or more can be placed side by side on a worktop to form attractive 'suites'.

The Empress case comes complete with self-adhesive feet and is available ex-stock from West Hyde Developments Ltd., Unit 9 Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET, tel 0296 20441.



			LECI	INCIVICS
BC 2148	10p 8F 195 12p 12p 9p 8F 197 12p 9p 8F 197 12p 9p 8F 198 10p 9p 8F 198 10p 9p 8F 198 12p 9p 8F 198 12p 9p 8F 198 12p 9p 8F 198 12p 9p 8F 290 40p 8F 224 15p 8F 224 25p 9p 8F 256 32p 10p 8F 256 32p 9p 8F 256 32p 9p 8F 256 32p 9p 8F 256 32p 9p 8F 258 32p 9p 8F 258 32p 9p 8F 258 32p 9p 8F 258 32p 32	MPSA 55	C 126B 90p 4001 C 126B 90p 4002 C 126B 90p 4006 MCR 101 30p 4006 MCR 102 34p 4007 D	14p
CA 3065 190p LM 567 1 CA 3080 72p LM 709 CA 3080 56p LM 710 CA 3080 170p LM 711 CA 3080 170p LM 711 CA 3130E 95p LM 747 CA 3140E 44p LM 748 CA 3160E 100p CA 3240AE MC 1455 CA 3240E 110p CA 3240E 110p CA 3240E 100p CA 8100M 250p MC 3401 LF 351 45p MC 1458 LF 353 80p LF 355 85p LF 356 88p LF 356 88p LF 357 110p LM 301 A2 6p LM 311 60p LM 324 40p LM 339 46p LM 339 46p LM 338 48p LM 338 68p LM 338 68p LM 5571 33	DB SAA5050 £10 SAA5050 £10 SAA5052 £10 SAA5052 £10 SL490 300p SN76115 98p SN76166 90p TBA120S 70p TBA52002200p TBA52002200p TBA55002200p TBA655 240p TBA655 100p TBA655 100p TBA650 70p TB	CAPACITORS	NA	## ## ## ## ## ## ## ## ## ## ## ## ##

CA 3065 190p	LM 567 150p	SAA5050 £10
CA 3080 72p	LM 709 35p	SAA5052 £10
CA 3086 56p	LM 710 70p	SL490 300p
CA 3089 170p	LM 711 60p	SN76115 98p
CA 3090AQ	LM 733 75p	SN76660 90p
300p	LM 741 14p	TBA120S 700
CA 3130E 95p	LM 747 50p	TBA120S 70p TBA520Q200p
CA 3140E 44p	LM 748 35p	TBA550 240p
CA 3160E 100p	LM 1458 36p	T8A570Q200p
CA 3161E 140p	LM 3900 47p	TBA625 100p
CA 3240AE	MC 1455 16p	TBA800 70p
165p	MC 1458 34p	TBA810AS95p
CA 3240E 110p	MC 1496 70p	TBA810S 950
CA 3260E 100p	MC 1748 35p	TBA820 75p
CA 810QM	MC 3302 72p	TBA820M 78p
250p	MC 3401 68p	TBA920 195p
LF 347 160p	MC 3403 65p	TBA950 210p
LF 351 45p	NE 529 220p	TCA270 120p
LF 353 80p	NE 531 160p	TCA800 250p
LF 355 85p	NE 532 56p	TCA940 180p
LF 356 88p	NE 544 200p	
LF 357 110p	NE 550 160p	TDA1022550p
	NE 555 16p	TDA1024 130p
LM 301A 26p	NE 556 45p	TDA2002100p TDA2003150p
LM 307 54p	NE 558 170p	TDA2003180p
LM 311 60p LM 318 120p	NE 565 410p	TDA2004295B
LM 318 120p LM 324 40p	NE 560 150p	395p
LM 339 46p	NE 567 110p	TDA2006240p
LM 348 60p	NE 570 350p	TDA2000250p
LM 358 48p	NE 571 320p	TDA2030220p
LM 380 68p	NE 644 380p	TDA2040450p
LM 380-8 80p	NE 645 270p	TDA2054M
LM 381 140p	RC 4558 48p	130p
LM 381 120p	SAA1027 5 50 p	· ·
LM 384 125p	SAA1056 4950	TL061 40p
LM 386 68p	SAA5000 350p	TL062 80p
LM 387 135p	SA A5010 580p	TL064 120p
LM 393 70p	SAA5020 620p	ULN2001 85p
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SAA5010 580p SAA5020 620p SAA5030 £10 SAA5040 £18

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25° 6p
63° 7p
16 6g
25° 6p
63° 9p
63° 12p
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10° 8p
10° 8p
10° 8p
10° 10p
25° 14p
25° 14p
25° 20p
10° 32p
25° 28p
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CP103 20 BC184/BC214 transistors, 10 of each	130g
CP104 20 BC549C/BC559C transistors, 10 of each	130p
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Fibre-Optic Lasers

wo new CW-operated injec-Two new Cvy-operates ..., series of long wavelength tranpreamplifier simpedance photodiode modules have been announced by RCA, designed specifically for fibre-optic communications systems.

The C86041E (pictured below) is a gallium-aluminium-arsenide CW laser module with an output wavelength of 820 nanometers which is well-matched with the wavelength of silicon photodiodes. The C86042E is an indium-gallium-arsenide-phosphide CW laser module with an output wavelength of 1300 nanometers which well-

matched with the wavelength of InGaAs/InP photodiodes. Both types are constructed with a 0.5 meter length of fibre-optic cable internally coupled to the emitting region of the laser chip and are supplied in a special dual-in-line package for simple mounting and good thermal dissipation. The package also contains photodiode which monitors the laser output, and which may be used in a negative feedback circuit to stabilise the output of the laser. An RTD temperature detector is provided for high duty-cycle pulsed operation at case temperatures up to 70°C.

The C30986E Series are high speed InGaAsP (p-i-n) photodiodes with hybrid preamplifier supplied in a 14-pin dual-in-line package. A glass window provides optical access to the photodiode and a 50 um graded index fibre pigtail is included. This device provides high responsivity between 900 and 1700 nanometers and is optimised for the detection of 1300 and 1550 nm sources.

Additional information may be obtained from RCA Electro-Optics and Devices, Lincoln Way, Windmill Road, Sunbury-on-Thames, Middx. TW16 7HW, tel 09327 85511.

New Op-Amps

Burr-Brown International have introduced two new operational amplifiers - a high power hybrid and a low bias current monolithic device with a IFET in-

The OPA501 is rated for continuous 80 W operation and will withstand peaks of at least 200 W without damage. It can deliver 10 amps peak into a 2 ohm load. 4 amps continuously into 5 ohms, and has output current limiting to protect both the amplifier and the load in the event of excessive drive or a fault occurring. Unity gain bandwidth is 1 MHz and the full power bandwidth is typically 16 kHz. Common mode input impedance is 250 M ohms and differential configuration input im-

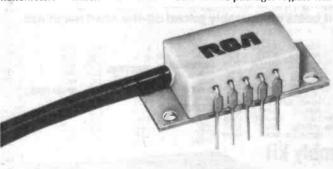
aren't more controls and audio amplifiers.

The OPA100 IFET monolithic operational amplifier has a bias current of less than 0.5 pA at room temperature and less than 1 pA at 75°C but does not sacrifice performance in other areas to achieve this. Maximum offset voltage is 250 uV, offset voltage drift is 5 uV/°C maximum, and input impedance is 1012 ohms. All specifications are guaranteed over the temperature range - 25°C to +85°C.

pedance is 10 M ohm.

The device is housed in an eight pin TO-3 package, the outer can being electrically isolated in order to simplify heat sinking power devices?). The OPA501 is designed to operate on supplies from \pm 10 V to \pm 36 V, and is very tolerant of supply voltage variations. Suggested applications include servo amplifiers, actuator

Supplied in an eight-pin TO-99 package, the OPA100 uses the standard 741 type pin connections. Suggested applications include current-to-voltage convertors, precision sample and hold amplifiers, and voltage amplification in high impedance circuits using biological probes, pH electrodes, etc. Burr-Brown International Ltd, Cassiobury House, 11-19 Station Road, Watford, Herts WD1 1EA.



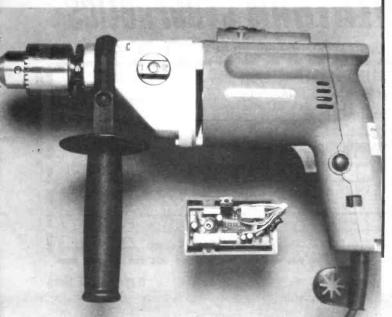
Motor Speed Controller

Ferranti Electronics has recently introduced the ZN411E which, with a minimum of external components, provides precise speed control for electric motors.

Originally designed for use in a professional power drill made by a well known UK power tool manufacturer, the ZN411 will operate from the AC mains or a suitable DC supply and has an on-chip shunt regulator. The circuit has a power down reset

facility and a 'soft start' capability whereby the speed builds up smoothly to the set speed. It produces negative triac firing pulses and has a triac retrigger facility. A reversing input on the chip will stop the motor, which then goes through the soft start to reach the speed set for the reverse direction.

The device is available in an 18 lead plastic Dual in Line package. Details from Ferranti Electronics Limited, Fields New Road, Chadderton, Oldham, Lancashire, OL9 8NP, tel 061-624 0515.



Small Memory

W ANG Laboratories Inc, has introduced a low-cost highdensity dynamic random access memory module. Called SIMM. (single in-line memory module) the module more than quadruples the density of the memory that can be positioned within a specified printed circuit board area, using industrystandard mounting practices.

Measuring only .75 x 3.00 inches, the WANG SIMM integrates nine separate 64K DRAMs and related decoupling chip capacitors into 64K bytes of related memory with parity (error detection). Suitable for either direct mounting or socketing on a PCB, the module offers the potential for clustering as much as one full megabyte of memory within a three-by-four-inch area of the PCB. WANG say that the SIMM could significantly lessen the need for 256K technology, since it is denser than 256K and is available now. WANG UK, 661 London Road, Isleworth, Middlesex TW7 4EH, tel 01-560 4151.

New CCDs From Plessey

Plessey have introduced four new CCD arrays: MS1002-1 and 2 850 bit registers. and the MS1003-1 and 3 910 bit registers. All these devices are intended for video line storage, an application to which CCDs seem to be well suited.

The MS1002-1 is for analogue storage with interrupted clocks; the MS1002-3 is for delay-line operation with a continuous clock. Both have a video bandwidth of over 5 MHz with a clock frequency of 13.3 MHz, three times the PAL sub-carrier frequency.

The MS1003-1 and 3 are similar, but are intended for use with a 14.3 MHz clock, four times the NTSC colour sub-carrier frequency.

The advent of satellite TV, if it ever does happen, will increase the damand for storage facilities within receivers; as regular readers may recall, the C-MAC system chosen for UK transmissions involves a large degree of time-multiplexing of the TV signal, as opposed to frequency multiplexing which is the predominant form used at the moment. Plessey Semiconductors, Cheney Manor, Swindon, Wilts SM2 1QW, tel 0793 36251.



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- Full renumber command
- Simple but powerful line editor
- Buffered i/o allows you to continue executing the program while still printing
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- Over 34K bytes available for basic programs
- Extended basic includes IF-THEN-ELSE
- Supports up to 16 output devices:
 Screen and cassette interfaces included as standard
- 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!

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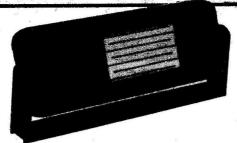
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Competition

Registrook of Reading have challenged the electronics world to a test of imagination with an astonishing new device—the problem is that they can't think of any use for it!

The device is a highly effective portable humidity sensor — so sensitive that it will react to the moisture in exhaled breath at a distance of two feet. It is battery powered and pocket sized, with an adjustable mounting bracket and no on/off switch. The unit features a sensing grid of interleaved gold filaments on a ceramic substrate, a robust plastic case, and hermetically sealed electronics for long term stability. It has an integral alarm

bleeper which cannot be / triggered by short circuiting the gold grid and which stops when the sensing grid is wiped dry.

A grand prize of a magnum of champagne, and ten second prizes of the actual moisture sensors are offered by Regisbrook for the best suggestions (serious or imaginative) of what to do with the things. Ever anxious to be of service (and to assist in the disposal of alcoholic beverages) ETI would like to suggest that a few samples be sent to Conservative Central Office for use in the selection of suitably 'dry' parliamentary candidates. Readers with better suggestions should contact Regisbrook Ltd., Studio House, 215 Kings Road, Reading, Berks.

Shorts

- Not one but two catalogues from Ambit! One is aimed at industrial and commercial users and comes free on request; the other is for lesser mortals and costs 80p from your friendly local newsagent. Ambit International, 200 North Service Road, Brentwood, Essex CM14 4SG.
- Concerned Technology, an exhibition of microprocessor based aids for the disabled and those with special needs, begins its twenty-nine stop tour in Hastings on September 8th. Details from Nancy Shawcross or Sue Hardwick on 01-789 4055/6.
- Silicon Valley, eat your heart out! The London borough of Islington is so proud of its local micro-electronics industries that it has made a film about them. "Silicon Green" runs for thirty minutes and is available to schools, business promotions, etc. Contact Jane Smith, 01-226 1234, ext. 268.
- NAHBO, the National Association of Hospital Broadcasting Organisations, is holding its autumn conference at the Ladbroke Mercury Hotel, Watford, on 14th/16th October. Exhibitors and individuals interested in Hospital Radio are welcome. NAHBO, 56 Fleet Road, Benfleet, Essex SS7 5IN.

- Sinclair Research are offering a ZX81, a 16K RAM pack, and a software cassette all for £45. Available for a two month trial period, the 'starter pack' will save you £30 on current prices and is on sale at Boots, John Menzies, and other Sinclair stockists. How long will it be before they start giving away computers with packets of breakfast cereal?
- The Intron IFG 422 is a 0.1 Hz to 2 MHz function generator offering sine, square, triangle, ramp, and pulse waveforms. It has 50 ohm and TTL outputs, is light and compact, and costs £195 from House of Instruments, Clifton Chambers, 62 High Street, Saffron Walden, Essex CB10 1EE, tel 0799 24922.
- Cable Check FC is a bench top go/no-go tester for insulation displacement type ribbon cables. It can test all cable/connector combinations up to 37 ways for both continuity and shorts. Cable Check Systems, Sanderson Centre, Lees Lane, Gosport, Hants, tel 07017 28396.
- The South Coast Hi-Fi Show will be taking its bucket and spade and an awful lot of audio goodies down to Brighton on the 11th, 12th and 13th November. Venue is the Royal Albion Hotel, Old Steine, and details are available from Tim Purcell, 137 Marina, St. Leonards-on-Sea, East Sussex TN38 0BT, tel 0424 715133.

Improve Your Knowledge Here

alling all would-be hams! Bradford & Ilkley Community College are running a 1 year course in preparation for the Radio Amateurs Examination. Enrolment starts on 6th interested September. Those should contact P. Nurse, Course Tutor, Bradford & Ilkley Community College, Great Horton Road, Bradford, West Yorkshire BD7 1AY.

For those unable to get to Bradford, Frank Fear is running a similar course at Barr Beacon Comprehensive School, near the M5/M6 junction. Enrolment is on 22nd September and there's even a special 10 week crash course for those with basic electrical knowledge. Further details, telephone Aldridge 52706.

If amateur radio isn't your scene why not try Information

- Market Logic's new Macrobyte printer buffer stores computer data output until the printer is ready for it, allowing the computer to carry on at its own speed. Designed to work with a Centronics interface, the Macrobyte comes in 16 k, 32 k and 64 k versions and prices start at £99.95. Tel 0432-70 456.
- Alcon Instruments claim their new pocket sized direct reading capacitance meter is as good as most bench-mounted bridges. The CP570 has five ranges from 0-50 pF up to 0-0.5 uF, a three inch meter scale, a basic accuracy of ± 3% and costs £51.06 complete with leads and case. Alcon Instruments Ltd, 19 Mulberry Walk, London SW3, tel 01-352 1897.
- ◆ Advanced Micro Devices now have available a 256 K EPROM which has an access time of only 170 nS. The Am27256 is organised as 32 K × 8 bits, requires a single 5 V supply, has TTL compatible inputs and outputs and uses the standard 28 pin configuration. Advanced Micro Devices (UK) Ltd, AMD House, Goldsworth Road, Woking, Surrey GU21 1JT, tel 04862 22121.
- For those whose penchant is listening to Stockhausen in the sauna, Fuji have introduced a high temperature cassette tape. The GT-1 will withstand 110°C (230°F) without damage to either shell or tape and is intended for use in cars. Bell & Howell, Alper-

Technology? Thames Polytechnic's new four year honours degree course starts in October and includes a year's industrial experience. Details from the Academic Registrar, Thames Polytechnic, Wellington Street, Woolwich, London SE18 6PF.

Salford University are running a series of one and two day courses on various aspects of the CBM/PET microcomputer. The first course starts on 13th September and the complete series will be repeated in three months time. For details, telephone 061-736 5843, extension 248.

Would-be movie directors should take their megaphones and folding chairs down to Piccadilly where JVC are holding two and three day courses in video production. The courses, which cater for both beginners and the more advanced, are repeated twice monthly. Dates, etc from Phil Compton or Mike Whyman at the JVC Video Information Centre, 82 Piccadilly, London W1, or telephone 01-491 3775.

ton House, Bridgewater Road, Wembley, Middlesex HA0 1EG, 01-902 8812.

- Just when you'd got all your accessories colour coordinated, Hanimex go and introduce their LC751. Described as a high fashion calculator, it is superslim and has a glossy black lacquer finish highlighted by gold keys and trim. And when fashions change, you can always use it to work things out on!
- With one snap of their powerful jaws, 3M's new TH212 and TH213 will strip both solid and stranded wires without damage to the conductor. The TH212 covers wires from 0.2 mm to 0.9 mm and the TH213 covers wires from 0.75 to 6 mm, both types adjusting automatically to all wire sizes within their range. 3M UK, 3M House, P.O. Box 1, Bracknell, Berkshire RG12 1JU, tel 0344 26726.
- Roxburgh Suppressors Ltd have introduced two mains filters designed for direct mounting onto printed circuit boards. The PC103 and PC105 are rated at 3 and 5 amps respectively and are full encapsulated. Roxburgh Suppressors Ltd, Eagle Road, Rye, East Sussex, tel 07973 3725.
- An Apple a day has clearly done wonders for the California based computer company. They've just produced the one millionth Apple personal computer and to celebrate are giving an Apple Ile to every school in the state.

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TYPEWRITER INTERFACE

Daft, isn't it? You can't get a daisy-wheel printer for less than about £400, but you can buy daisy-wheel typewriters containing not just the printer, but a keyboard and some electronics for just over £200. Jon Tyler shows us how you can interface one to your micro.

he Silver Reed EX 42 typewriter is logically divided into two parts. The keyboard is controlled by its own 8049 microcontroller while the printing mechanism is controlled by an 8039 with an EPROM containing the software appropriate to printing the required character set. Information is passed between these devices using a serial interface. It is possible to interface to the machine via an edge connector on the main PCB but if it is to be used as an output device only, a simpler interface may be constructed which operates in parallel with the existing keyboard.

The keyboard is arranged as a 8 × 8 array of keyswitches which are positioned according to the normal QWERTY convention. There are 25 connections made between the keyboard and the electronics, these taking the form of one 10-way and one 15-way ribbon cable connector. The modification to the typewriter is to disconnect these and reconnect them through suitable plug-socket pairs. In the prototype, these connectors were made from a 40-way wire-wrap IC socket cut into suitable lengths.

Construction

The prototype was constructed in a plastic box measuring about 3" by 4.5" by 1.5". A 26-way ribbon cable and matching connector was used to connect to the typewriter and a 12-way connector used to connect to the micro-computer parallel port. The ribbon cable was connected to the typewriter using the home-made adaptors shown in Fig. 5. These were made by cutting a 40-way wire wrap socket into 10

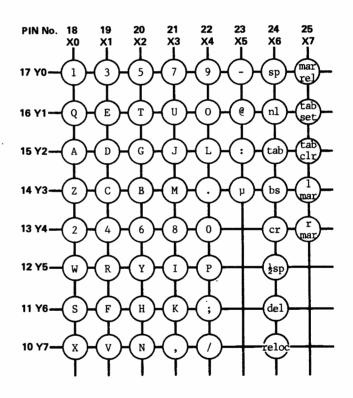
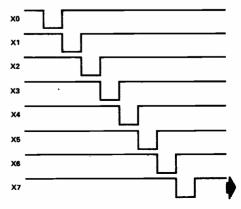


Fig. 1 (above) Keyboard matrix with pin connections.

Fig. 2 (right) How the typewriter scans the input multiplex lines to the keyboard.

and 15 way lengths which were soldered to strips of Veroboard. The ribbon cable was then soldered to these adaptors, the 26th way being left free and fitted with a solder tag.

The typewriter cover is removed by unscrewing the two grub screws at either end of the platen (roller) using an Allen key. Remove the



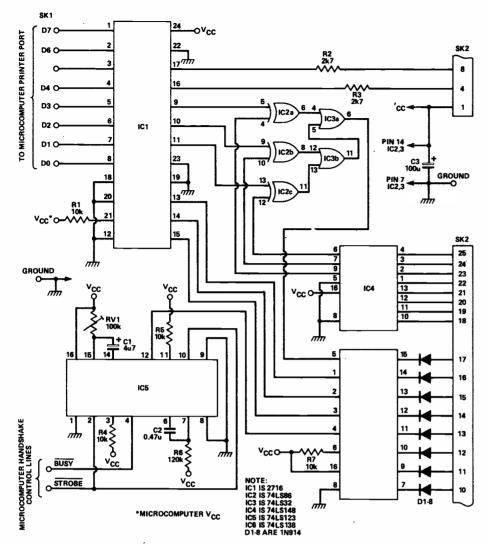
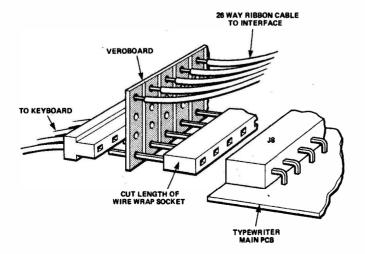


Fig. 3 Circuit diagram for the interface.

= BUYLINES =

The only difficult item here is the wire-wrap socket. We suggest you experiment with any odd DIL wire-wraps you may have around before splashing out on anything fancy. 26 way ribbon cable is easily obtained by chopping up 30 or 34 way, etc. RV1 is available from Maplin,

the 26 way PCB plug and socket from Ambit, the 2716 and other semiconductors are available from several of our advertisers, and the PCB can be obtained from you-know-where (but see page 77).



HOW IT WORKS

The microcomputer is programmed to put out an 8 bit ASCII coded character via a parallel port. The codes used to denote the X and Y position of the typewriter keys do not correspond to the ASCII codes, and upper and lower case character are selected by pressing the 'shift' key. Each character to be printed by the microcomputer must therefore be translated into the required 3 bit X and 3 bit Y code together with the one bit shift code. This may be achieved either in the microcomputer software (see Fig. 6) or alternatively by programming a suitable EPROM. A listing of the required codes is given in Table 1.

The eight 'X' lines X0 to X7 are scandal but the translater of the codes is a suitable to the translater of the codes.

The eight 'X' lines X0 to X7 are scanned by the typewriter as shown in Fig. 2. These lines are connected to 1C1 in the interface which encodes the 8 line signal into a 3 bit code. The three outputs A0, A1 and A2 from this priority encoder form the logical inverse of the 3 bit column number which corresponds to the 'X' line currently enabled. These three bits are compared with the least significant 3 bits of the output byte using IC3 and IC4 which perform an exclusive-OR operation. When a match occurs, pin 6 of IC4 goes low and this is used to control the 'Y' outputs.

The pressing of a key is detected in the typewriter by reading in the eight-bit value on the 'Y' lines and comparing this with the previous value. When a key is pressed, the corresponding 'Y' line, which is normally held at '1' by a pull-up resistor, will be made 'O' when the appropriate 'X' line is enabled. The typewriter saves the current 'X' (rolumn) code together with the 'Y' (row) code whenever a 'Y' line goes low. To simulate this, a 3 line to 8 line decoder, IC2, is used. The select inputs A,B and C are connected to bits 3,4 and 5 of the output from the microcomputer parallel port.

The shift operation is invoked by pressing the shift key, which is a normally open switch separate from the scanned keys. This switch operates the interrupt line INT to the 8049 microcontroller in the typewriter and is normally held low. In the interface it is connected to bit 6 of the parallel output. There is a similar arrangement to select the 'alternate character set' which is required for 3 of the ASCII codes. This function was assigned to bit 7.

The typewriter manufacturers give a maximum printing speed of nine characters per second. A monostable, IC5, is used to achieve the correct operating speed. IC5 is triggered by an output strobe line which in the prototype was arranged to be active on the positive going edge.

After a valid character has been out-

After a valid character has been output from the microcomputer, the strobe line triggers the monostables, and the Q_1 output is used with the output of the exclusive-OR circuit to activate the 3 line to 8 line decoded IC2. The monostable output Q_2 is used as a busy signal by the microcomputer.

Fig. 4 (left) This shows how the improvised connector is made and how it is fitted into the typewriter.

PROJECT: Typewriter Interface

PARTS LIST RESISTORS (5% 1/4W) 10k 2k7 R6 120k 100k multi-turn CAPACITORS (10V working min) 4μ7 tant (see text) C2 470n polyester C3 100µ tant **2716 EPROM** IC1 74LS86 IC2 74LS32 IC3 74LS148 IC4 IC5 74LS123 74LS138 IC6 D1-8 1N914 or similar MISCELLANEOUS 26-way PCB mounting plug and socket (BICC-vero 901-71105D or similar); 0-way wire-wrap socket (see text); PCB; ribbon cable; connector and cable to suit microcomputer used.

Fig. 6 (below) Program to drive the interface, to be used when an EPROM is not used.

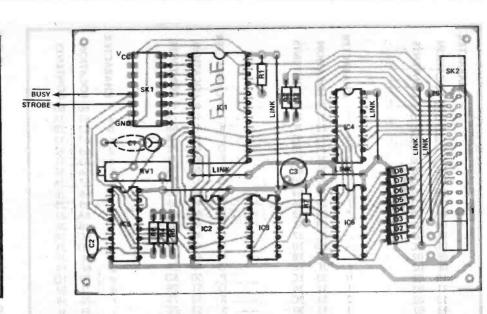


Fig. 5 (above) Overlay diagram of the interface PCB.

```
10 REM PRINTER SIMULATOR ROUTINE
```

20 DIM D(128)

30 FOR N=1 TO 128

40 READ D(N)

50 NEXT N

60 INPUT "FILENAME", BE : REM READ A FILENAME

70 OPEN 1 BE : ON EOF GOTO 340

80 GET 1 CE

90 FOR P=1 TO LEN(CE) : REM GET EACH CHARACTER

100 AE=MIDE(CE.P.1)

110 GOSUB 200

120 IF AE=CHARE(13) GOTO 140 : REM CHECK FOR CR

130 GOTO 180

140 AE=CHARE(10): REM IF SO PUT IN A LF

150 GOSUB 200

160 FOR N=1 TO 125 : REM AND A DELAY

170 NEXT N

180 NEXT P

190 GOTO 80

200 X=D(ASC(AE)+1) : REM SUBROUTINE TO PRINT A CHARACTER

210 OUT(16R7E)=X : REM OUTPUT TO A SUITABLE PORT

220 OUT(16R7F)=0 : REM ISSUE THE STROBE

230 OUT(16R7F)=1

240 Y=IN(16R7F) : REM CHECK FOR BUSY

250 Y=MOD(Y,2)

260 IF Y<>0 COTO 240

270 RETURN

290 DATA 8,120,124,83,112,104,108,96,100,88,82,94,39,16,27,31,28,56,60,48

300 DATA 52,40,44,32,36,24,18,30,231,92,220,95,17,122,107,115,114,113,118

310 DATA 106,110,101,98,102,90,99,111,89,93,121,117,126,105,97,119,125

320 DATA 127,109,123,209,8,145,8,80,96,58,43,51,50,49,54,42,46,37,34,38,26

330 DATA 35,47,25,29,57,53,62,41,33,55,61,63,45,59,8,159,8,8,2

340 CLOSE 1

350 STOP

360 END

paper pan which is clipped in position under the platen, then unscrew the four screws in the base and remove the top cover by gently raising it at the back and pulling it forward. The keyboard may then be removed from its clips and turned upside down so as to gain access to the ribbon cable connectors. These are then removed from their receptacles on the PCB and the adaptors fitted. The 26th way from the ribbon cable must be taken to ground; a suitable point exists on the typewriter PCB marked 'GND'. The typewriter should then be reassembled and the interface connected to the microcomputer.

The period of the monostable must now be adjusted. Set up the microcompter to send a reasonably long text file and adjust the preset (RV1) to give a printing rate of about nine characters per second. Allowance must be made for the time taken to perform a carriage return and line feed. If this is not done in the microcomputer's standard software (normally by sending an appropriate number of 'null' characters) then CR and/or LF must be detected in the interface program and suitable delays introduced. (See BASIC program, Fig. 4.)

Note that if you decide to use your micro to do the character coding rather than the EPROM (see How It Works and Fig. 6), then the EPROM should be ommitted and what would have been its pins 1 to 8 should be linked to pins 17, 16, 15, 14, 13, 11, 10 and 9 respectively. If you want to retain the option of using an EPROM at a later

PROJECT: Typewriter Interface

NO OC OC OC OC OC OC OC	H	0 11	NOLLY NOT 60 60 61 3A 62 2B 63 33 64 32 65 31 66 36 67 2A 68 2E 69 25 6A 22 6B 26 6C 1A 22 6B 26 6C 1A 39 72 35 73 3E 74 29 75 21 77 3D 78 3F 79 2D 75 21 76 37 77 3B 78 3F 79 2D 08 7C 9F 7D 08 7E 08 7F 02
---------------------------------------	---	------	--

Table 1 EPROM contents and what they do.

stage, then perhaps the best way of doing this is with a header plug in the IC socket.

Once source of trouble that you may have is with the stability of C1. We've specified a tantalum type, but you may find it necessary to use a polystyrene (we known, we know, they're big and expensive). The exact value of C1 isn't important, but it must not vary too much over time or with temperature and electrolytics are capable of doing just that.

One option you might like to use is to connect two on off toggle switches between the 5 V rail and pins 6 and 8 of the connector SK2. These allow the selection of 15 characters per inch type spacing and of an alternative keyboard to be selected, both independent of the computer output.

This isn't necessarily the end of the story. We're so impressed by the keyboard on the EX42 that we're looking at ways of using it too. Watch this space!

ETI

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RESISTORS	SPOVEC 250VAC IDEAL AS MARIS	100 3V 32p	25×17 2.99 3.75×17 3.85 4.79×17 4.93	D COMMECTORS Scider Type Male	R3 9x5x2%" 3:15 R4 11x6x3"	800mA	PCB RELAYS 240VAC 10 emps Contacts	2N2102 3 2N2217 3 2N2218 3 2N2218A 2	18p 2N44 18p 2N42 13p 2N42 15p 2N42	21 95p	2N6126 76p 2N6129 78p 2N6130 93p	9C167A 10p BC167B 13p BC168 10p BC168B 10p	8C409 30p 8C413 25p 8C414 25p 8C415 30p 8C415 30p 8C416 30p 8C440 32p 8C440 32p 8C460 32p
CARBON FILM BYS HI STAB 160 TO	SUPPRESSORS 10-F 28p	PERFINDE	VO Board 1.92 Dip Board 3.90 Frack Cutter 1.48	9 way 80p 15 way 1.03 25 way 1.60	3.85 R5 11x7½x3½″ 4.75	ואר און און	SPOT 1x % " 6v	2N2219 2	7p 2N42 8p 2N42 2b 2N42	23 97p 24 98p	2N6131 98p 2N6132 83p 2N6133 1.14 2N6134 1.38	BC168C 10p BC169 10p BC169B 10m	BC416 30p BC418 30p BC440 32p
10M 1 W E 24 20 1 W E 24 20 p 1 W E 24 6	100nf 43p 150nf 48p	FORMERS 100mA	Pin Inserter 1.79 100 Pins 55p	37 way 2.50 Female 9 way 99p	R6 13x8x4%" 7.35 R7 15x8x4"	2A 17p 10p	2.75 24v 1150Ω 2.95	2N2221A 2 2N2222 2	2p 2N42 3p 2N42 4p 2N42	37 1.21 38 95p	2N6212 3.27 2N6253 1.45 2N6254 1.55	BC169C 10p BC170 15p BC170A 17p	BC460 32p BC461 33p
2W E24 12p	220nF 55p 1000VDC PLASTIC	6-0-6V, 9-0-9V, 12-0-12V, 15-0-15V 95p	Verobloc 3.99 Vere Wiring Pan + Spool 3.36 Space Spool 786	15 way 1.75 25 way 2.05 37 way 3.30	7.75 VEROBOXES	5A 17p 10p 6 3A 17p 10p 10A 17p 10p	48v 4600Ω 3.04	2N2223 2: 2N2223A 4.	50 2N42 60 2N42 15 2N42	40 3 00 48 15p	2SC1096 95p 2SC1306 95p 2SC1307 1.60	8C1708 17p 8C170C 18p 8C171 12p 8C171A 15p	BC461 33p BC478 22b BC479 30p BC516 44p BC517 13p BC547 13p BC547 14p BC547 14p BC548 12p BC548 13p BC548 15p BC548 15p BC548 15p BC548C 15p BC548C 15p
ULTRA HISTAB ULTRA LOW NOBE	1nF, 2n2 26p 4n7, 6n8 25p 10nF 31p	6VA 06+06V 2.66	Spare Spool 75p Combs 6p	Angled PCB 25w Male 2.45 25w Female	Black Plastic V1 3x2x1"	11/4" Slow Fast 100mA	RECHARGE BATTERIES	2N2369 1	15p 2N42 15p 2N42 10p 2N42 18p 2N42	50 17p 58 75p	2SC1923 40p 2SC2078 1 70 2SJ49 3.50 2SJ50 3.75	BC171A 15p BC171B 15p BC172 12p BC172A 15p BC172B 15p	BC547 13p 8C547A 14p BC547B 14p
0.4W 100 TO 100 2% E24 Sp 1% E24 Sp	22nF, 33nF 37p 47nF 41p 100nF 45p 220nF 78p	0-12 - 0-12V 2.85 0-15 - 0-15V 2.85	DNL SPST 4 way- 67p	2.90 Covers 99p	V2 120x80x	19a 15a	Guaranteed minimum 500 charges HP2(1 2AH) 2.39	2N2410 1. 2N2411 3. 2N2483 2	15 2N42 60 2N42 15p 2N42	75 48p 84 32p 85 35p	2SJ82 4.29 2SK134 3.50 3SK135 3.75	BC172C 16p BC173 11p	BC548 12p BC548A 13p BC548B 14p
LOW OHMIC GLAZE E12	470HF 1.25	0-20 - 0-20V 2-65	6 way 82p 8 way 90p 10 way 1.40	EURO CONNECTORS Male	1.60	315mA 17p 500mA	HP2(4AH) 4.75 HP7(12AH) 99p HP11(12AH)	2N2646 4	16p 2N42 15p 2N42 18p 2N42 12p 2N42	89 15o	2SK226 4.29 2N139 3.30 3N140 1.07 3N143 2.85	BC1738 16p BC173C 16p BC174 21p BC174A 24p	8C548C 15p 8C549 13p 8C549B 14p 8C549C 15p
0 2251to 8 25111p	CERAMIC 100pF 1KV 25p 100pF 2KV 30p	30VA 6+6+9+9V (total 30V 1A)	TOGGLE (MINN) SPST 48p	31 way 1.75 64w. A - B Straight 2.25	VEROCASES V5 220x174x	17p 10p 600mA 17p 10p	2.29 PP3(110mAH) 4.95 Chergers	2N2848 6 2N2890 1. 2N2891 2.	10 2N42 10 2N42 28 2N42	92 45p 94 45p	3N152 3.00 3N153 2.47 3N154 2.56	BC1748 24p BC175 75p BC177 16p	BC550 15p BC550C 25p BC557 15p
2 to 3W 0 229 to 3300 28p 4 to 7W 0 47!!	100pf 3KV 33p 100pf 4KV 37p 220pf 6KV 35p 470pf 2KV 38p	50VA 0-12 + 0-12V	SPDT 58p OPDT 69p DPDT C.OFF 79p 4PDT 2.75	64w. A+B Angled 2.95 64w A+B	V6 171x121x 75mm 5.65	800mA 17p 10p 1A 17p 10p	TYPEN. Adjusted to 6 of any HP type	2N2904A 2 2N2905 2	00 2N43 27p 2N43 28p 2N43	02 39p 03 40p 04 41p	3N200 6 93 3N201 2.98 3N211 3 35	BC177A 25p BC177B 26p BC17B 16p	BC557A 18p BC557B 16p BC558 14p
to 6K8 33p 10 to 11W 1Ω to 33K 37p	470pF 6KV 48p 1nF 2KV 39p 1nF 6KV 44p	4.35 100VA	All types of bused toggles in stock	Straight 2.40 64w. A + C Angled 2.95	REMOTE CONTROL (Handheld) BOX 94x61x22 5mm	1.5A 17p 10p 2A 17p 10p 3A 17p 10p	Above £15.59 TYPE M As above but	2N2906 2	29p 2N44 25p 2N44 30p 2N44 250 2N44	01 27p 02 30p	35K88 89p 40360 60p 40361 67p 40362 67p	BC178A 24p BC178B 25p BC179 20p BC179A 25p	8C558A 15p 8C558B 16p 8C559 15p 8C5596 16p 8C559C 17p
POTS & PRESETS	2n2 2KV 44p 2n2 5KV 48p 3n3 2KV 47p	0 12 + 0 12V 6.95 TORONDALS	Please phone PUSH BUTTON Non-Latching	Female 31 way 1.75 64w. A - B	White 89p	4A - 10p 5A - 10p 6A - 10p	taster charge for 4AH £25.95 TYPEP: PP3 £5.50	2N2907A 2 2N2920 8 2N2923 2	50 2N44 50 2N44 25p 2N44	10 42p	40363 2.95 40364 3.25 40372 1.80	9C179B 25p 8C179C 27p 8C182 10p	BC560 329 BC560 150
LOW NOISE E3 ROTARY POTS WITH %	3n3 4KV 52p 4n7 4KV 57p 10nF 2KV 57p	Up to 500VA in stock. Please Phone	Push to Make 15p Push to Break	Straight 2.75 64w A + 8 Angled 3.25	SIFAM PROFESSIONAL	10A - 10p 15A - 10p 20A - 10p	TYPE A: HP7 (Up to 14-at a time) £5.85	2N2525 1 2N2926 1	Op 2N48	40 12 58 70 80p	40374 2 84 40406 1 39	BC182A 12p BC182B 13p BC182L 10p BC182LA 13p	BUCKEN AKA
4K7 TO 2M	1nF 500V 7p	Please add adequate P&P as transformers	25p KEY-SWITCH	64w A + C Straight 2.95 64w. A + C	All tin 14 "spindles Black (suffix B)	1" PLUG FUSES	HEATSINKS CLIP ON	2N3011 6: 2N3019 5 2N3053 2	5p 2N48 5p 2N48 5Up 2N48 2N49	88 99p 98 1 29	40407 75p 40408 1 59 40409 1 50 40410 1 80	8C182LB 14p 8C183 10p 8C183A 11p	8C651 46p 8CY70 16p 8CY71 16p 8CY72 19p 8CY77 34p 8CY78 22p
LOG 32p As above with DP Mains Switch	FRIMMERS MAN FILM (MULLARD) UP TO 100VDC	as transformers are heavy!	Mains 4 amps DPST withdraw	Angled 3.35	\$1508 plain 56p	In Packs of 4 2 amp 59p	TO1 (AC128:18p TO5:8FY51:18p TO18:8C 109)	2N3054 5 2N3055 6 2N3055RCA	80p 2N49 80p 2N49	02 1 85 03 1 98 04 2 15	40411 2 85 40412 90p 40422 2 95	8C183B 12p 8C183C 13p 8C183L 10p	BCV87 6.60
As above stereo ino switch! 83p	1800MHz1 23p 2pF to 10pF (600MHz) 27p	PRICES PER METRE	Key in both positions line 2 keys) 3.80	CONNECTORS PCB Male + Latch	\$150G plain 56p \$1518 - line 64p \$151G - line 64p	5 amp 59p 7 amp 59p	102201TIP291 36p		6p 2N49	06 2 99 07 3 20	40467A 1 29 40513 1 75 40537 96p 40594 99p	BC 183LA 13p 8C 183LB 13p 8C 183LC 14p 8C 184 10p	BCY88 4.90 BCY89 4.10 BD115 58e BD116 2.50
PRESETS E3 1000 TO 10M	2pF to 22pF (400MHz) 29p 5p5 to 65pF	Solid Hook up. Any colour 5p	FOOTSWITCH with metal buttons	Straight 10 way 89p 16 way 1.29	K 1508 plain 57p K 150G plain 57p	13 amp 59p PANEL	UHFMOD	2N3250 .3 2N3251 3	16p 2N49	09 2 90	40595 99p 40600 2 58	BC184B 12p BC184C 13p BC184L 10p	80121 955 80124 Mulard 2 28
Meni Vert 15p Meni Horiz 15p Standard Vert.	ELECTROLYTICS	SPEAKER Twin 1 Amp 14p Twin 2 's Amp	SPDT 1.85 DPDT 2.75	20 way 1.45 26 way 1.75 34 way 1.99	K1518 - line 66p K151G - line 66p 15mm Winged	FUSEHOLDERS 20mm 36p 1'. 36p	Astec 8MHz Wideband 4.50	2N3440 8 2N3441 1 2N3442 1		14 2 69 15 2 95	40601 2 36 40602 1 68 40603 1 09 40604 1 85 40608 2 44	BC184LB 13p BC184LC 14p BC186 24p	8D131 44p 8D132 44p 8D135 35p 8D136 35p 8D137 37p
Standard Honz. 18p Thumbwheel or	Axiel by Siermons or Metaushits (Not. Penseonic) uFd V	3 Core 2's Amp 18p	Main DP 4 amps with 'a spiridle	40 way 2.25 50 way 2.45 PCB Male + Latch	W1508 74p W150G 74p 21mm Short	QUARTZ CRYSTALS	BOOKS	2N3444 1	85 2N49 70 2N49	17 47p 18 65p 19 75p	40631 2 12 40635 1 35	BC 187 24p BC 204 29p BC 205 29p	BD136 35p BD137 37p BD138 37p
¼ Spindle for Standard Types only Sp	47 63 Bp	3 Core 6 Amp 31p 3 Core 13 Amp 56p	Stop Type Ip 1 to 12 way	10 way 95p 16 way 1.47	S2108 plain 69p S210G plain 69p S2118 - line 75p	Please enquire about types	Prices inc. post in UK. Cheaper to callers	2N344F 6 2N3447 5 2N3448 6	90 2N49 09 2N49 72 2N49 56 2N49	20 85p 21 55p 22 69a	40637 2 00 40643 1 80 40673 70p 40822 1 80	BC 206 29p BC 207 29p BC 208 29p BC 209 29p	BD138 379 BD139 389 BD140 389 BD142 2 40 BD153 1 25
N. CERMET 20 TURN PRESETS 500, 1000	47 350 30p 1 63 8p 1 100 Sp 1 500 40p 2 2 25 8p	SCREENED Single 14p	55p 2p 2 to 6 way 55p	20 way 1.60 26 way 1.99 34 way 2.40	S211G - line 75p 21mm Standard K210B plain 69p	not listed 32 768K Hz 95p 100KHz 2 35	Tower Transistor Manual (Bible) 10 50	2N3512 1 2N3553 2 2N3563 2	06 2N49 65 2N49 20p 2N49	24 92p 26 95p 27 95p	40871 79p 40872 79p AC125 49p	BC212A 12p BC212A 12p BC212B 13p	BD155 1.20 BD157 540
2002, 5008, 1K. 2K, 5K, 10K, 20K, 50K, 100K.	2.2 63 Sp 2.2 100 11p 2.2 350 30p	Stereo 27p Mini Single 12p Mini Stereo 15p	3p 3 to 4 way 55p 4p 4 to 3 way	40 way 2.55	K210G plain 69p K2118 - ine 78p K211G - Ime 78p	200KHz 2.65 1 00MHz 2.74 2 00MHz 2.24	Elektor 301 Circuits 6.50 Texas TTL	2N3565 2 2N3566 5	25p 2N49 20p 2N49 50p 2N49	64 27p 65 25p	AC126 32p AC127 32p AC128 35p	BC212L 10p BC212LA 13p BC212LB 14p BC213 10p	80158 55p 80160 3.80 80181 1.75 80182 2.50
200K, 500K each 88p THERMSYORS	3.3 25 10p 3.3 40 11p 3.3 63 12p	4 Core 4 Screens 44p 4 Core. Single Screen 54p	55p	10 way 84p 16 way 1.07 20 way 1.25	21mm Winged W2106 86p W210G 86p	2 097152MHz 3 49 3 2768MHz 1.49	Data 10.50 Texas Op to 5.18	2N3568 5 2N3569 5	55p 2N49 50p 2N49 50p 2N49 35 2N49	67 25p 68 25p	AC151 51p	9C213A 11p 8C213B 12p 8C213C 13p	BO183 2 70 BD187 1 09 BO201 1 30
& VDRs PLEASE PHONE	4.7 16 8p 4.7 25 9p 4.7 40 11p 4.7 63 12p	8 Core 81p 12 Core 80p Heavy Duty	Switches in stock Please Phone	26 way 1.49 34 way 1.75 40 way 1.95	29mm Standard K 290B 88p K 290G 88p	4 00MHz 1.49 4 194394MHz 1.99 4 433619MHz	Texas Mos Memory 4.95 Texas Linear	2N3571 5 2N3572 4 2N3584 2	73 ₹N50 95 ₹N50 76 ₹N50	1012 75 1113 85 30 44p	AC153K 64p AC176 27p AC176K 37p	BC213L 10p BC213LB 13p BC213LC 14p BC214 10p	BD202 1 39 BD204 1 44 BD220 1 00 BD221 '95e
CAPS CERAMIC DISC/PLATE	4 7 100 14p 10 25 6p 10 40 12p	Mike Guitar Lead 25p AERIAL	CONN ECTORS PLUGS &	50 way 1.99	CAPS: Blk, Red Yel, Grn, Grey	5 00MHz 1:50 6 00MHz 1:39	National Interface 2.95	2N3585 2 2N3632 9 2N3638 5	99 2N50 88 2N50 55p 2N50	36 160 39 190	AC187 25p AC187K 28p AC188 25p AC188K 40p ACY17 150	BC214B 12p BC214B 12p BC214C 13p BC214L 10p	BD 223 100 BD 224 95p BD 232 1 11
MICRO - MINI 100V TYPICALLY 5%	10 63 14p 10 100 16p 10 350 55p	50Ω RG58A 25p 75Ω UHF 29p 75Ω VHF 28p	SOCKETS OH SOCKETS	2 pm 9p 3 pm 11p 5 mg 180° 12p	Blue. (Please state colour)	6 9375MHz 3.50 8 00MHz 1 49 10 00MHz 1.75 18 00MHz 1.79	National Special Function 2.95 National Data	2N3639 6 2N3641 6	70p 2N50 85p 2N50 89p 2N50 50p 2N50	87 39p 88 37p	ACY17 150 ACY20 75p ACY21 75p	BC 214LB 13p 8C 214LC 14p BC 237 14p	BD233 70p BD234 72p BD237 98p BD238 96p
1pF to 1OnF 7p	22 25 11p 22 40 14p 22 63 18p 22 100 21p	300Ω Flat 14p	Pins prof W Wp 8 8p 25p	5 pin 240° 16p 5 pin Domino 5 pin 18p	15mm plain 5p 15mm - dot 8p 15mm - line 8p	20 OOMHz 1.99 27 648MHz 1.99 48 OOMHz 1.69	Conversion 2.95	2N3643 3	30p 2N51 38p 2N51 86p 2N51	72 15p. 75 58p. 79 39p	ACY22 75p ACY28 75p ACY44 98n	BC237A 16p BC237B 17p BC237C 18p	8D239A 57p 8D239C 64p 8D240A 58p
MONOLYTHIC MINE CERAMIC 10nf, 22nf 10p	47 25 14p 47 40 17p 47 63 26p	Prices per foot 8 way 25p	14 9p 35p 16 10p 40p 18 16p 50p	7 pin 30p	21mm plain 5p 21mm - dot 8p 21mm - line 8p	100 00MHz 2.95 5.5 MHz Ceramic filter 50p	Toshiba CMOS 7.95 Hitachi Micro	2N3662 1	16p 2N51	83 1 00 84 1 10	AD150 79p	8C238 14p 8C238A 15p 8C238B 16p 8C238C 17p	80240C 73p 80241A 61p 80241C 67p
33nF, 47nF 10p 88nF 14p 100nF 14p	47 100 28p 100 16 14p 100 25 16p	10 way 25p 16 way 39p 20 way 48p	20 20p - 22 22p - 24 24p 70p 28 28p 79p	SOCKETS 2 pin · Sp 3 pin · 10p	29mm (Red. Bik. Grey only) 8p	TOOLS	processor 9.00 Hitachi Memory 7.50	2N3703 1	10p 2N51	99 100 90 68p 91 70p	A0161 39p A0162 39p AF106 75p AF109 75p AF114 65p AF117 1 00	BC239 15p BC239A 16p BC239B 17p	8D242A 65g 8D242C 70p 8D243A 72p 8D143C 85g
BARRIER LAYER CERAMIC DISC	100 40 22p 100 63 25p 100 100 30p 220 10 16p	24 way 62p 30 way 75p 32 way 82p	40 30 p 99 p	5 pin 180° 10p 5 pin 240° 16p 6 pin 20p 7 pin 25p	Nut Covers 15mm	Top quality Hand Tools Lindstrom	Hitachi Powerfet 8.00 TEXAS	2N3706 1 2N3707 1 2N3708 1	10p 2N511 10p 2N511 10p 2N51	94 79p 95 99p	AF114 65p AF117 1 00 AF118 89p	BC239C 18p BC250 22p BC250A 23p	80244A 829 BC244C 1 00 8D245A 1 14
POLYSTYRENE	220 16 17p 220 25 22p 220 40 25p	40 way 88p	FORCE DIL SOCKETS 24 pm 4.25	OW LINE SOCKETS	Colours as above Bp	4 3" 14 EE	STANDING" Solid State	2N3710 1 2N3711 1	10p 2N52	96 1 08 09 24p	AF118 89p AF124 72p AF125 72p AF126 72p AF139 40p AF170 80p AF172 80p AF172 80p AF178 80p AF200 65p	BC250B 24p BC250C 25p BC251 25p BC251A 26p	BD245C 1 30 BD246A 1 20 BD246C 1.50
5% OR BETTER 10pf, 15pf. 22pf, 27pf.	220 63 30p 220 100 40p 470 16 22p 470 25 28p	GRADE DNE	40 pm 5.25 UNF PL 269 TYPES	2 pm 10p 3 pm use 5p 180° 5 pm 15p	Colours as above	L890.Snipe Nose Pliers 5 2 10.35	4.95 Orgital 4.95 Car Electronics	2N3713 1 2N3714 2 2N3715 3	38 2N52 98 2N52 31 2N52	20 15p 21 25p 22 26m	AF170 88p AF172 88p AF178 88p	BC251B 27p BC251C 28p BC252 22p	BC249A 2.00 BD249C 2.31 BO250A 2.11 BD250C 2.46
33pF, 39pF. 47pF, 68pF. 100pF, 150pF.	470 40 33p	GLASS PCB SINGLE - SIDED 178 × 240mm 1.50	Low loss, superior quality 500	PHONO PLUGS Metal 20p	DIALS 15mm	Pliers 4.7"	Security Elec	2N3724 1	75p 2N52 75p 2N52 85p 2N52	23 15p 24 38p 26 25p	AF201 75p AF239 55p	BC252B 23p BC252C 24p BC253 22p BC253B 23p	80433 79p 80 434 55p 80435 81p
180pF, 220pF, 270pF, 330pF, 390pF 10p 470pF 680pF	470 63 43p 470 100 60p 1000 16 30p 1000 25 38p 1000 63 65p 2000 16 40p	420 × 195mm 1.95 420 × 245mm	Line plug 45p Reducer 15p Round skt. 40p Sqr skt 40p	Plastic Red. Yellow. Green. Black 15p	Grey - Point 26p		Optronics 4.95 Communications 4.95	2N3734 1	86 2N52 88 3N52 30 3N52 45 3N52		AF240 1.00 AF2798 1.19 AF279G 1.19 AL102 3.49	BC253C 24p BC256 25p BC256A 26p	80436 81p 80437 88p 80438 88p 80439 90p
470pf, 680pf, 1nf, 1 5nf 12p 2.2nf, 3 3nf 13p 4.7nf 14p	2000 16 40p 2200 25 63p 2200 40 70p	PERRIC	8NC 500 Plug 1.10	PHONO CHAS SOCKETS Single 16p	Clear 1 to 1026p Clear Taper 26p OIALS 21mm	Cutter 10.02	Computer Science 4.95 Microprocessors	1 2N374) 2	00 N52	17 45p 48 46p 49 48p	AU106 4.57 AU110 2.20 AU113 3.67	BC257 26p BC257A 27n	1 80440 9to 1
10nF 15p SR.VERED MICA 1%	470 63 43p 470 100 60p 1000 16 30p 1000 25 30p 1000 25 48p 1000 83 65p 2000 16 40p 2200 25 43p 2200 40 70p 2200 63 134p 4701 16 75p 4701 175 88p	CHLORIDE PELLETS Quick dissolving. Enough to make	Socket 1.00 Line sk1 1.15	Dual 20p Quad 25p	Red - Point 28p Blk + Point 28p Grey - Point 28p	C73 4½" Side Cutter 9.28 C72 4½" Pliers	4.95 SOLDER	2N3766 2	76 2N520 90 1N520 19 3N520 75 2N520	93 966p 94 1.28	BC107 10p BC107A 12p BC107B 12p	8C258 24p BC258A 25p BC258B 26p BC259 25p	80529 1.20 80530 1.30
PLEASE PHINNE POLYESTER	Radial by Matsushita	over 1 litre 1.69 ETCH RESIST	COAX (TV) All Metal Plug 25p Socket 25p	BATTERY, CONNECTORS PP3 Snaps 10p PP9 Snaps 12p	Clear 1 to 1028p Clear Taper 28p	(Snipe) 7.52 DE-SOLDERING	Antex irons C240 (15W)	2N3772 1 2N3773 1 2N3773	.83 2N529 2N529 2N530	96 1.28 98 1.37 02 3.20	BC108 10p BC108A 12p BC108B 12p BC108C 14n	9C259C 276	8D535 75p 9D536 75p 8D537 8Dp 8D538 8Dp 8D539 8Dp 8D539 110
TYPE (RADIAL)	10 16 to 22 10 to 22 16 7p	Inc. Spare Nibt SOp	CANNON TYPE	Box for 4HP7 27g Box for 6HP7	STANDARD KNOBS (All for '4"	PUMP BT 100. High Suction	XS240125W1 5.25	2N3773RCA	2.67 2N536 2N536 2.75 2N536 2N536	05 25p 06 37n	8C109 10p 8C1098 12p 8C109C 12p	BC260 30p BC2608 32p BC260C 33p BC261 33p BC261A 34p	80539C 1.10 80540 85e 80540C 1.20
10nf. 15nf. 22nf. 33nf. 47nf. 68nf. 100nf 7p	47 10 79 47 16 89 100 10 89	ETCH RESIST TRANSFERS 1. Thin lines	AUDIO PLUGS (3 PIN XLR) Male 1.70 Female 1.85	Box for 4HP11 33p	spindles) Grub Screen Fitting	Anodised 4.55 Spare Teflon Nose B5p	Elements	Thomson 2N3779	2.75 N53 1.70 N53 3.27 N53	08 25p 54 19p	8C113 30p 8C114 19p 8C115 22p 8C116 37p	BC2618 35p BC2616 36p BC262 31p	80540C 1.20 80540C 1.20 80675 72p 80675 72p 80677 78p 80677 78p 80711 1.32 80712 1.32 80X14 1.30 80X18 1.58
150nF, 200nF 10p 330nF, 470nF	100 16 10p 220 10 11p 220 16 12p 470 10 17p	2. Thick lines 3. Thin bends 4. Thick bends 5. DIL pads	Sockets (Chassis) Male 1.50	TRANSISTOR SOCKETS TO 18 (BC 109)	Black Plastic M1.25 + metal Insert 34p	TEST METERS	No 2 (Small) 85p	2N3790 2 2N3791 2 2N3792	2.73 ZN531 2.47 ZN531 2.68 ZN531	57 28 0	BC116A 37p BC117 19p BC118 19p	8C262A 32p BC262B 33p BC262C 34p BC263 30p	BD711 1.32 BD712 1.32 BDX14 1.30
13p 680nF 18p 1µF 22µ 1 5µF 38p 2 2µF 38p	1000 10 20p	6. Transistor pads 7 Dots + holes	Female 2.35	105 (8FY50) 3Sp	M2. 33mm = metal insert 39p M3.	Push Button 2 amps AC/DC,	No. 6 (Micro) 85p XS250/X25 Bits	2N3794 2N3819 2N3820	25e 2N544 35p 2N54 38p 2N54 184 2N54	15 1.10 16 1.54	BC119 380 BC121 82p BC123 82p	BC263B 31p BC263C 32p BC264 40p	8DX32 3.47 8DX668 5.95
SHEMENS	2200 10 34p 2200 16 44p 3300 10 50p	8. 0.1' edge connectors 9 Mixture	Huge Discount for quantity	TO3 (2N3055) 40p	36mm + metal insert & skirt 39p	1KV DC 750₄ AC	No 50 (Small) 85p No 51 (Med 185p	2N3822 2N3823 2N3824	1.84 2N54 90p 2N54 45p 2N54 1.70 2N54 78p 2N54	48 19p	8C125 37p 8C132 39p 8C134 36p 8C135 45p	BC2648 4.2p BC266 38p BC266A 38p	BDX678 5.95
POLY-C 5% 250V 7.5666 Inf. In5. 2n2	3300 16 85p 4700 10 85p 4700 16 85p	Any sheet of above 35p	14 Mono 20p 14 Stereo 30p 14 Metal Mono 30p	Bare Wire Mains Safety Block £7.96	M4. As M3 numbered 1 to 10 39p	34.50	No 52 (Lge.) 85p SOLDER 125gms 18swg 2.95	2N3826 2N3827	78p 2N54 78p 2N54 44p 2N54 30p 2N54	57 29 m	BC136 45p BC137 39p BC138 55p	BC2668 37p BC300 45p BC301 44p BC302 43p BC303 47p	BDY55 1.75 BDY56 1.80 BDY57 5.25 BDY58 6.15 BDY62 2.34
3n3, 4n7, 8n8 7p 8n2, 10n, 12n, 15n, 18n, 22n, 27n, 33n, 38n,	CAN ELECTROLYTICS 4700 of 40V 2.50 4700 of 63V 3.50	SENSITIVE PCB 1st Class Epoxy Glass. For better results than	2½ mm Mono 12p 2½ mm Metal	IEC MAINS 6 AMP 3 PIN	M5. As M3 but 30mm 42p M6. As M4 but	Pocket Size 2000 OPV	18swg 2.95 22swg 3.10	2N3855 2N3855A 2N3856 2N3858	40p 2N544 45p 2N54	61 SOp 82 SOp	8C140 250 9C141 379 9C142 259 9C143 300	BC302 43p BC303 47p BC304 46p. BC307 13p	BDY92 3.76 BF115 35p BF119 1.00
47n Sp 58n, 68n, 82n, 100n, 150n 10p	10,000 F 80V 4.50	spraying. Expose to UV	Mono 20p 3% mm Mono 12p	Plug (Holes) 58p Chassis-Skt (Pins) 35p	30mm 42p M7. Pointer 24p	Analog Metér 5.55 MICROTEST 80	SISTORS UK's Greatest Retail Variety	2N3858A 2N3859A 2N3860	37p 2N54 31p 2N54 31p 2N54	85 29 p 90 1.37	BC147 10p BC147A 10p BC147B 10p	8C307A 14p 8C207B 15p 8C308 12p	8F121 75p BF123 70p BF127 80p
SIEMENS POLY-C 5% 100V 7 SAME	TANTALAM BEADS 0 1 35V 14p	100 × 160 2.10 100 × 220 2.50 203 × 114 2.40	3½ mm Stereo 35p 3½ mm Metal Mono 20p	Line Skt. Pins 60p Chessis Plug (Holes) 50p	16mm SOLID ALUMINIUM MATCHING	Superior 20,000 OPV 1000v	Please phone about types not listed due to		90p 2N54	92 1.56	8C147C 20p BC148 10p BC148A 12p	BC304 48p. -BC307 13p '8C307A 14p BC207B 15p BC308 12p BC308A 13p BC308A 14p BC309A 15p	8F153 38p BF154 28p BF157 58p 8F158 28p
100n, 120n, 150n 11p 190n, 230n,	22/35V 14 33/35V 14 47/35V 14e	233 × 220 5.20 Double sided 100 × 160 2.20 100 × 220 2.80	JACK SOCKETS	13 AMP DOMESTIC	KNOBS M8. 15mm 48p	AC/DC, 5 ADC. 2.5A AC, 0.1Ω to 5M 19.00	insufficient space. Only top quality	2N3903 2N3904		51 317m	BC148B 13p BC148C 13p BC149 10p BC149B 12p	9C309B 18p	9F159 589 BF160 559 BF161 580
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	3.3/35V 10p 4.7/16V 10p 4.7/36V 20p	above (do not use Sodium Hydroxide)	2% mm Mono 15p 3% mm Mono 15p	Trailing Skt B2p	FUSES	to 10M 32.00	2N929A 45p 2N930 20p 2N930A 30p 2N1131 24p 2N1132 25p	2N3962 2N3964 2N4030	30p 2N56 1.42 2N60 75p 2N60	86 5.95 27 30p 30 8.80 31 6.96	BC154 279 BC157 119 BC157A 129	8C327 14p 8C326 14p 8C337 15p	BF170 78p BF173 25p BF174 77p BF177 25p
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15n, 22n, 33n 11p	15 16V 22p	VEROBOARD 0.1' COPPER CLAD	'4" Stereo 30; '4" Stereo Metal 50p	CASES Covered with Black Rexine	19p 15p 250mA 17p 10p	open (1 amp)	20/1711 36m	2N4037 2N4058 2N4059 2N4060 2N4061	48p 2N61 10p 2N61 17p 2N61 12p 2N61 10p 2N61 10p 2N61	11 1.00 21 57a	COLOTA 12-2-2-2-2-2-2-2-2-2-2-2-2-2-2-2-2-2-2-	BC321 200 BC327 140 BC328 140 BC338 150 BC338 150 BC338 200 BC382 300 BC382 300 BC382 300 BC383 300 BC384 300	BF181 38p BF182 38p BF183 38p
47n, 66n, 100n 14p 180n, 220n 18p 330n 38p	22/6.3V 28 22/16V 28 33/10V 35 47/6.3V 35	25×37 83p 25×5 99p 375×375 99p	3½ mm Mono 15p 3½ mm Mono	(Scratchproof) R1 6x4½x1¼" 2.38	315mA 17p 10p 500mA	& Screen 2.95 12v 530Ω 1.99	2N1890 50p 2N1893 45p	2N4061 2N4062 2N4064 1	10s 2961 10s 2961 115 2961	22 55p 23 85p 24 55p	BC1598 13p BC159C 18p BC160 42p BC161 48p	8C383L 30p 9C384 30p 8C384L 30p 8C407 24p 8C408 24p	8F185 -37p 8F185 -37p 8F184 12p 8F185 13p
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8F240 38p MJ491 172 TIS91 30p	W04 (200) 28p voltages only W08 (800) 40p 3V3, 3V6, 4V3, 2 amp type 4V7, 5V6, 7V5,	CA3046 69p LM1801 2.99 CA3047 4.60 LM1812 8.00	TAA700 2.60 7402 11p TAA930A 2.50 7403 12p	74LS05 12p 74LS0 74LS08 12p 74LS0	643 99p 4023 12p 644 99p 4024 32p	PORT
BF244B 38p MJ900 2.90 TIS93 54p BF245A 30p MJ901 3.10 VN10KM 60p BF245B 51p MJ1000 2.50 VN46AF 84p	Square with hole S01 (100) 37p 10V, 12V, 20V, S02 (200) 40p 33V, 51V, 62V,	CA3049 3.21 LM1820 2.15 CA3050 4.11 LM1828 4.79	TAA9308 2.83 7404 120 TAA970 2.45 7405 18e 18A120AS 88p 7406 18e T8A500 2.97 7407 18e T8A500 3.11 7408 14e T8A510 3.05 7409 14e T8A510 3.05 7410 14e T8A510 2.57 7411 18e	74LS10 120 74LS0 74LS11 120 74LS0 74LS12 120 74LS0	670 1.19 4026 /9P ADCORD	04 4.40
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9F259 35p MJ150152 45 ZTX313 36p 8F262 80p MJ15016 3 34 ZTX314 24p	K01 (100) 2, 20 Y = Yellow K02 (200) 2, 30 Large Oiffused K04 (400) 2, 80 1+50+	CA3076 3.42 LM2917N8 1.89 CA3078T 2.25 LM3301 1.60 CA3080 1.89 LM3302 74e	TBA560C 2.87 7422 19p TBA570 2.37 7423 19p	74LS38 15p 74S6 74LS40 13p 74S6 74LS42 28p 74S	64 1.02 4040 39p MM530 65 1.02 4041 39p MM530 74 75p 4042 39p MM535	7 12.75 7 22.50
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BSX21 400 RELEASED	12A TIC126C 73p TIC126D 77p TIC126M 96p BPX48. 6.76 BPX60 4.75	LM318N 1.49 NE592 1.95 LM319H 2.48 NE5534 95p LM319N 2.10 NE5534 A 1.25 LM324N 29p OM335 7.20	TDA2571 4.40 74123 35p TDA2581 3.75 74125 35p TDA2582 3.95 74128 34p	74LS191 36p 74C 74LS192 36p 74C 74LS193 37p 74C 74LS194 32p 74C	C90 1.06 4521 86p Z80AC C93 1.06 4526 68p Z80AC C95 1.26 4527 62p Z80AD	ART 5.50
BSX28 346 BSY95A 256 BUI04 2.22 BUI05 1.70 CATALOGUE	SCRS/THIACS 174 550	LM335 1.30 PLL02A 4.95 LM337K 4.39 PLL03A 12,75	TDA2582 3.96 74126 340 TDA2590 5.20 74128 350 TDA2591 4.73 74132 290 TDA2593 3.16 74136 279	74LS194 32p 74LS195 32p 74LS196 45p 74LS197 46p 74LS197 46p	C107 60p 4528 74p Z80AP C151 2.66 4532 63p ZN425 C154 2.86 4534 3.86 ZN426 C157 2.10 4536 2.88 ZN427	SER 3.39
8U108 3.95 8U109 3.29 £ 1 0.0	BT101 500R ILQ74 1.85	LM337MP 1.65 RC4136 59p LM337T 1.75 RC4194 3.95 LM339AN 1.60 RC4195 2.95 LM339N 44p S5568 2.59	I TDA2611A 2.50 1 74143 2.08	74LS197 48p 74C 74LS221 60p 74C 74LS240 58p 74C	C157 2.10 4536 2.68 2N427 C160 1.06 4538 78p C162 1.06 4538 88p C162 1.06 4543 88p C163 1.06 4553 2.26	7E8 5.99 BE8 4.05
8U204 2.25 BU205 1.75 INC. VAT. p&p	BT116 Use LD461 25p LD466 1.45	LM345K 8.80 SAA1024 4.99 LM348N 820 SAB3209 3.98	TDA2640 3.84 74144 2.08 TDA3000 2.76 74145 50p TDA3300 15.80 74147 74p TDA7000 3.50 74148 58p	74LS241 85p 74L 74LS242 55p 74L 74LS243 55p 74L	C163 1.06 4543 606 C164 1.20 4555 35p (Sc C165 1.20 4556 35p	REGS ice also icer ICs)
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BU3205 2.35 TIP29A 29p 6AY38 20 BU406 145 TIP29C 38p BAY44 15 BU407 1.45 TIP30A 350 BAY93 10	TRIACS LD479 1.65 LD481 27p LD486 1.25	LM376N 65e SAS590 2.95 LM377N 1.68 SFF96364 7.99	TL064 95p 74153 39p TL071 24p 74154 53p TL072 45p 74155 39p	74LS248 55p 744 74LS249 55p 744 74LS251 25p 744	C193 1.05 4584 380 78L12	A 25
8U408 1.35 TIP30C 38p 88103 70 8U409 1.25 TIP31A 33p 881048 80	TO 220 C+++ 10488 1 70	LM378N 3.40 SL470 3.47 LM379S 4.50 SL490 3.47 LM380N 750 SL610C 4.00	TLO74 99p 74156 39p TLO81 24p 74157 29p	74LS253 32p 74 74LS257 28p 74 74LS257 28p 74	C195 1.06 COMP IC S 500	A 70202
8UV20 11.00 TIP32C 34p B8104G 80 BUV21 10.90 TIP32C 42p B8105 52 BUV23 13.60 TIP32C 42p B81058 58	P TIC 236D(12A) DRP12 950	LM380N8 1.60 SL611C 4.00 LM381AN 2.26 SL612C 4.00 LM381N 1.40 SL620C 8.00	TL082 45p 74159 75p TL083 75p 74160 58p TL084 89p 74161 48p TL170 48p 74162 38p	74LS259 55p 74 74LS261 98p 74 74LS266 18p 74	C221 1.56 CPUs 7805A C901 57p 1802 6.50 7812A C902 57p 6502 3.24 7815A	M 55p M 55p M 55p
BUV25 15.00 TIP34A 740 BY126 11	TIC246D(16A) TIL38 44p	LM382N 1.12 SL621C 6.00 LM383T 3.40 SL623C 10.00	T1 420 80 1 74162 700	741 C272 BAn /4		TO220
BUX20 17.00 TIP35A 1.09 BY134 52		LM386N1 88p SL64OC 6.00	ULN2003 750 74166 480 UPC575C2 2.00 74170 1.26	74LS275 1.25 74 74LS279 25 74 75LS280 85 74 75LS283 350 74 74LS283 4.70 74	C907 57p 8035 3.49 78127 C908 1.10 8060 10.50 78157 C911 8.60 8080A 2.50 78247	T 35p 35p 35p 35p 35p
J300 48p 11936A 1.39 8Y206 36 J310 53p 11936C 1.39 8Y207 36	2.11 TiL138 2.40 TiC263N TiL139 2.40 125A 800Vi 2.46 TiL209 Sp	LM387N 1.25 SN76018 3.90 LM391N60 1.70 SN76003N 2.95 LM391N80 1.93 SN76013N 2.96	UPC1024H SSp 74172 2.49 UPC1025H 3.95 74173 55p UPC1032H 1.50 74174 54p UPC1035C 2.95 74175 48p	74LS290 38p 74 74LS293 38p 74 74LS295 74p 74 74LS298 78p 74 74LS299 1.49 74	C914 1.10 8900 57.75 78056 C915 1.55 9900 19.95 78128	Armo TOO3 K 1.39 K 1.39
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MES101 280 TIP2955 770 EF9365 35. TIP3055 700 EF9366 35.	00 3.3-82 V 14p CA303QA 2.97	LM1303N 1.20 TAA320 2.06 LM1304N 3.80 TAA521 1.60	ZNA234E 8.47	74LS398 2.70	1014 489 7489 1.66 7919 1015 35 7418 00 7924	K 1.99

AUDIO DESIGN PART 2

s a general classification, one can divide linear ICs into two broad categories: purpose-built or dedicated ICs, aimed at the performance of one specific application; and general purpose ICs, such as the operational amplifier types, which are designed for use as versatile building blocks in a wide range of circuit configurations. The first of these categories contains a host of useful devices, whose numbers increase daily, that are capable of doing a very wide range of jobs, from providing well stabilised, ripple free, power supplies, to complete radio systems or audio amplifiers in a single package.

As a rule, hi-fi circuit designers and their customers tend rather to look askance at such purpose-built ICs in audio applications, since these devices are intended mainly for use in mass-produced consumer hardware, to simplify and reduce the cost of manufacture of competitively priced domestic electronics. A hi-fi specification is not usually either part of the IC designer's brief or of the customer's cost expectation. Nevertheless, some of these dedicated ICs perform extremely well, and have found their way into some of the most prestigious of audio systems. One must, therefore, try not to harbour preconceived opinions about their potential quality, but rather to judge these devices on their individual merits.

So far as the circuitry associated with these dedicated ICs is concerned, although it is great fun to explore their internal construction and to work out schemes for using them in applications their designers had never envisaged, this is rather an exotic field, and full of pitfalls for the unwary. So, in general, it is prudent to stick fairly closely to the circuit applications and component values recommended by the manufacturers in their application data sheets (which one should make sure one gets with the device) since it will probably be difficult to improve greatly upon these recommendations. With general purpose ICs, these constraints upon the method of possible use do not exist, and a very wide range of circuit uses can be envisaged.

Basic IC Amplifier Layouts

Taking the op-amp gain block as a starting point, this will be familiar as a simple, fairly wide bandwidth amplifier unit, having two inputs — one phase-inverting, one non-inverting, an output pin, and two further pins for connection to a + ve and - ve DC voltage supply. Some ICs of this type (in fact, most of the packages which contain just one gain block) also have two further pins which can be used, when connected to an external trimmer potentiometer, to adjust the DC output level of the amplifier when this is used as a DC amplifier stage. Such an op-amp IC will normally be designed to work over supply voltage ranges from ± 1.5 v to ± 15 v, or indeed, in a suitable circuit layout, from a single DC supply within the range 3-30 volts.

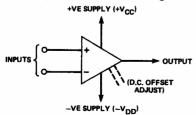


Fig. 1 Conventional circuit drawing of an operational amplifier.

The conventional circuit drawing for such an op-amp is shown in Fig. 1, where, as ever, the + and - symbols on the input leads imply the non-inverting and inverting amplifier characteristics. Although on this drawing I have shown the + and - supply connections to the IC, it is a common practice to take these as read where the ICs are used from a symmetrical or otherwise unremarkable power supply arrangement, and I propose to follow this convention and omit the power supply connecitons, where these are standard, in future drawings.

Most of the popular op-amps of the 741 type are what is known as internally compensated, which implies that negative feedback can be used in the circuit by the connection of a suitable network between the output and the inverting input pins, without having to worry about whether the amplifier will then be stable. In some of the earlier op-amp ICs, internal HF compensation was not provided, on the grounds that the necessary worst-case (unitygain) compensation would lead to a less good HF performance from the IC, at higher than unity-gain conditions, than if the compensation was done by a suitably chosen network of Rs and Cs external to the IC package. However, this situation has been overtaken by progress in IC design, and most of the contemporary IC designs will give a good HF performance without the need to accept an inconvenient external RC network.

Typical values of open-loop (ie, before any negative feedback is applied) small signal, low frequency voltage gain are in the range 100,000-200,000, and the rejection of unwanted noise and voltage fluctuations on the voltage supply lines is usually of a similar order. The common mode rejection ratio (the ratio between the open loop gain and the 'fault' gain you get when you tie the + and - inputs together and use them as if they were just one input) is usually in this range also, but it is very difficult to organise any circuit layout which will allow gains much higher than 1000 to be achieved. The most common pinconfigurations for IC op-amps are shown in Fig. 2, and a typical circuit for a small signal AC voltage amplifier is shown in Fig. 3a.

The circuit will give a stage gain determined by the ratio $(R_3 + R_2)/R_2$. For the resistor values shown this is 48, and this circuit will have a frequency response at 1 V out

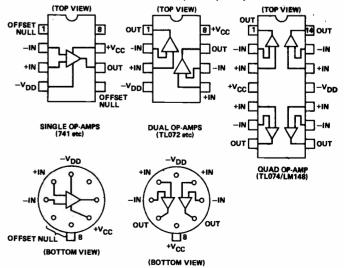


Fig. 2 Common op-amp pin connections.

Problems and ICs often, as we all know, go together. John Linsley Hood takes a look at the two of them in audio.

(RMS) — assuming a ± 15 V DC supply — which is substantially flat from 10 Hz to 30 kHz, the LF limit being set by the value chosen for C1 (bigger = lower) and the HF end being determined by the characteristics of the IC itself, as a

consequence of its internal HF compensation.

At 1 V RMS and 1 kHz, a typical distortion figure into a 2k ohm load, would be about 0.02% and a S/N ratio (assuming a low source impedance) of about 75dB, when measured over the 10 Hz-30 kHz bandwidth. Substituting one of the newer designs of IC intended for audio use, such as a TL071 or a LF351, would halve the noise, increase the bandwidth to about 300 kHz, and reduce the 1 kHz distortion to some 0.002%. Such is progress!

Such a gain block, particularly when built using a TL071 or a LF351, both of which have high impedance FET inputs and very low noise characteristics, makes a very respectable hi-fi amplifier stage, in any application where a flat gain/frequency response is appropriate. To take advantage of the convenience of a single power supply rail, which facilitates joining IC circuity on to discrete transistor layouts, the circuit of 3a can be rearranged as shown in Fig. 3b without any loss of performance. (To assist in comparing the layout of 3b with that of 3a, I have retained some of the component numbering of 3a in 3b.) Lower supply voltages diminish the available output swing and tend to worsen the THD (total harmonic distortion) at any given output, though this will only become conspicuous as the expected output signal level begins to get near the maximum available due to the DC supply provided.

Both of these op-amp gain stages compare favourably, both in terms of the cost of the components and in terms of performance, with the comparable separate transistor versions, the only major snag being the limit on the possible output voltage swing imposed by the ICs restricted HT supply capability. It is no use, therefore, to try to use an IC of this type if one wants a 100 V P-P signal output.

As shown in Fig. 2, IC op-amps of this type are available in packages which contain up to four separate amplifiers on the same chip, usually with very little sacrifice in performance, and with only minimal signal breakthrough from one to another. In particular, the dual op-amp TL072 and LF353 types have become very popular among audio circuit designers as a means of handling a pair of stereo signal channels in one device.

Frequency Response Shaping

While quite a lot of audio signal handling can be done with stages with linear gain/frequency characteristics, it is very useful to be able to modify this frequency response. I have mentioned above, in the case of Fig. 3a, that the LF response was determined by the value of C1. This is because, in a feedback amplifier, the gain of the stage is really determined by the ratio of the impedances in the two limbs of the feedback network. So long as the impedances of any capacitors (or inductors) in these limbs can be ignored in comparison with the resistive elements, the gain will be independent of frequency. However, if the effects of these reactive components are significant within the audio band, this linearity of frequency response will be modified, and this gives the designer considerable scope.

In order to do this kind of design work properly, it is very desirable to be able to work with complex numbers (ie, those containing the so-called imaginary value i or j, which is the square-root of -1). Doing the necessary

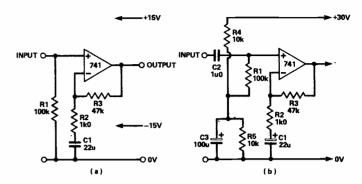


Fig. 3 Simple op-amp circuit. Note that in theory C1 should be unpolarised, in practice an electrolytic is used. (b) is the circuit arrangement for use with a single-rail power supply, in all other respects it is equivalent to (a).

calculations with this type of equation is not really at all difficult, once some simple rules have been memorised, and this allows one to work out quite precisely how a circuit containing capacitors and inductors will operate, and gives both the actual gain and the phase shift. However, it is very hard to find text books which give a simple explanation and I propose, later on in this series, to give a non-mathematician's brief guide.

However, for the moment it is sufficient to remember that the -3dB point (the frequency at which the gain is reduced to 71% of its flat response value) occurs in a stage such as that shown in 3a when the impedance of the capacitor C1 (given by $Z_c = 1/(2\pi fC)$) is equal in value to R2. Where the impedance of C1 is either very much less than R2 or very much greater than R2, the stage gain

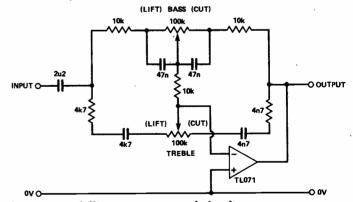


Fig. 4 'Baxandall' type tone-control circuit.

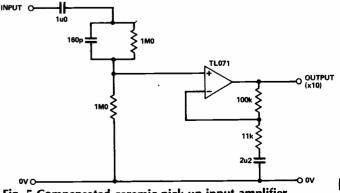


Fig. 5 Compensated ceramic pick-up input amplifier.

calculations can be simplified to (R3 + R2)/R2 or $(R3 + Z_c)/Z_c$. If one draws a graph and smoothly joins these three points, one will get a near-correct idea of the true way the circuit will behave.

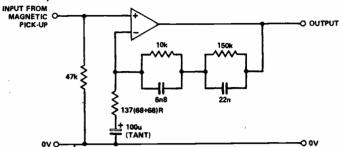


Fig. 6 Conventional RIAA-equalised magnetic pick-up amplifier stage (gain = 100 at 1 kHz).

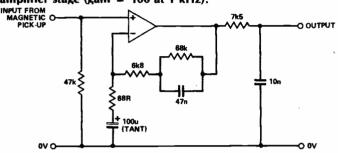


Fig. 7 Improved RIAA-equalised magnetic pick-up amplifier (stage gain = 100 at 1 kHz).

Thus the circuit varies its response according to frequency, and this is entirely due to the presence of the reactive components (more usually capacitors than inductors). Very many practical and useful designs are made possible: some examples are Fig. 4, which is a tone control circuit, and, as explained in the captions, Figs. 5, 6 and which are pick-up amplifiers that accord with the RIAA specifications as shown in Fig. 9. The circuit arrangement shown in Fig. 7, in which the necessary double-step correction of the curve shown in Fig. 9, is done in two stages, is more accurate, particularly in respect of the sonically important transient performance, than the simpler, more commonly used arrangement of Fig. 6. The ceramic cartridge equalisation has a different requirement, since this is an amplitude - rather than velocity - sensitive device, and requires the type of replay curve shown in Fig. 10. Otherwise, when it is used with an adequately high input impedance to give a flat LF response, the reproduced sound is rather lacking in treble.

Combining bass cut and treble cut stages allows one to make local lift and local cut response circuits, such as those shown in Figs. 11a and 11b and whose performance is illustrated in Figs. 12a and 12b. Figs. 11a and b are really both the same circuit, but with the 'shelf' frequencies moved sideways.

I have illustrated all these later circuits using op-amps

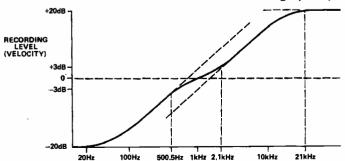


Fig. 8 Recording velocity characteristics employed in RIAA pre-emphasis convention for 33 and 45 RPM discs.

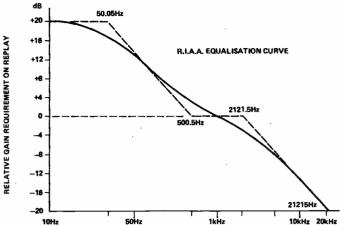


Fig. 9 Required replay curve for magnetic (velocity sensitive) pick-up cartridges.

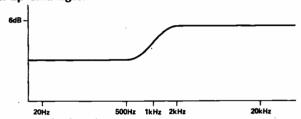


Fig. 10 Required replay curve for flat frequency-response output from ceramic (displacement sensitive) pick-up cartridges.

(a TL071 will work satisfactorily in all these). Let me confess that this was at least partly for convenience - it's much simpler (and easier to follow) if one can just show an amplifier as a triangle with three leads going to it. However, this also makes the point that circuit design (and circuit lay-out in the PCB) with op-amps is very much easier than with the equivalent discrete components (this is provided, of course, that the devices you are using have adequate performance in terms of output capability, distortion, noise, etc). But I still have the feeling that, for 'ultimate-fi', circuits using discrete components alone can be superior, if only because one can get the equivalent results with far fewer components (remember that a typical op-amp can contain the equivalent of 39 separate resistors, transistors, diodes, and capacitors, each with its own imperfections, all of them contributing to an accumulated total imperfection). Instinctively, I feel that the less one handles a hi-fi signal the better the end result.

Steeper cut circuits using two or more RC elements

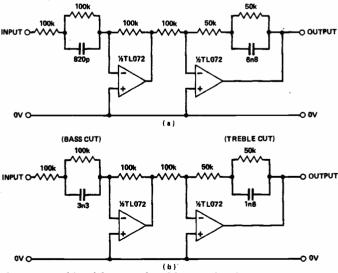


Fig. 11 Combined bass and treble cut circuits.

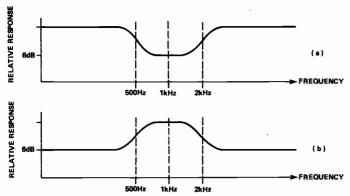


Fig. 12 Response curves for the two circuits in Fig. 11.

can be built, and if these RC groups are included in the feedback network we are now building active filters. These are great fun, but working out just what is going to happen requires rather more tricky maths, and a few useful dodges. Again, this is a topic I will defer until later. So, while I certainly use ICs in my own designs, and I accept that I will do so even more in the future as they get better and more versatile, nevertheless I do not see them displacing the circuits built up with separate transistors and resistors yet awhile. On the other hand, if one is making something like a car radio to which hi-fi standards are not really appropriate, or an FM tuner where the discrete component circuitry would be very cumbersome, not to use ICs would be truly ostrich-like behaviour.

Noise And Distortion — And Other Problems!

So far, I have largely pretended that we are living in an ideal world, where everything is as good as we would wish. Unfortunately, this isn't true, and the extent to which we will be successful in the field of audio design — as in any other — will depend on our ability to recognise the possible existence of defects, and to shape our designs, both on paper and as hardware, to avoid them. The problem, of course, is that it just isn't possible to optimise everything simultaneously, so what one ends up with must be a working compromise in which one has tried to assess what are the most important problems likely to affect one's listening pleasure, and to make sure that these are adequately dealt with.

This is, incidentally, one of the areas in which the DIY designer has a great advantage over the person who simply goes along to his hi-fi shop and hands over a wodge of pound notes for the latest black and chrome creation. This is because the commercial hi-fi is built to provide a good specification/price ratio, which will get a good review in the buyers' guides and ensure healthy sales. Unfortunately, no one really knows what makes hi-fi equipment, such as amplifiers, tuners and recorders, sound well; so, in the absence of any firm knowledge, a series of specifications relating to bandwidth, signal-to-noise ratio, power output, distortion and channel separation, have arisen - and these are the specs for which the commercial manufacturers seek to get good values. Whether the final thing sounds well cannot be so easily specified, but there are some areas, and I will look at these later, where something which measures less well does indeed sound better. So, if one is doing ones own thing one can design for sound rather than specifications.

Noise

If, in this term one includes all unwanted intrusions into the signal output, this consists of five main categories. These are: thermal noise, defective component noise,

radio breakthrough, impulse noise, and hum (from the AC mains power supply). There are also some other kinds of device noise with transistors (and ICs) which relate to the device operating conditions, and I have lumped these with thermal noise. I will leave this until last.

Hum: in any normal domestic environment, there is a possibility of the local (in the UK, 50 Hz) AC mains field intruding into the circuitry, even when this is battery operated. The only answer, in this case, is full screening of the lot, and care in the layout of connecting wires. Diecast metal boxes, such as those made by Eddystone and ITT. provide ideal housings for low-level and high-gain circuitry. Where one is powering equipment from the mains anyway, these problems multiply. Here one must make sure that one does not earth the equipment separately in more than one place (the all too familiar earth loop problem), one must make sure that the mains transformer has an adequately low external AC magnetic field, and that it is sited as faraway as possible from low signal level areas. Also, one needs to remember that the currents flowing in the transformer secondary, rectifier, and reservoir capacitor loop have very high peak values and will produce quite significant voltages across even small wiring resistances. Take care, therefore, to take off the DC supply from across the reservoir capacitor, including your OV return! A further important point to watch is that there is no incipient instability in the circuitry of any amplifier, in that this will make it very prone to a hard rasping hum sound - similar to that given by two different earthing points on the mains DC supply.

Impulse noise: this has a lot in common with radio breakthrough, and is that annoying problem of clicks and bangs when other mains operated equipment in the same locality, lamps, fridges, central heating equipment, and so on, is switched on and off. This can be caused, partly, by the same things as radio breakthrough (see below), but is particularly exaggerated by incipient instability and unnecessarily wide gain bandwidth. If one had a moving coil head amp feeding the PU input, and if the head amp had a 10 MHz bandwidth, one would expect impulse noise problems. Thorough screening will also help here

blems. Thorough screening will also help here.

Radio breakthrough: for those who suffer from it, this is one of the most infuriating of problems — worse even than noisy neighbours. There is, unfortunately, no universal answer. In general, the problem arises because the various connecting leads act as aerials feeding signals into the amplifier, which are then rectified by slightly less than perfect plug-socket connections, transistors or IC semiconductors, or even by poor soldered joints. Decoupling those earth returns which are not directly connected to the chassis, via a non-inductive (eg, ceramic disc) capacitor will help, as will the connection of judicious 100 to 1000 pF ceramic capacitors between input transistor emitters and bases. Also, putting a few ferrite beads on likely live-side input leads can help. Alas, the trick which works in one case may be useless in another, so this requires a lot of experimentation, and not a little luck.

Defective component noise: in my early days as an electronics enthusiast, resistors which crackled, capacitors which spluttered, sizzled, and hissed, and valves which rang like a bell when one tapped them, were just part of life — and one tried, by replacement, to end up eventually with a good set, until yet another component 'went noisy'. Happily, things have changed for the better, and nowadays defective components are relatively rare, at least at normal signal levels, where an electrolytic capacitor installed with reversed polarity is likely to be the major noise culprit.

However, at low signal levels, such as at the phono input to an audio amp, this isn't so reliably the case, and

while proper selection of components for the application will help, for very low level use there is no real substitute for individual testing to guarantee good performance. Remember also that most electronic components don't like heat, so if one has had to spend a lot of time with the soldering iron bit close to the component in question perhaps in taking it out of a PCB and in reinstalling it — it may not be as good afterwards as it was to begin with. Thermal noise: this is the result of the random motions of electrons - the basic carrying elements - as a consequence of their being excited by heat. This noise compowith absolute increases ($^{\circ}$ K = 273 + $^{\circ}$ C), and with the amount of resistance in the circuit. The formula for calculating this is $V = \sqrt{4k.T.dF.R}$ where V is the mean AC output voltage, k is Boltzmanns

where V is the mean AC output voltage, k is Boltzmanns constant (1.38 \times 10⁻²³), T is the absolute temperature (° Kelvin), dF is the measurement bandwidth and R is the circuit resistance. It follows from this, immediately, that the larger the amount of resistance in the circuit (other things being equal) the worse the noise. A graph showing this relationship is given in Fig. 13.

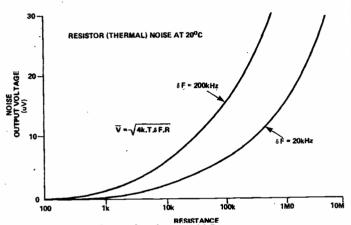


Fig. 13 Resistor thermal noise at 20°C.

Other sources of noise, related to circuit resistance, occur in junciton and other transistors. These are those due to what is known as base spreading resistance (which decreases as the chip size and dopant concentration increase), and shot noise, which is a statistical problem and decreases, within limits, as the ratio of the total emitter current to the fundamental electronic current lumps, the electrons, increases. There is also modulation or I/f noise, which is proportional to the current and inversely proportional to frequency: this is very much depedent on the device used. Finally, there is reverse leakage noise, which worsens as the collector (or drain in the case of an FET) voltage increases.

To summarise this, the lowest noise in a transistor. stage will be given by an optimally chosen device (in respect to type and performance), operated at the collector current which is best suited to its base and emitter circuit resistance and its chip size, at the lowest sensible temperature and operating voltage, and the lowest input impedance. Since all of the noise sources are bandwidth dependent, those which arise before a bandwidth limiting filter, such as an RIAA equalising stage, are less obstrusive than those which occur after this — other things being equal. Also, those noise sources which are inductive in character, such as a magnetic pick-up on the input to a preamplifier, have an impedance which increases with frequency, and will therefore give a worse noise level since the ear sensitivity increases with frequency up to a few kHz - than a simple calculation based on its DC resistance would suggest.

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MACHINE CODE PROGRAMMING

Machine code programming has two uses: firstly, as a way of getting your (normally BASIC-loving) microcomputer to go faster; and secondly, it's the only way to get a 'naked' microprocessor to do what you want. This latter use is what will primarily interest ETI readers. However, it's pretty difficult to learn on a bare micro, so in this short series, Bob Bennett will be showing us how it's done on a home computer, with some comments on using a microprocessor in the raw.

he best way to learn to programme using machine code is to have a go, after all, that was how you learned to programme in BASIC. But then, BASIC does bear some resemblance to everyday English, and machine code looks like . . . well . . . code, so how is it done? To answer that you need to have an insight into what is happening inside the computer — not a lot, just enough to make machine code programming clearer. In this magazine, starting in August of 1982, Owen Bishop wrote an excellent series on designing micro systems, and explained how all the pieces are put together to make a computer. I'll start with a short recap of some of the points relevant to machine code programming.

Deep In The Heart (of Texas?)

At the heart of any computer is a processor, and in most home computers it is a single chip. The Jupiter, Lynx, Spectrum and many others use a Z80 type, whilst the processor in the BBC, Vic 20, Apple, etc, is a type 6502. Each processor has its own instruction set, which is a repertoire of instructions the processor will obey, and each processor has a

CENTRAL PROCESSOR UNIT (CPU)

CPU DATA BUS

ADDRESS BUS

Fig. 1 Layout of a minimal computer.

register set, most of which can be used directly by the programmer. It is by the judicious use of the instruction set that the programmer manipulates the data in the registers to execute, in a controlled sequence, the various effects which constitute the desired aim of the overall programme.

CPUs differ quite a lot in both the sizes of their instruction repertoirs and in the number of registers that they contain. We'll be looking at registers in a moment.

The two more common types of memory used in home computers are random access memory (RAM), and read only memory (ROM). Fundamentally they appear the same in general makeup, inasmuch as they both have a number of locations (called addresses) where data can be placed, but in ROM that data is sealed in and cannot be altered, hence read only. It is in the ROM where the designer has put the routines to control all the effects I mentioned earlier, such goodies as PRINT, PLOT, SCROLL, etc, in fact everything your computer can do. RAM is where the machine code programmer (that's you!) places the instructions (program) which the processor hopefully will obey. The designation random is a bit of a misnomer: there is nothing random in the way the memory is accessed, at least, not (we hope) in a computer!

Bits And Pieces

So what's the connection between RAM, ROM, registers and the processor? The answer is a bus. Not the number 8 to the office, but another name for a connecting wire, or, as is more usual in a computer, a group of wires (or tracks on a PCB). These wires carry information in the form of electrical signals, and it is the level of the voltages present on the bus which conveys the meaning of the signals. An acceptable high level can be taken to mean a 1, and an acceptable low level can signify a 0, which leads us to use binary notation on computing (convenient isn't it?).

If there are n wires making up a bus, then the total information on the bus can be represented as 2ⁿ. Most home computers have eight-bit registers (where bit is a contraction of Binary digIT), so the highest number this register can hold is 2⁸-1 which is 255 if all the bits are 1s. These eight bits are known as a byte.

255 is not a very high number to play around with so it

is arranged that registers can be used in pairs, but only in certain combinations. This combination broadens our horizons somewhat because we can now use numbers up to 216 which is equal to 65,536 decimal. The normal way to present data is one byte at a time, so our data bus usually has only eight wires. However, because we need a lot of memory, we use 16 wires on the address bus which allows up to 65,536 addresses, or locations to be used. This is known as 16K or 16 Kilobytes because it gets tedious writing

-CONVERSIONS CONVERSION OF HEXADECIMAL TO DECIMAL

A single hexadecimal register holds up to 256, and, as we do when counting in tens, we split this into a 16¹ figure and a 160⁰ figure (as in tens and units). A register pair would hold figures for 16³, 16², 16¹

hex	16 ³	16 ²	161	16º
0	0	0	0	0
1	4096	256	16	1
2	8192	512	32	2
3	12288	768	48	3
4	16384	1024	64	4
5	20480	1280	80	5
6	24576	1536	96	6
7	28672	1792	112	7
8	32768	2048	128	8
9	36864	2304	144	9
A	40960	2560	160	10
В	45056	2716	176	11
C	49152	3072	192	12
D	53248	3328	208	13
E	57344	3584	224	14
F	61440	3840	240	15

Using the table: decimal 15 in a register pair = 000F whereas 240

decimal in a single register would = F0. A0B0 hex = 40960 + 176 = 41136 decimal FEDC hex = 61440 + 3854 + 208 + 12 = 65514

CONVERSION OF DECIMAL TO BINARY OR HEXADECIMAL Conversion can be achieved in two ways, successive division or by spotting powers of two. Let's look at an example: To convert 365 into binary by successive division goes as follows:

365 divided by 2 is 182 remainder 1 182 divided by 2 is 91 remainder 0 91 divided by 2 is 45 remainder 1 45 divided by 2 is 22 remainder 1 22 divided by 2 is 11 remainder 0 11 divided by 2 is 5 remainder 1 5 divided by 2 is 2 remainder 1

2 divided by 2 is 1 remainder 0 1 divided by 2 is 0 remainder 1

all successive divisions by 2 will yield the result 0 and the remainder

The very first remainded we obtained the value of 20, the next is 21, the next is 22, etc

So the binary for 365 is 0001 0110 1101 and the hex is 01 6D. Spotting the powers of two would work as follows:

365 is over 256 (28) but under 512 (29) so the binary bit corresponding to 28 is 1

365 - 256 = 109

109 is less than 128, so the bit for 27 is 0 109 is greated than 64 so the bit for 26 is 1

109 - 64 = 45

45 is greater than 32 so the bit for 25 is 1

45 - 32 = 13

13 is less than 16, so the bit for 24 is 0

13 is greater than 8 so the bit for 23 is 1

5 is greater than 4 so the bit for 22 is 1

1 is less than 2 so the bit for 21 is 0

1 is equal to 1 so the bit for 26

We follow this through in the same way as before.

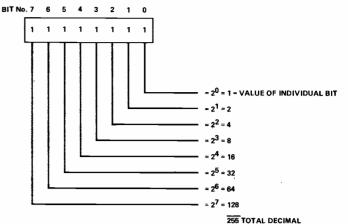


Fig. 2 The make-up of an eight-bit register.

out complicated binary numbers in decimal all the time. A K is 2^{10} , and this is equal to 1024 - it's the nearest convenient binary number to 1000, but note that a capital K is used to distinguish it from the decimal k (= 1000). We just have to hope that the context is such that any numbers are obviously not absolute temperatures (ie in degrees Kelvin or K)!

When you see advertisements extolling the virtues of home computers you will probably notice something along the lines of "16K ROM and 16K RAM". You will know that the ROM is for the routines that the designers have built into the machine. The start of the ROM area is usually (but not always!) address 0, so in the example given, it will extend up to address $16 \times 1024 - 1$, ie 16383 (the -1 is because we've started counting at 0 rather than 1 as is usual outside computers - think of a street with 16 houses, if the first is numbered 0, the last will be number 15).

Unfortunately, this doesn't leave the RAM entirely free for the user to place all his or her programs, data, etc, because the computer needs some space to use for its own internal housekeeping (it stores what are known as the systems variables). It is very important not to over-write or corrupt the areas that the computer needs for this purpose doing so is a very effective way of bringing your micro to its knees (or whatever the micro equivalent of a knee is). However, even in the most modest of systems, there will be more than enough space left for a decent machine code program.

Do You Do Voodoo?

If you are a student of the occult you may have come across the word hex before (I believe it has something to do with casting a spell), but in computing circles it is a word that machine code buffs drop all over the place. Actually it is short for hexadecimal, where hexa is from the Greek pertaining to six, and decimal of course is all about tens, so putting them both together means we are counting using the base 16. Some people may believe that this is the Martian base for counting because they have sixteen fingers! Starting at zero (written as O) we count up to 9 and then we go from A to F where A = 10 decimal and F = 15 decimal

Note that we would write down 10 decimal as OA hex (or OAH), and 15 decimal is OF hex (or OFH): you must get used to the idea of writing hexadecimal numbers as two characters; for example, F on its own is meaningless whereas OF equals 15 decimal, and FO equals 240 decimal. FF hex equals 255 decimal which, if you remember, is the maximum that a register can hold, and also the number that eight bits would represent if they were all 1s which in turn represents one byte (see how it all fits in?), so two hex characters equal one byte. All this means that it is possible to write a machine code program in either binary, decimal or hexadecimal and still get the same result, but I think that you can discount using binary because it's far too cumber-

FEATURE: Machine Code Programming

some (although a knowledge of the binary system is essential for some applications as you will see).

To sum up so far: a machine code program is written to (or placed in) addresses in RAM one byte at a time, some bytes representing instructions, and some representing data. Registers, either singly or in pairs, are used to manipulate the instructions and data, and the processor sorts out all that little lot. According to the information in the programme, different routines in ROM are called into use to give different effects. This is a very simplified explanation, but essentially correct, and although I have only been talking about typical home computers, very much the same sort of process happens in larger computers, only on a much grander scale.

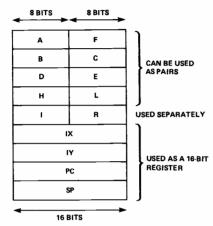


Fig. 3 The Z80 register set. Note that there is also an alternate set of registers A,B,C,D,E,F,H, L, usually referred to as A',B', atc.

I mentioned earlier that I would discuss registers in greater detail, so here we go. Using the Z80 set as a model (Fig. 3), the A register is historically called the accumulator because it was used to accumulate the results of computations. It is still a hard worked register, and there are certain operations that can only be carried out using the A register, but more of that later. The F register is the flags register alias the status register. This is so important to machine code programming that it warrants a section to itself. The B,C,D,E,H, and L registers are general purpose registers which are not found in a lot of CPUs.

When an input device requires the attention of the CPU it sends out a signal called an interrupt. What happens then depends on the CPU type, but usually an indicator signals the fact that an interrupt has occurred, and then the interrupt routine is entered. The Z80 has a rather unique way of dealing with an interrupt, however. Once an interrupt has been acknolwedged, the decive puts the low byte of an address onto the data bus. The high part of the address is in the I register, the two parts forming the address of a routine to handle the interrupt.

The R register is a simple counter (0 to 255) which is used to periodically refresh memory cells in RAM in order not to lose the contents. When a GOSUB is used in BASIC the computer uses a portion of RAM as a stack to store the address of the next instruction to be executed after meeting a RETURN. The stack is also used when pushing and popping (more later) to keep tabs on the addresses. It seems quite logical therefore to have a stack pointer to hold the address of the last item to be put onto the stack, this is the SP pair. The last registers in this set are the two used as a program counter (PC), the PC holds the address of the current instruction.

I have saved the two sets of register pairs IX and IY until now because not many CPUs have these sets. They are used

for indexed addressing which, very simply, is this, using IX as an example. The IX pair are made to hold the address of a table, where information relating to your program has been stored, this is known as the base address. When required the IX pair will meet instructions pertaining to their role in the program. These instructions are in two parts, the first part is a number, which is added to, or subtracted from the base address. This will point to an address in the table. The second part is an instruction relating to what will happen at that address, and this may, or may not influence what happens next in your program.

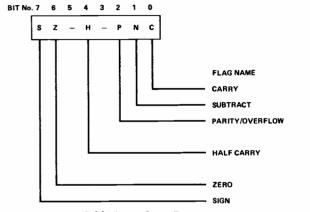


Fig. 4 The flags available in register F.

A Bit Of Flag Waving

As well as the general purpose registers, each processor will have a **flag**, or **status register**. These are constructed in exactly the same way as any other register, but the bits are used as indicators, or **flags**, to signal whether or not certain conditions have been met. The convention is that when a bit is set it is 1, and when reset, it is 0; when the condition has been met the flag is set, and reset otherwise.

Every micro I know of has a zero flag of some sort — one that is set when the contents of a particular register are zero. As an example, let's look at what is involved in the execution of a FOR-NEXT loop; something like this will be taking place: load a register with n (the loop count); do the task contained in the loop; decrement the count (n=n-1); test the flag to see if the register is zero. If it is not, then go back and do the task again; if it is, go on to the next task. Note that both conditions of the flag can apply, and we program the computer to do one thing if the flag is set, another if it isn't.

The more usual flags are zero, parity/overflow, sign, carry, half-carry, substract, and others may be interrupt, decimal and break. Whatever flags your processor uses, get to know them along with the instruction set. Any good computer handbook should give the instruction set, and any good library will have a computer section with a good selection of books on micros.

Other registers will include the **stack pointer** (SP), which may be a pair or a single register, which is used as a pointer to the stack area of memory. **Index registers** may come singly or in pairs, and are usually designated X and Y singly, and prefixed with I in pairs. As their name implies, these are used for indexing along tables of data. If you remember, a program is stored in a number of addresses, so a **program counter** (PC) is used as a pointer to these addresses. One last register: dynamic RAM will need refreshing (electrically) every now and again so that information isn't lost, so there is a **refresh register** (they think of everything). This list isn't exhaustive and don't worry if it isn't all completely clear what's going on. However, I hope that your appetite is whetted enough to probe further into your computer.



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QTY	REF	DESCRIPTION	PRICE	TOTAL.
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	HB/2003	DECODER PCB ONLY	00.83	
Price	inclusive of	VAT & carriage. Please allow	TOTAL	

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ETI/10/83

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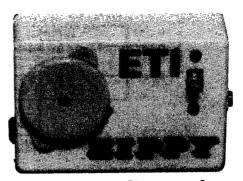
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SUPPLY PROTECTOR



Does that flickering of the house lights all too often indicate that your ZX has just had its memory corrupted? Here's a very simple remedy, designed by Phil Walker.

esigned primarily with the ZX81 home computer in mind but applicable to many others, this project aims to protect the program that you've just spent three hours correcting from short term mains failure or accidental supply disconnection. The sort of thing we mean is the temporary (or worse) dimming of the lights caused by lightning strikes on the grid lines or load switching at a sub-station. These effects usually only last a few tenths of a second but can cause your computer to forget itself and delete your program - resulting in instant frustration!

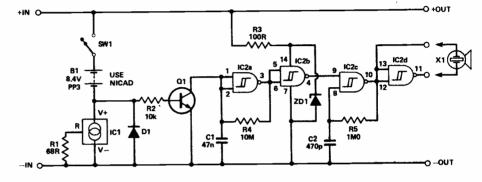
The solution is embodied in this project. What is needed is that the computer should be rapidly switched over to a standby battery. This need only be able to supply the current drawn for a few minutes until the normal supply is restored. The ETI Zippy does this and also sounds an alarm to tell you that

something is wrong

The Circuit

The main part of the circuit consists of B1, D1 and IC1. B1 is a Nickel- Cadmium rechargeable battery with a capacity of 110 mAh at a voltage of around 8.4 volts. This means that when fully charged it should be able to supply a ZX81 for at least 6 minutes - longer if you do not have many extras plugged in. This will even give you time to save your program on tape (provided you have a battery powered tape recorder). D1 effects the switch-over from normal supply to Zippy's internal battery while IC1 recharges the battery while the mains is available. The rest of the circuit provides the audible warning signal from the piezo-electric sounder when the normal supply voltage drops too low.

It is probably a good idea to



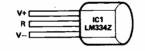




Fig. 1 Circuit diagram of Zippy

HOW IT WORKS

B1 is the main energy store with a capacity of 110 mAh and a terminal voltage of 8.4 volts. IC1 is a constant current device whose operating current is set at about 0.6 mA by R1. This level of

rs set at about 0.6 mA by R1. This level of current can be sent through the battery constantly with little degradation of performance and will keep it ready for use.

D1 blocks current flow from the power pack to the battery but will allow current to flow from the battery on to the supply lines if the power pack voltage drops below about 7.7 volts. This ensures that the supply lines never This ensures that the supply lines never drop below this level. The internal regulator in a ZX81 needs about 6.5 to 7 volts minimum at its input pin to keep it

working correctly.

While the input voltage from the power pack is more than a volt or so greater than the battery voltage, Q1 will be turned on by current flowing through R3. This will keep C1 discharged. This

will cause the outputs of IC2a and IC2c to stay high and IC2b and IC2d to stay

If the input voltage falls below this level, Q1 will turn off and allow C1 to be changed via R4 until it reaches the switching threshold of IC2a. The output of IC2a will now go low and C1 will be discharged via R4 until it reaches the lower switching threshold of IC2a whereupon IC2a output will go high again to repeat the cycle. While IC2a output is low the output of IC2b will be high. This enables a similar oscillator configured around IC2c. The frequency of IC2a oscillator is of the order of 2 Hz while that of IC2c is around 2 kHz; the resulting output from IC2c is bursts of 2 kHz which when applied to the piezo sounder make a slow bleep-bleep noise. IC2d is used to invert the output from IC2c and increase the signal voltage applied to the sounder.

charge the battery periodically so that you don't get caught out.

Construction

The project can be built into a small plastic box of the type made by Bicc-Vero (see Buylines). It is a tight fit in the one specificed so some care must be taken when

siting the switch and input socket. The PCB is designed to fit along one side of the box with the battery along the other. Don't forget to cut the corners off the PCB where marked.

Assembly of the PCB is straightforward but care should be taken when fitting the diodes,



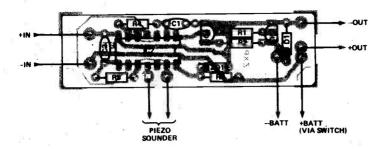


Fig. 2 Component overlay for the PCB

transistor and ICs that they are the right way round. Connect all the lead-out wires except those to the sounder before assembling the

complete unit.

In our unit, the sounder was glued to the outside of the case and the wires taken inside through a small hole. Holes should also be cut for the switch, input socket and output wire. Make sure everything will fit before deciding where these holes will be.

For a ZX81, the input connector is a 3.5mm jack socket and the output wire is terminated in a matching plug (after assembly), but for your system these can be as required. Beware . . . not all power

supplies have the centre conductor positive, so check this before wiring

When everything is ready, put the PCB, switch and input socket in the case, thread the output lead out through the hole provided for it (you did cut one, didn't you?) fit a grommet if you want it to look nice, and wire up the sounder and other components as neatly as possible. Do not have the battery connected while you do this, as it has a very low impedance and can discharge with some violence. The PCB can be fastened in with a bit of sticky tape if you want but it cannot move about much in the limited space available.

PARTS LIST_

	(1 W 5% carbon film)
R1	68R
R2	10k
R3	100R
R4	10M
R5	1M
CAPACITO	RS (disc or plate ceramic etc.)
C1	47nF
C2	470pF
SEMICOND	UCTORS
IC1	LM334Z
IC2	CD4093
D1	
וטן	1N4001 (Germanium or
	Schottky of 1A+ rating
	may improve
	performance)
ZD1	BZY88C15V (or similar
1,2	15V zener)
Q1	BC182L
MISCELLAN	IFOLIS
X1	
B1	PB2720 piezo sounder
DI	8.4 V 110 mAh PP3 size Ni- Cd
SW1	min, on/off slide switch
Box	Vero general purpose
	202-21024B
	ck plug & socket or as re-
1 .	3 battery connector; PCB;
small grom	net, wire etc.

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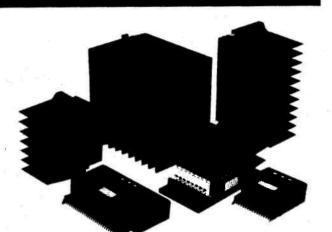


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HY30	15	4-8	0,015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4-8	0,015%	< 0.006%	± 25	120 x 78 x 40	420	£18,69
HY124	60	4	0,01%	< 0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	60	8	0.01%	< 0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	< 0.006%	± 35	120 x 78 x 50	520	£25,47
HY248	120	8	0.01%	< 0.006%	± 50	120 x 78 x 50	520	£25.47
HY364	180	4	0,01%	<0.006%	± 45	120 x 78 x 100	1030	£38.41
HY368	180	8	0.01%	< 0.006%	± 60	120 x 78 x 100	1030	£38,41

Protection: Full load line, Slew Rate: 15v/µs, Risetime: 5µs, S/N ratio: 100db, Frequency response $\{-3d8\}$ 15Hz \sim 50KHz, Input sensitivity: 500mV rms, Input Impedance: $100K\Omega$, Damping factor: 100Hz>400,

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Module Number	Module	Functions	Current Required	Price inc. VAT £7.60	
нү6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble	10mA		
HY66	Stereo pre amp		20mA	£14.32	
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic +	20mA	£15.36	
HY78	Stereo pre amp	separate Volume Bass Treble + Mix As HY66 less tone controls	20mA	£14.20	

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Model Number	For Use With	Price in		
PSIT52X	2 x HY124	£17,07		
	2 x MQS128	£17.86		
PSU 54X	1 x HY248	£17.86		
PSU 55X	1 x MOS248	£19.52		
	2 x HY244	£21,75		

MOSFET MODULES									
Module Number	Output Power Watts rms	Loed Impedance 	mpedance T.H.D. I.M.D.		Supply Voltage Typ	Size mm	WT gms	Price inc. VAT	
MOS 128 MOS 248 MOS 364	60 120 180	4-8 4-8 4	<0.005% <0.005% <0,005%	<0.006% <0.006% <0.006%	± 45 ± 55 ± 55	120 x 78 x 40 120 x 78 x 80 120 x 78 x 100	850	£30.4 £39.8 £45.5	

retection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).

ew rate: 20ν/μs, Rise time: 3μs. S/N ratio: 100db requency response (-3d8): 15Hz - 100KHz, Input sensitivity: 500mV rms put impedence: 100K Ω. Damping factor: 100Hz > 400.

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X in part no. indicates primary voltage. Please insert "O" in place of X for 110V, "1" in place of X for 220V, and "2" in place of X for 240V.

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15 VA 62 x 34mm 0.35Kg Regulation 19%	0x011 6 0x012 12 0x013 15 0x014 18 0x015 22 0x016 25	6+6 9+9 2+12 5+15 8+18 2+22 5+25 0+30	1.25 0.83 0.63 0.50 0.42 0.34 0.30 0.25	£5.12 + på p£0.78 + VATE0.89 TOTAL £6.79	120 VA 90 x 40mm 1.2Kg Regulation 11%	4x010 4x011 4x012 4x013 4x014 4x015 4x016 4x017 4x018 4x028 4x029 4x030	6+6 9+9 12+12 15+15 18+18 22+22 25+25 30+30 35+35 110 220 240	10.00 6.66 5.00 4.00 3.33 2.72 2.40 2.00 1.71 1.09 0.54 0.50	£7.42 + p&p£1.72 + VATE1.37 TOTAL£10.51	. 300 VA 110 x 50mm 2.6Kg Regulation 6%	7x013 7x014 7x015 7x016 7x017 7x018 7x026 7x025 7x033 7x028 7x029 7x030	15+15 18+18 22+22 25+25 30+30 35+35 40+40 45+45 50+50 110 220 240	10.00 8.33 6.82 6.00 5.00 4.28 3.75 3.33 3.00 2.72 1.36	£10.88 + p&p£2.05 + VATE1.94 TOTAL£14.83
30 VA 70 x 30mm 0.45Kg Regulation 18%	1x011 1 1x012 1 1x013 1 1x014 1 1x015 2 1x016 2 1x017 3 2x010	6+6 9+9 2+12 5+15 8+18 2+22 5+25 0+30	2.50 1.66 1.25 1.00 0.83 0.68 0.60 0.50	£5.49 +p&p£1.10 +VAT£0.99 TOTAL £7.58	160 VA 110 x 40mm 1.8Kg Regulation 8%	5x013 5x014 5x015 5x016 5x017 5x018 5x026	9+9 12+12 15+15 18+18 22+22 25+25 30+30 35+35 40+40	8.89 6.66 5.33 4.44 3.63 3.20 2.66 2.28 2.00	£8.43 + p&p£1.72 + VAT£1.52 TOTAL£11.67	500 vA 140 x 60mm 4Kg Regulation 4%	8x016 8x017 8x018 8x026 8x025 8x033 8x042 8x042 8x028 8x029 8x030	25+25 30+30 35+35 40+40 45+45 50+50 55+55 110 220 240	10.00 8.33 7.14 6.25 5.55 5.00 4.54 4.54 2.27 2.08	£14.38 + p & p £2.40 + VAT £2.52 TOTAL £19.30
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80 VA 90 x 30mm 1Kg Regulation 12%	3x011 13x012 113x013 113x014 113x015 213x016 213x017 3x028 3x029	6+6 9+9 2+12 5+15 8+18 2+22 5+25 0+30 110 220 240	6.64 4.44 3.33 2.66 2.22 1.81 1.60 1.33 0.72 0.36 0.33	£6.66 + påp£1.72 + VAT£1.26 TOTAL £9.64	T3	6x017 6x018 6x026 6x025 6x033 6x028 6x029 6x030	30+30 35+35 40+40 45+45 50+50 110 220 240	3.75 3.21 2.81 2.50 2.25 2.04 1.02 0.93	+ P&P £2 05 + VAT£1.78 TOTAL £13.64		9x030	240	2.60	√A are

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Output Voltage	+13.8v ± 5%	+13.8v ±5%
Output Current	Up to 3A	Up to 6A
Current limit (nominal)	3.5A approx	7A approx
Maximum Input Voltage	+30v	+30v
Minimum Input Voltage	+16v	+16v
Maximum Input Voltage for nominal output current	+20v	+20v
Maximum output current at 30v input	1.8A approx	3.5A approx
Output ripple (100Hz) - See Note 1	<10mV rms	<10mV rms
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CURVING ELECTRONS

Magnetic fields can be mind-bending when you try to understand what's going on. They can also bend the paths of poor little innocent electrons, too. John Dance shows us a practical import of this phenomenon.

iscovered as long ago as 28th October, 1879 by Edwin Hall of the John Hopkins University, Baltimore, the Hall effect found few applications until high quality semi-conductor materials became available since it is so small that it is difficult to detect in metals. Hall found that if a magnetic field is applied to a current carrying conductor at right angles to the direction of the current flow, a potential difference appears across the material in a direction which is at right angles to both the direction of the current flow and to that of the magnetic field.

In Fig. 1(a), the potential applied between the two electrodes causes an electric current to flow through the material. If this material is homogeneous and no magnetic field is present, the current flow through it is of uniform density. In the case of the P-type semiconductor material shown, current is effectively carried by the majority hole carriers which behave as positive charges, and these move in the same direction as the conventional current flow in the external wires.

If a magnetic field is now applied so that its direction is into the paper, Fleming's left-hand motor rule indicates that the moving holes will experience a force towards the left and will tend to curve in this direction, as shown in Fig. 1(b). As holes cannot flow out of the left-hand face of the block of P-type material, some positive charges will accumulate there. Similarly, negative charges will accumulate on the right-hand face of the block of material since no holes can flow into this face.

The electric field created by these charges tends to repel the holes from the positively charged left-hand face

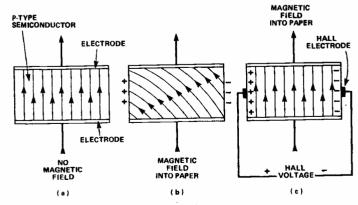


Fig. 1 (a), (b) and (c) The Hall effect illustrated by hole flow.

towards the negatively charged right-hand face. The field increases until the positive charges are again moving uniformly across the block of semiconductor material as shown in Fig. 1(c). Any tendency on the part of the positive charges to move to the left will increase the electric field, causing the charges to move directly across the block of material so that the balance is accurately restored. A pair of Hall electrodes placed in the position shown in Fig. 1(c) can be used to detect the Hall voltage produced in this way.

In the case of N-type semiconductor materials in which the majority carriers are electrons, the flow is in the opposite direction to that of the conventional current in the external wires. The left-hand rule again shows that the charge carrier movement is towards the left, but in this case the negative charge carriers build up a negative charge on the left-hand side and a positive charge on the right-hand side. Thus we can use the Hall effect to distinguish between N and P-type materials by detecting the polarity of the Hall effect voltage produced.

the polarity of the Hall effect voltage produced.

In most metals one obtains a Hall effect voltage with the same polarity as in an N-type semiconductor material, since conduction is by means of electrons. However, the Hall voltage is much smaller than in semiconductor materials and a few metals, such as zinc, produce a Hall voltage of the opposite polarity; in such metals the interaction of the moving electrons with fixed positive ions results in the current being effectively carried by holes. Intrinsic (pure) semiconductor materials show a small Hall effect; although the numbers of electrons and holes per unit volume are approximately equal, the electrons are more mobile, and the overall behaviour is normally like that of an N-type material.

The Hall effect in semiconductor materials produces a much larger Hall voltage than in metals because the number of charge carriers per unit volume is far smaller. The Hall voltage, $V_{\rm H}$, is given by the equation:

$$V_H = \frac{BI}{Net}$$

where B is the magnetic flux density

I is the current flowing through the specimen N is the number of charge carriers per unit volume

e is the charge of an electron $(1.6 \times 10^{-19} \text{ coulombs})$

t is the thickness of the specimen. If one considers a piece of copper of thickness 1 mm carry-

ing a current of 1A in a magnetic field of 1 Tesla (10,000 Gauss), V_H works out as a mere 62.5 nV, since N is about 10^{29} electrons per m³ for copper. It is extremely difficult to measure 60 nV in such a circuit. In silicon, however, N may be 10,000 times smaller, so under the same conditions one obtains a V_H value of 625 μ V which is a much more reasonable voltage for measurement. Hall first detected the effect using a thin gold foil.

The Hall effect has been widely used in materials science research where it enables information to be obtained about the charge carriers. When indium antimonide semiconductor Hall cells became available, they were used for the measurement of magnetic fields, but indium arsenide produces a Hall cell with about one-tenth of the temperature coefficient of indium antimonide, although its Hall output voltage is lower. Hall cells can be used as multiplying devices, for example in wattmeters, where a voltage is used to generate a proportional current through a Hall cell using a series resistor, while the load current passes through coils which generate the magnetic field in which the Hall cell is placed. Thus the output is proportional to the product of the voltage and current.

Other important applications of discrete Hall devices include their use in brushless DC motors in which the conventional brush and commutator system is replaced by Hall effect devices and suitable amplifiers. The use of such brushless motors avoids the inconvenience of brush replacement and improves reliability, but the elimination of sparking at the brushes is perhaps the most important advantage where low electrical noise is important (such as in high quality tape recording equipment).

Hitachi developed a Hall effect tape replay head in 1977 which is stated to have a high signal-to-noise ratio and excellent transient response (since it is non-inductive). A thin film of indium antimonide is employed, the output being determined only by the magnetic flux present so that a constant response is obtained at the lower frequencies — even down to zero frequency.

Monolithic Hall Devices

Silicon Hall effect devices have the great advantage that other circuitry can be integrated on the same silicon chip using normal IC production processes. Unfortunately the Hall voltage from silicon cells is about a hundred times smaller than that of Hall devices made from indium arsenide, but the temperature stability of silicon devices is far better and the small output levels can be amplified by on-chip components. Typical Hall voltage outputs from silicon cells are in the millivolt to tens of mV region, depending on the operating conditions.

Although most Hall effect devices are used in switching circuits, there are plenty of applications for linear

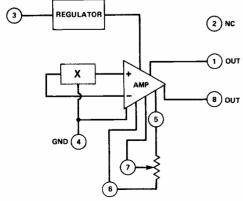


Fig. 2 Block diagram of a monolithic linear Hall effect device.

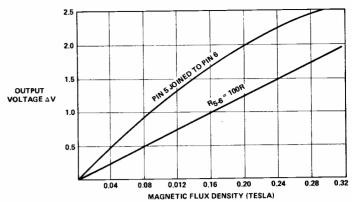


Fig. 3 Output voltage versus magnetic flux density for a UGN-3501M.

Hall devices. The basic internal circuit of the Sprague UGN-3501M linear device is shown in Fig. 2; it can be seen that the small output from the Hall cell itself is amplified by an op-amp. Offset output nulling facilities are included in this eight-pin DIL device, but not in the UGN-3501T which has only 3 connections. The UGN-3501T operates on from 8 to 12 V and the UGN-3501M from 8 to 16 V power supplies. The output voltage from a UGN-3501M device at various values of magnetic flux density with a 12 V supply, a 10 k load and two different values of resistor between pins 5 and 6 are shown in Fig. 3. The frequency response of these devices extends to about 25 kHz (-3dB). The sensitivity of the UGN-3501T is roughly twice that of the UGN-3501M.

Fig. 4(a) shows an application of the UGN-3501T as a ferrous metal detector and Fig. 4(b) is the circuit used. The pole of the magnet is fixed in contact with the Hall device and the output falls by 20 mV peak as the 25 mm steel ball rolls above the sensing device. This signal is amplified by a 741 device and drives the 2N8512 to conduction so that 0.5 A passes through the load. The low frequency response may be controlled by changing the value of the 22 µF coupling capacitor and high frequency attenuation may be introduced by using a small capacitor to shunt the feedback resistor of the 741.

By attaching the opposite pole of the magnet to the

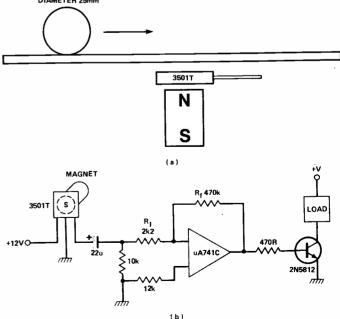


Fig. 4 (a) and (b) A ferrous metal detector using the UGN-3501T.

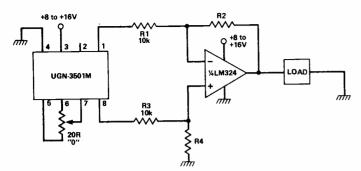


Fig. 5 A Hall effect switch using the UGN-3501M.

Hall device, it can be made to sense the absence of fer-

romagnetic material rather than its presence.

Fig. 5 shows the use of a LM324 operational amplifier to supply a voltage gain and to transform the differential output of a UGN-3501M into a single-ended output so that the circuit can drive a load which has one side earthed. The LM324 can be operated from a single power supply provided that the output does not swing below 0V. The connections shown are suitable for the detection of the field from a south pole, but if that from a north pole is to be detected, pins 1 and 8 should be reversed.

Another application for linear devices is in flux-meters, but calibration will be required. A typical UGN-3501M provides a differential output of about 1.4 mV in a 0.1 T field. The response is quite linear to 0.1 T, but the useful linear range can be extended to 0.3 T if a resistor of about 47 R is placed between pins 5 and 6 (see

Fig. 2).

Linear devices can also be employed in current measurement applications. The device may be placed in the gap of a toroid and the current passed through a coil on the toroid. This may be used for overload detection in

electric motors, current limiting, etc.

Siemens have recently introduced a KSY 10 linear Hall effect position sensor in which a gallium arsenide (GaAs) substrate is employed. This device is unique in that it is manufactured by an ion implantation planar technique which produces a doped layer only 0.3 µm in thickness; the use of this thin layer enables a sensitivity of 200 ± 30 V/AT to be obtained with a temperature coefficient of only about $\pm 5 \times 10^{-4}$ per degree K. For example, it will provide a Hall output of about 200 mV with a 5 mA control current in a field of flux density 0.2 T. The sensitivity can be selected in the range 30 to 300 V/AT by choosing the appropriate ion doping level during manufacture. The two Hall voltage output connections and the two control current connections are interchangeable, since the active sub-regions are symmetrical.

The output from the KSY 10 device is proportional to the effective magnetic field and to the control current passing through the device. The sensor is only 1 mm deep, so it can easily be positioned in the magnet yoke of current converters for current measurements. The active area itself is a mere 0.2 mm by 0.2 mm and lies 0.35 mm behind the front of its mini-plastic case. The device is very suitable for determining the position or speed of toothed gears or of rack and pinion mechanisms. The wide band gap of the gallium arsenide material used enables this device to be used at temperatures of up to 150°C, so applications in the engine compartment of motor vehicles are envisaged and

it may also be used in brushless DC motors

It is interesting to note that Yoshito Takehana's Group of the Electronic Devices Development Division of the Sony Corporation of Tokyo has developed a very sensitive silicon Hall effect sensor inside a special transistor. The output terminals of this magnetic sensor are in the reverse

biased depletion layer; a magnetic field perpendicular to the flow of the charge carriers between the base and collector terminals will produce an output of about 85 V/cm at a flux density of 0.1 T. If such a linear device is successfully developed to the production stage, a much wider field of application may be opened to Hall effect sensor devices at some future date.

Switching Devices

Switching or digital Hall effect monolithic devices are especially easy to use and are finding many applications in keyboards, in vehicle circuits, in toys and in any applications where movement must be converted into an elec-

trical digital type of signal.

The basic circuit of a typical Hall effect switching device is shown in Fig. 6. An on-chip regulator is usually incorporated in the device, since this is necessary to produce a constantly repeatable performance, especially in automobile applications where the supply voltage can vary over a wide range. The regulator supplies a constant current through the Hall cell (shown by a X in Fig. 6) and the two connections which supply the Hall output voltage feed the inverting and non-inverting inputs of a comparator device which in turn drives a Schmitt trigger circuit and an output stage.

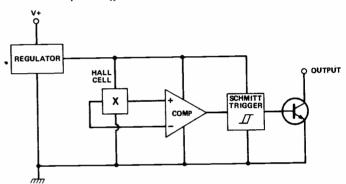


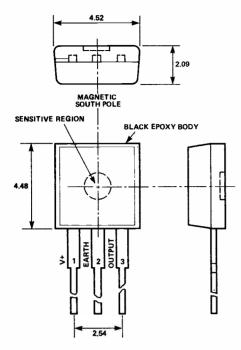
Fig. 6 Block diagram of a monolithic switching Hall effect device.

When the magnetic flux density in the Hall cell changes, the Hall voltage from this cell will change so that the comparator will switch the state of the Schmitt trigger circuit. A suitable amount of hysteresis is built into the circuit so that if a small increase in the magnetic flux density causes the output to switch into its other state, an appreciably larger decrease in the flux density will be required to cause the circuit to switch back to its former state. This prevents repeated rapid switching between the two states for very small changes in the flux density.

The Sprague UGN-3019T device (formerly coded ULN-3006T), is an economical product very suitable in most applications for the experimenter. This is encapsulated in the T-type package shown in Fig. 7, the Hall element itself being at the centre of one face of the device as indicated. As Hall effect devices are used in conjunction with a magnetic field, it is obviously important that the package used should allow the device to be easily orientated with respect to the field and to be easily mounted. The type of package shown is, in the opinion of the writer, usually more convenient for magnetic field sensing than the dual-in-line packages sometimes used for Hall Effect designated UGN-3201M (formerly The sensors. ULN-3006M) is very similar to the UGN-3019T, but is mounted in an 8-pin dual-in-line package.

The UGN-3019T may be used in the basic circuit of Fig. 8. In the absence of any magnetic field, the internal output transistor is cut off and passes only a very small col-

FEATURE: Curving Electrons



ALL DIMENSIONS IN MILLIMETRES

Fig. 7 The UGN-3019T — "T" type package.

lector current (typically, 1 μ A, maximum 20 μ A). The output voltage is therefore 'high' and has a value which is almost equal to the positive supply voltage; this supply voltage may have any value from +5 V to +16 V with an absolute maximum of +20 V (above which the device may be damaged).

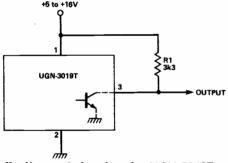


Fig. 8 A Hall effect switch using the UGN-3019T.

If a magnetic field of adequate flux density and of the correct polarity is now applied perpendicular to the face of the device, the internal Hall cell provides a voltage to the comparator of Fig. 6 which switches the Schmitt trigger so that the output transistor in the device conducts. The output falls to its low state with a typical value of +0.15 V and a maximum value of +0.4 V. The UGN-3019T can sink a current to its output of up to 15 mA, so the load resistor R1 of Fig. 8 must be chosen so that not more than 15 mA will flow into pin 3 with the particular value of positive supply voltage used.

The writer found that a UGN-3019T would switch to its low voltage output state when a small bar magnet was brought within about 3 mm of the centre of the body of the device. Owing to the built-in hysteresis in the internal circuit of the device, it did not revert back to the 'high' output state until the bar magnet was withdrawn to a distance of over 10 mm. The hysteresis characteristics of the ULN-3019T are shown in Fig. 9. A typical device switches to the 'low' output state at a field of 0.05 T and all devices are certain to switch at a field of 0.075 T at the centre of their face. A typical device reverts to the 'high'

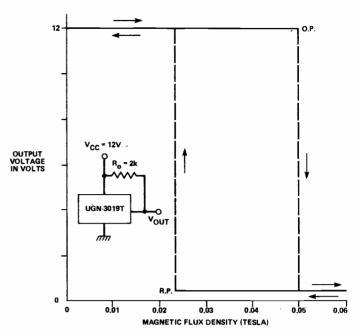


Fig. 9 Output voltage versus magnetic flux density for a UGN-3019T.

output at 0.0225 T and all devices at a value not less than 0.01 T. The device is unaffected by small stray magnetic fields from any transformers, relays, etc. which may be near to it.

UGN-3019T circuits are unaffected by the application of a field of the opposite polarity to that required to switch the output to the low voltage state. If the field is too weak to cause switching to the low output state, an improvement in the sensitivity can be obtained by placing a piece of iron or other ferromagnetic material on the far side of the device from the magnet as close to the device as possible. A greater increase in sensitivity can be obtained if the device is placed between two magnets with opposite poles on each side of the device. It is important that the magnet should be moved on a line directly towards the centre of the device, since a displacement of about 3 mm from the centre line can more than double the required flux density.

The UGN-3019T requires a supply current of about 7 mA (maximum 9 mA) with a 5 V supply and about 12 mA (maximum 16 mA) with a 12 V supply. A particular advantage of Hall effect switching devices over mechanical contact switching is their high speed of operation, the rise and fall times being measured in nanoseconds with operating speeds of up to about 100kHz. The output pulses are 'clean' without the 'bouncing' which is characteristic of mechanical contacts. Monolithic Hall effect devices are comparable in price to reed switches.

Using Hall Switches

An important use of Hall effect switching devices is for the detection and measurement of rotation. Many types of mechanical system arrangement are possible. In the 'slide by' mode one or more small magnets are mounted on a spinning disc and these magnets pass close to the face of a Hall effect IC. Each time a magnet passes the device, the circuit switches first to its low output voltage state and then back to the high output voltage state as the magnet moves away from the device.

An alternative system is the 'vane switch' technique, in which soft iron vanes attached to the rotating metal disc pass between the magnet and the Hall device. Each time a vane passes through this gap, the magnetic flux no longer

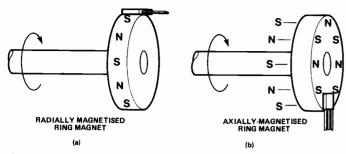


Fig. 10 (a) and (b) Ring magnet revolution indicators.

reaches the Hall device owing to the shielding effect of the iron in the vane, and the Hall circuit switches back to its high output voltage state.

Fig. 10(a) shows a system for detecting rotation which uses a radially-magnetised ring magnet. Suitable inexpensive ring magnets for use with either type of system are readily available. Up to eight pulses per revolution per 10 mm diameter of the magnet disc are possible, so 80 pulses per revolution can be obtained from a 100 mm diameter disc. These two arrangements have been designed for the UGN-3030T device; this is similar to the other devices discussed except that switching to the low voltage state occurs at a typical flux density of 0.016 T (maximum 0.025 T) and return to the high voltage state at 0.011 T (minimum 0.025 T). The power supply current required is only about half that needed for the UGN-3019T. It should be noted that to ensure switching of the UGN-3030T back to the high voltage state, a field of the opposite polarity is required of flux density -0.025 T; this is provided by the use of alternate polarity magnetic poles in the ring magnets of Figs. 10(a) and 10(b).

Rotational systems as described above have a very wide range of use in engines and machinery. One that many readers will have first-hand experience of is in car ignition circuits, where the contact breakers are replaced. This leads to the ignition timing being a once-and-for-all setting, as there is no wear, and this can only help improve fuel economy and lower exhaust pollution.

The same sort of sensor head can be used for measuring rotational speeds and counting the number of revolutions. In this case possibly the best course to take with the electronics is to have a pulse-generating circuit after the Hall effect device, so that the pulses can either be counted or fed to an analogue meter (to get a rate of revolution indication).

When fitted to a vehicle wheel such a system could have a further important use, namely in an anti-skid braking system. In this the electronics would detect when the wheel was not turning while the car was still moving. The system would then momentarily reduce the brake

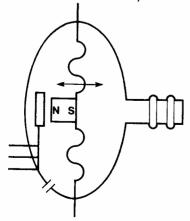


Fig. 11 A Hall effect pressure switch.

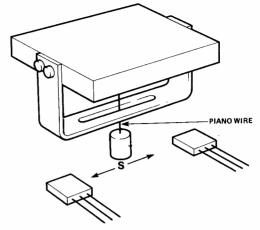


Fig. 12 An acceleration sensing system.

force to the wheel so that it would turn again and control would be restored, after which full braking force would be restored. This has the effect of pumping the brakes — but be warned, it's not eary to construct such a system, and we strongly recommend not trying!

Hall effect devices can be used to detect linear motion; Fig. 11 shows a simple pressure switch. Coupled with a push-button, this sort of arrangement is common in keyboard switches. A similar application is as an acceleration detector, and Fig. 13 shows how this can be done. In this, acceleration forwards or backwards causes the magnet to move nearer to one of the two Hall devices. Conversely, the tilt sensor in Fig. 13 works by detecting when the magnet moves away from directly above the Hall device.

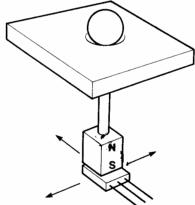


Fig. 13 A Hall effect tilt sensor.

As transducers go, Hall Effect devices can give a relatively large switching capability, being capable of sinking ample current to interface directly with TTL. Fig. 14 shows a suitable circuit for interfacing to CMOS devices.

Fig. 15 shows a handy buffer circuit that can be used to drive larger loads, such as a 12 V relay coil. In Fig. 14, when the magnetic field is strong enough, the output from the Hall device will be low and the transistor will be off. Hall devices can drive reed relays directly provided that they do not pass too much current, and provided that a transient suppressing diode is connected across the coil to prevent the back-EMF from destroying the Hall device (the diode cathode should go to the positive terminal of the relay coil).

If a Hall device such as the UGN-3030T is required to control a triac such as the RCA 40669 which can handle up to 8 A RMS, a transistor amplifier stage is required between the Hall device and the triac as shown in Fig. 16. When the Hall device conducts, a current of 9 mA flows from the base of the PNP 2N5811 transistor which in turn

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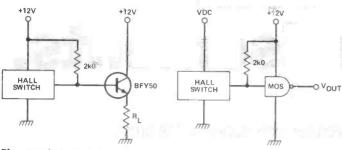


Fig. 14 (left) Driving CMOS from a Hall effect device. Fig. 15 (right) A current amplifier for the Hall device.

supplies 80 mA to the triac gate to turn on the load current. It should be noted that the Hall device is connected to one side of the mains supply; this could be avoided by the use of an opto-coupling device between the Hall IC and the triac circuit.

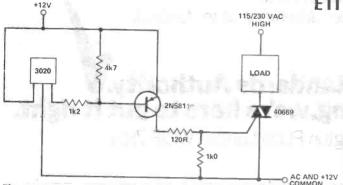


Fig. 16 AC power control using a Hall effect device.

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TECH TIPS

ZX81 Background Reverse

F.W. Picken, Stoke on Trent

This simple circuit uses readily available (and cheap!) components to provide white symbols on a dark background. It can be put together on a small piece of circuit board which could then be housed inside the case of the computer and held in position by double-sided tape or Araldite.

The change-over switch, used for switching from black symbols on white and vice-versa, can be

mounted on the side of the case, a push-on push-off type probably being the most suitable due to ease of mounting. The power requirement is

B O NOTE:
IC1 IS 4011B
D1 IS 1N4148

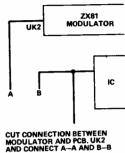
B O 101 IS 101

ple: IC1a and c carry the negative-going sync pulse and nothing else, thus ensuring that this is not inverted. The remainder of the video signal is inverted by IC1b. The value of RV1 needs careful setting to obtain the best results.

very low, and can be taken from the

Action of the circuit is very sim-

ZX81 supply line.



Sophisticated 5V Supply

A.J.J. Gilchrist, Paris

This supply will deliver up to 6A at +5V. It has an active overvoltage clamp on the output. Current is limited at around 6A and has foldback short-circuit protection.

Starting on the line side, S1 is a transient suppressor which helps protect the supply against high voltage transients (studies have shown spikes of 5kV to be common on the domestic mains!), and C1, R1 cut down on switch arcing when the supply is switched off. R2 is a bleed resistor which is useful if the suply is not permanently connected as it prevents the output staying high after the unit is switched off.

Q2 is the pass resistor, it is switched on by R3 when more than 100mA is being drawn from the supply. Q1 and Q3 provide the current limiting. When current through R7 is 6A the voltage on the base/emitter junction of Q3 is given by:

$$V = V_{out} - \frac{R5*(V_{out} + R7*6)}{(R5 + R6)}$$

= 0.58V for the values shown.

Thus Q3 begins to conduct, switching Q1 on, which increases the base voltage of Q2, thus limiting the current.

This arrangement also provides foldback limiting. If we consider the output shorted, the voltage at the base of Q3 will be about 0.6V; thus the voltage at the collector of Q2 is approximately given by:

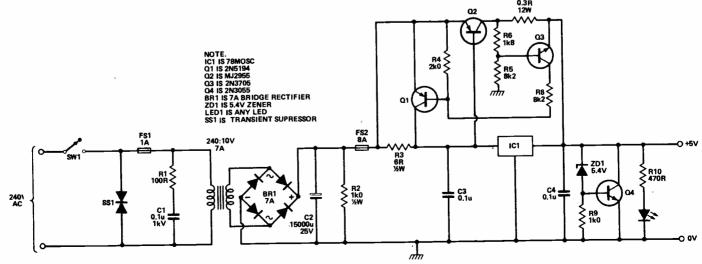
$$V = 0.6(R6 + R5)/R5$$

= 0.7V

thus the current supplied will be i = 2.3A. The foldback current may be changed by altering R5, R6 and R7. I have set this high to ensure the supply starts up under heavy loads.

ZI, R9 and Q4 provide an active overvoltage clamp. When the output voltage rises above the zener drop plus the switch-on voltage for Q4, Q4 conducts. This circuit is capable of sinking 15A indefinitely (with a proper heat sink) with a much higher peak current. This ensures that the fuse blows before the protection circuit. This active clamp is necessary because one of the most common types of failure in power supplies is the pass transistor failing with the collector/emitter junction shorted.

Note that Q1, Q2 and Q3 should all be mounted on heat sinks, and Q1 must be capable of passing the maximum output current of the 78M05 (500mA).



Ramped Pulse **Generator For Stepper Motors**

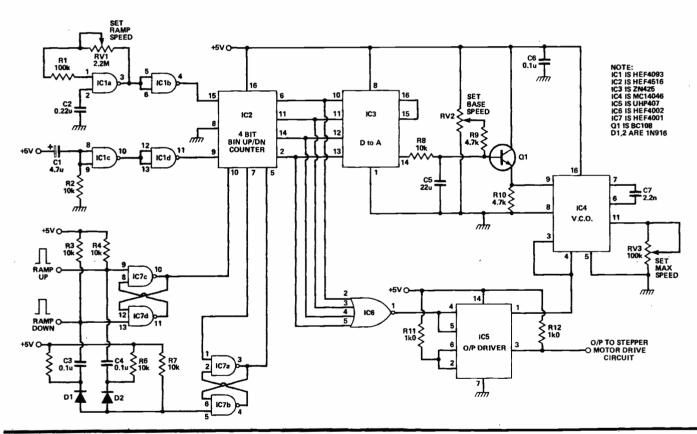
Clive Pantrey Farnborough

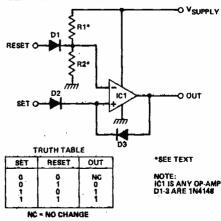
A circuit that I needed for use with an experimental robot arm was one which would ramp up or down the pulse repetition rate of pulses delivered to a stepper motor drive circuit. With the motor stopped, the command 'ramp up' should start the motor at its base speed (ie the speed at which the motor will start and stop

under load, without loss of synchronisation), ramp up to maximum speed (the top speed available without loss of synchronisation) and run for as long as required. The command 'ramp down' should make the motor slow down to base speed and then stop.

The figure shows the circuit that was eventually produced. IC1a/b provide clock pulses (Ramp Speed) to a four-bit binary up/down counter, IC2. On receipt of a ramp up command IC7c/d sets count up and IC7a/b enables the counter. Unless a ramp down command is received the counter will reach its maximum count (Max Speed) and hold at this until the ramp down command is

received; this will set count down and enable the counter, which will count down to zero (Base Speed), and hold again until the next ramp up command. The counter output drives a D-to-A IC3 whose ramping output controls the VCO, IC4. The lower frequency of the VCO, (Base Speed) is set by the bias adjustment of Q1. Upper frequency (Max Speed) is set by the 100k pot at pin 11 of IC4. IC5 provides open collector drive for the output pulse train and also the on/off gate, controlled by IC6, when the counter is at zero. IC1c/d provides a set zero pulse to IC2, to ensure that the output, at pin 3 of IC5, is at base speed and off each time the generator is switched on.





Latch

T. P. West, Lancaster

Although CMOS gates are commonused to provide analogue amplifiers, the operational amplifier is often overlooked for use in digital applications. Often, a circuit design calls for a set-reset latch within an analogue circuit: this normally requires digital circuitry to be included in the design. By the use of this cir-

Analogue Set-Reset

cuit, spare op-amps in a package may be utilised to provide the set-reset function. The op-amp used may be of any type with the low and high voltages at the output being only a function of the op-amp's internal output drive circuitry. The resistors R1 and R2 should be chosen so that R2 2.4R1 and R2 < V_{supply}/0.05. Although the circuit is shown for a single supply rail, it will work on a dual supply but produces a low of around the negative supply voltage. All changes in state occur on the lowto-high transition. ETI

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7414 7416 7417	20p	74351 150 74365A 30	P 74LS324 P 74LS348	150p 120p	4028 4029	40p 45⊜	6-way 105p LM377 175p 10-way 150n LM380 75p	\$566B 225p \$AA1900 £16	8080A 250p 8085A 350p	Z80ACTC 280p Z80ADART	TMS9927 £14 TMS9928 £20	ICs	1.8432 210p 2.00 225p
7420 7421	20p 16p 18p	74366A 30 74367A 30 74368A 30	P 74LS353	60p		15p 125p	AD7581 £14 LM382 120p ADC0808 990p LM386 90p	SAD1024A 850p	8086 £22 8088 £18 8748 £18	Z80ADMA £9	INTERFACE	8271 £36 8272 £20	2.45760 210p 2.5 250p
7422 7423	20p 18p	74376 100 74390 75	P 741 S363	250p 140p 140p	4032 4033 4034	80p 125p 140p	ADC0808 990p LM386 90p AN103 200p LM387 120p AY1-5050 99p LM389 95p	SFF96364 800p SN76488 450p SN76489 480p	INS8060 £11 TMS1601 £12	Z80SI 0/1/2 £9 MEMORIES	ICs	FD1771 £20 FD1791 £22	2.662 250p 3.276 150p 3.5795 100p
7425 7426	20p 18p	74393 90 74490 90	P 74LS365	27p 27p	4035	45p 275p	AY3-1270 750p LM391 150p AY3-1350 350p LM392N 60p	SN76495 400p SP0256AL £10	TMS9980 £20 TMS9995 £12	2102-3L 120p	AD558CJ 776p AD561J £20	FD1793 £23 FD1795 £28 FD1797 £28	3.686 300 p 4.00 150 p
7427 7428 7430	20p 18p 14p	74LS SERIES 74LS00 11	74LS368	27p 27p	4037 4038	110p 110p	AY3-8910 350p LM393 100p AY3-8912 500p LM394CH 300p	TA7120 150p TA7130 160p	Z8 £24 Z80A 300 p	2111A 300p 2112-A 300p 2114-2L 100p	AM25S10 350p AM25LS2521	FD2793 £42 FD2797 £42	4 194 200 p 4 43 110p
7432 7433	18p 22p	74LS01 11 74LS02 12	P 7415374	55p 55p 45p	4040	290p 40p	AY5-3600 600p LM709 36p AY5-4007D LM710 50p 520p LM711 70p	TA7204 150p TA7205 90p	Z80AS10/0/1 £9 Z80AS10/2/9	2147 450p 4027-3 -300p	AM26LS31	WD1691 £15 WD2143 550p.	4.608 250 p 4.915 250 p 5.0 175 p
7437 7438	22p 22p	74LS03 12 74LS04 12	P 74LS377 P 74LS378	60p 75p	4041 4042 4043	40p 40p	CA3028A 120p LM725 300p CA3019 80p LM733 60p	TA7222 150p TA7310 150p TBA231 120p	Z80B £9	4116-15 120 p 4116-20 90 p	AM26LS32 125p	CHARACTER	5.068 £2 6.0 150p
7439 7440 7441	25p 15p 55p	74LS05 14 74LS08 14 74LS09 14	P 74LS390	80p 50p	4044 4045	40p 105p	CA3046 70p LM741 18p CA3048 220p LM747 70p	TBA810 100p	SUPPORT DEVICES	4118-3 450p 4164-2 400p 4164-15 450p	D7002 390p DAC80 £28	GENERATORS RO3-2513	6.144 150 p 7.0 150 p
7442A 7443	70p	74LS10 14 74LS11 14	P 74LS395/	50p 90p 160p	4046 4047 4048	50p 45p	CA3059 285p LM748 35p CA3060 350p LM1011 480p CA3080E 70p LM1014 150p	TBA820 80p TBA950 225p	2651 £12	4416-15 500p 4532-20 250p	DM8131 275p DP8304 250p	U.C. 750p L.C 700p	7.168 175p 8.00 175p 8.86 175p
7444 7445	70p 60p	74LS12 14 74LS13 16	74LS445	100p	4048 4049 4050	50p 24p 24p	CA3086 48p LM1801 300p CA3089E 200p LM1830 250p	TC9109 750p TCA210 250p TCA220 350p	3242 800p 3245 450p 6520 280p	4816AP-3 2 70 p 5101 300 p	DS3691 300p DS8830 150p DS8831 140p	DM86564 £12 MC66760 750 p	10.00 175p 10.5 250p
74464 74474 7448		74LS14 25 74LS15 14 74LS20 14	P 74LS466 P 74LS467	90p 90p 200p	4051 4052	45p 60p	CA3090AQ LM1871 300p 375p LM1872 300p	TCA270 350p TCA940 175p	6522 310p 6522A 550p	5516 750p 6116-3 420p 6116LP-3 550p	DS8832 250p DS8833 225p	SN74S262AN £10	10.7 150p 12.00 150p
7450 7451	15p 15p	74LS21 14 74LS22 14	74L\$540	120p	4053 4054	50p 90p	CA3130T 110p LM1889 350p	TCA965 120p TDA1004A £3	6532 550p 6551 650p	6514-45 200p 6810 120p	DS8836 150p DS8838 225p	KEYBOARD	14.318 175p 14.756 250p
7453 74 54	15p 15p	74LS26 14 74LS27 14	74LS610 74LS612	£19 £19	4055 4046 4059	90p 90p 450p	CA3140T 90p LM3302 75p CA3160F 100p LM3900 50p	TDA1008 320p TDA1010 200p	6821 100p 68B21 220p 6829 £12.50	74S189 150p. 74S201 350p	LF13201 450p MC1488 55p MC1489 55p	ENCODER AY5-2376 950p	15.00 200 p 16.00 200 p 17.7 200 p
7460 7470 7472	15p 30p 25p	74LS28 14 74LS30 14 74LS32 14	p 74LS626	90p 150p 150p	4060 4063	55p 90p	CA3161E 150p LM3909 85p CA3162E 450p LM3911 125p	TDA1022 500p TDA1024 120p TDA1170 300p	6840 375p 68B40 600p	74\$289 150 p 93415 600 p 93425 600 p	MC3418 950p MC3446 250p	74C922 500p 74C923N 500p	18.00 200p 18.432 150p
7473 7474	25p 20p	74LS33 14 74LS37 14	p 74LS629 p 74LS640	90p 100p	4066 4067 4068	27p 225p	CA3189E 300p LM3914 200p CA3240E 110p LM3915 200p CA3280G 200p LM3916 225p	TDA2002 325p TDA2003 325p	6850 110p 68850 220p	93L422 950p	MC3459 450p MC3470 650p MC3480 850p	BAUD RATE	19.968 150p 20.00 200p 24.00 £2
7475 7476	22p 25p	74LS38 15 74LS40 14	74LS640- 74LS641	1150p 100p	4068 4069 4070	14p 14p 14p	D7002 390p LM13600 110p DAC0800 £2 M51513L 230p	TDA2006 350p TDA2020 320p TDA7000 350p	6852 250 p 6854 700 p 68B54 800 p	ROMs/	MC3486 500p MC3487 300p	GENERATORS	26.690 150p 38.6667 175p
7480 7481 7482	48p 120p 65p	74LS42 30 74LS47 40 74LS48 40	74LS643-	1150p 100p	4071 4072	14p 14p	DAC0808 £2 M51516L 500p DG308 300p MB3712 200p	TLO64 95p TL071/81 25p	6875 570 p 8154 950 p	PROMs 74S188 140p	MC4024 325p MC4044 325p	MC14411 700p COM8116 800p 4702B 750p	48.0 175p 55.5 400p
7483A 7484A	38p	74LS51 16 74LS54 16	74LS644 74LS645	100p 100p	4073 4075	14p 14p	HA1366 190p MB3730 400p HA1388 250p MC1310P 150p ICL7106 700p MC1413 75p	TL072/82 45p TL074 100p	8155 350p 8156 350p	74\$287 200 p 74\$288 140 p	MC14411 675p MC14412 750p 75107 90p	UARTS	116 300 p 145.80 250 p
7485 7486	60p 18p	74LS55 16 74LS73 18	7415668	1150p 70p 70p	4076 4077 4078	16p 16p	ICL7660 200p MC1490 30p	TL083 75p TL084 90p TL094 200p	8205 225 p 8212 110p 8216 100p	74\$387 225p 74\$473 850p 74\$474 650p	75110/12 160p 75114/15 160p	AY-3-1015P 300p	REAL TIME
7489 7490A 7491	170p 20p 35p	74LS74A 18 74LS75 20 74LS76A 20	74LS670 74LS674	90p 550p	4081 4082	14p 15p	ICL7611 95p MC1495L 350p ICL8038 300p MC1496 70p	TL170 50p	8224 110p 8226 250p	74S474 650p EPROMs	75121/22 140p 75150P 120p	AY-5-1013P 300p	MK3805 ETBA
7492A 7493A	25p	74L\$83 38 74L\$85 36	74LS682	250p 400p	4086 4089	55p 125p	ICM7217 750p MC3340P 120p ICM7555 80p MC3401 50p ICM7556 140p MC3403 65p	UA1003-3 935p UA2240 120p	8228 270 p 8243 280 p	2532 350 p 2532-30 700 p	75154 140p 75159 220p	COM8017 300p IM6402 360p	MM58174 700p MSM5832 350p
74 94 7495A	35p 35p	74L\$86 18 74L\$90 22	74S SEE	_	4093 4094 4095	24p 90p 75p	LC7120 300p MF10CN 320p LC7130 325p MK50240 900p	UAA170 170p ULN2003A 75p ULN2004 75p	8250 850 p 8251 250 p 8253 390 p	2564 £6 2708 300 p	75365 150p 75451/2 72p 75453/4 72p	ZIF SKTS	TELETEXT
7496 7497 74100	35p 90p 90p	74LS91 36 74LS92 32 74LS93 22	74502	30p 30p 30p	4096 4097	70p 290p	LC7137 270p MK50398 700p LF347 150p ML920 800p	ULN2068 290p	8255 250 p 8256 £36	2716 250p 2732 350p	75491/2 85p 8T26 120p	(TEX TOOL)	DECODER SAA5020 600p
74104 74105	50p 55p	74LS95 40 74LS96 45	74S05	60p 60p	4098 4099 4500	90p 100p 575p	LF351 48p MM5/160 620p LF353 95p MN6221A 600p LF356P 95p NE531 140p	ULN2803 150p ULN2804 150p UPC575 275p	8257 400p 8259 400p 8271 £36	2732A-35 450p 2764-25 £4.50 27128-25 £22	8T28 120p 8T95/96 90p 8T97/98 90p	24 pin 575p 28 pin 800p 40 pin 975p	SAA5030 700p SAA5041 £16
74107 74109 74110	22p 25p 30p	74LS107 22 74LS109 22 74LS112 22	74511	40p 50p	4502 4503	60p 45p	LF357 110p NE544 150p	UPC592H 200p		E SOCKETS BY		RE WRAP SOC	SAA5050 900p
74111 74112	55p 170p	74LS113 22 74LS114 22	7/921	40p 50p 50p	4504 4505	75p 400p	VOLTAGE REGULATORS	275p UPC1185H £5		pin 16p 24 pin	_	25p 18 pin 50	
74116 74118	50p 55p	74LS122 32 74LS123 34 74LS124 90	74530	40p 70p	4506 4507 4508	35p 35p 130p	FIXED PLASTIC	XR210 400p XR2206 300p XR2211 575p	14 pin 10p 20	pin 18p 28 pin pin 22p 40 pin	26p 14 pin	35p 20 pin 60 40p 22 pin 66	p 28 pin 60p
74119 74120 74121	60p 60p 25p	74LS124 90 74LS125 28 74LS126 28	74S37 74S51	60p 75p	4510 4511	45p 45p	1A +ve -ve 5V 7805 40p 7905 45p 6V 7806 40p 7906 45p	XR2240 120p ZN414 80p	BD380 60p BD677 40p	MPSU45 90p MPSU65 78p	2N2484 25 p 2N2646 40 p	3N128 120p 3N140 120p	TRIACS
74122 74123	30p 36p	74LS132 34 74LS133 30	74\$85	75p 300p 90p	4512 4514 4515	48p 120p	8V · 7808 40p 7908 45p 12V 7812 40p 7912 45p	ZN419C 190p ZN423E 130p	BF244B 35p BF256B 50p	TIP29A 35p TIP29C 40p	2N2904/5 25p 2N2906A 25p	3N141 110p 3N201 110p	PLASTIC
74125 74126	30p	74LS136 25 74LS138 30 74LS139 30	745112	90p 90p	4516 4518	110p 55p 40p	15V 7815 40p 7915 45p 18V 7818 40p 7918 45p	7N426E 200-	BF257/8 32p BF337 30p BFR39 25p	TIP30A 35p TIP30C 40p TIP31A 40p	2N2907A 25p 2N2926 Sp 2N3053 25p	3N204 200p 40290 250p	3A 400V 60p 6A 400V 70p
74128 74132 74136	30p	74LS145 60 74LS147 90	745124	90p 300p	4520 4521	50p 90p	24V 7824 40p 7924 45p 5V 100mA 78L05 30p 79L05 45p 6V 100mA 78L06 30p		BFR39 25p BFR40/1 25p BFR79 25p	TIP31C 45p	2N3054 55p 2N3055 35p	40361/2 75p 40408 90p 40409 100p	6A 500V 88p 8A 400V 75p 8A 500V 95p
74141 74142	55p 175p	74LS148 90	745133	110p 60p 110p	4522 1 4526 4527	60p	8V 100mA 78L08 30p 12V 100mA 78L12 30p 79L12 50p	ZN429E 210p ZN450E 790p	BFR80/1 25p BFR96 180p	TIP32C 40p TIP33A 70p	2N3442 140p 2N3553 240p	40410 100p 40594 120p	12A 400V 85p 12A 500V 105p
74143 74144 74145	200p	74LS153 36 74LS154 60 74LS155 30	74S139 74S140	120p 60p	4528 4532	60p 50p 70p	15V 100mA 78L15 30p 79L15 50p	ZN459 600p ZN1034E 200p ZN1040E 670p	BFX29 40p BFX30 27p BFX84/5 40p	TIP33C 80p TIP34A 90p TIP34C 120p	2N3584 250p 2N3643/4 48p 2N3702/3 10p	40595 120p 40673 75p	16A 400V 110p 16A 500V 130p
74145 74147 74148	75p 60p	74LS156 36 74LS157 27	74S151 74S153	180p 180p	4534 4536	100p 270p	REGULATORS	ZNA134 £23	BFX86/7 27p BFX88 27p	TIP35A 120p TIP35A 120p TIP35C 140p	2N3704/5 10p 2N3706/7 10p	40871/2 100p DIODES	T2800D 130p TIC 206D 60p TIC 226D 75p
74150 74151	50p A 36p	74LS158 30 74LS160 36	74S157 74S158	250p 195p 300p	4538 4539	90p 70p 75p	LM309K 1A 5V 140p 78P05 900p LM317K T03 250p 78H12 650p LM317T 100p 78HGKC 600p	TRANSISTORS	BFX89 180p BFY50 24L	TIP36A 140p TIP36C 150p	2N3708 10p 2N3773 200p	BY127 12p	TIC 246D 110p
74153 74154 74155	60p	74LS162 36 74LS163 36	745174	250p 320p	4553 2 4555	35p	LM337T 225p 78HO5KC 550p LM323K 3A 5V 450p 78GUIC 200p	AD161/2 45p BC107/8 13p	BFY51/2 24p BFY56 33p BFY90 80p	TIP41A 50p TIP41C 55p TIP42A 60p	2N3819 20p 2N3823 30p 2N3866 90p	BYX36300 20p OA47 8p OA90/91 9p	THYRISTORS 3A 400V 45p
74156 74157	40p 30p	74LS164 40 74LS165 50	74S188 74S194 74S195	150p 120p 300p	4557 3	35p 300p	LM350T 350p 79GUIC 225p LM723N 30p 79HGKC 700p	BC109C 14p BC169C 12p	BRY39 45p BSX19/20 24p	TIP42C 65p TIP54 160p	2N3902 700p 2N3904 15p	OA95 9p OA200 9p	8A 600V 180p 12A 400V 160p
74159 74160 74161	75p 40p	74LS166 60 74LS168 85 74LS169 85	745196	300p 300p 300p	4566 1	60p	TL494 300p ICL 7660 250p TL497 £3 LM305AH 250p 78S40 225p SG3524 300p	BC172 12p BC177/8 17p	BU104 225p BU105 190p	TIP120 75p TIP121 75p	2N3906 16p 2N4037 65p	OA202 10p 1N914 4p	16A 100V 180p 16A 400V 180p
74161 74162 74163	40p 40p 40p	74LS170 70 74LS173A 50	74S200 74S201	450p 320p	4569 1 4572	70p 30p	OPTO ELECTRONICS	BC182/3 10p	BU108 250p BU109 225p BU126 150p	TIP122 60p TIP142 120p TIP147 120p	2N4056 85p 2N4123/4 27p 2N4125/6 27p	1N916 7p 1N4148 4p 1N4001/2 5p	MCR101 36p 2N3525 130p
74164 74165	45p 45p	74LS174 36 74LS175 36 74LS181 90	745240	510p 250p 300p	4584	40p	2N5777 40p TiL32 55p OCP71 180p TiL78 55p ORP12 120p TiL31A 120p	BC187 30p BC212/3 11p	BU180A 120p BU205 200p	TIP2955 78p TIP4055 70p	2N4401/3 25 p 2N4427 90 p	1N4003/4 6p 1N4005 6p	2N4444 180p 2N5060 30p
74166 74167 74170	48p 150p 120p	74LS181 90 74LS183 90 74LS190 40	74S244 74S251	300p 250p	40014 40085	40p 90p	ORP12 120p TIL31A 120p ORP60 120p TIL81 90p ORP61 120p TIL100 75p	BC214 12p BC237 15p	BU208 200p BU406 145p BUX80 600p	TIS93 30p VN10KM 50p	2N4871 50p 2N5087 27p 2N5089 27p	1N4006/7 7p 1N5401/2 12p	2N5061 32p 2N5064 35p
74172 74173	250p 50p	74LS191 40 74LS192 40	74S257 74S258	250p 250p 70p	40097 40102 1	45p	OPTO ISOLATORS	BC327 16p BC337 16p BC338 16p	BUY69C 350p E310 50p	VN66AF 90p VN88AF £1 ZTX108 12p	2N5172 27p 2N5191 90p	1N5403/4 14p 1N5404/5 14p 1N5404/7 19p	PCB
74174 74175	55p 50p	74LS193 40 74LS194 35 74LS195 35	/45261	300p 850p	40105 1	70p 10p 40p	ILD74 130p TIL111 70p MCT26 100p TIL112 70p MCS2400 190p TIL113 70p	BC461 25p BC477/8 30p	MJ802 400p MJ2501 225p	ZTX300 13p ZTX452 45p	2N5245 40p 2N5401 60p	IS920 Sp	MOUNTING
74176 74177 74178	40p 45p 70p	74LS196 45 74LS197 45	74\$373 74\$374	400p 400p	40109 1 40110 2	100p 275p	MCS2400 190p TIL113 70p MOC3020 150p TIL116 70p ILQ74 180p	BC516/7 40p BC547B 14p BC548C 12p	MJ2955 90p MJ3001 225p MJ4502 400p	ZTX500 15p ZTX502 16p ZTX504 18p	2N5459 30p 2N5460 60p 2N5485 36p	RECTIFIERS	RELAYS 6 or 12V DC
74179 74180	70p 40p	74LS221 50 74LS240 60	74C SE		40174	50p	EDS FND357 120p	BC549C 16p BC557B 14p	MJE340 60p MJE2955 100p	ZTX552 55p ZTX652 60p	2N5875 250p 2N6027 30p	1A 50V 19 p	Coil SPDT 2A 24V DC 160p
74181 74182	115p 40p	74LS241 55 74LS242 55 74LS243 56	74C245	160p 180p	40193	/5P	TIL209 Red 10p FND507 140p MAN4640 200p	BC559C 16p BCY70 18p	MJE3055 70p MPF102 40p	2N697 25p	2N6052 300p 2N6059 325p	1A 100V 20p 1A 400V 25p	6 or 12V DC Coil DPDT 5A
74184 74185 74186	A 90p	74LS244 60 74LS245 80	74C374	160p 160p	40245 40257	160p	TIL212 Yel 15p MAN8910 250p	BCY71 22p BD131 75p BD132 80p	MPF103/4 30p MPF105 30p MPSA06 30p		2N6107 66p 2N6247 190p 2N6254 130p	1A 600V 30p 2A 50V 30p 2A 100V 35p	24V DC 240V AC 200p
74188 74190	250p 45p	74LS247 50 74LS248 56	4000	10p	40374	160p	0.2" NSB5881 570p TIL311 600p TIL312/3 110p	BD135/6 40p BD139 40p	MPSA12 50p MPSA13 50p	2N918 45p	2N6290 85p 2SC1306 100p	2A 400V 45p 3A 200V 60p	6 or 12V DC Coil SPDT 10A 24V DC
74191 74192	45p 45p	74LS249 55 74LS251 36 74LS253 36	4001 4002	10p 12p	14412 8 14416 3	300p	TiL222 Gr 12p TiL321/3 130p TiL228 Yel 15p TiL330 140p	BD140 40p BD189 60p	MPSA20 50p MPSA42 50p	2N1131/2 36p 2N1613 25p	2SC1307 150p 2SC1957 90p	3A 600V 72p 4A 100V 95p	240V AC 225p
74193 74194 74195	40p	74LS256 150 74LS257A 35	4007	50p 14p 36p	14419 14490	280p 350p	LEDs(R,G,Y) 30p 88rgraph 225p	BD232 60p BD233 75p	MPSA43 50p MPSA56 32p	2N1711 25p 2N2102 70p	2SC1969 150p 2SC2028 80p 2SC2029 200p	4A 400V 100p 6A 50V 60p 6A 100V 100p	ZENERS
74196 74197	40p 40p	74LS258A 35 74LS259 60	4009 4010	24p 24p	14495 14500	300p 700p	DL704 140p 9368 250p	BD241 60p BD242 60p	MPSA70 50p MPSA93 40p MPSU06 63p	2N2219A 25p 2N2222A 25p	2SC2029 200p 2SC2078 160p 2SC2335 200p	6A 400V 120p 10A 400V 200p	2.7V-33V 400mW 9p
74198	80p	74LS260 30	4011	11p	14599 2	290p	DL707 Red 140p 9370 300p	BD379 60 p	MPSU07 60p		2SC2612 200p	25A 400V 400p	1W 15p

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Z80 CONTROLLER COMPUTER

The UK is now full of MARVINs just sitting there rusting, or worse, complaining about the pain in their diodes all down one side. Peter Grigson and David Harris tell us about the software needed to make them all spring into life.

he following is split into two sections; the first is a general introduction on machine code programming the Z80. Without writing an entire book, we can't really tell you all about it, so what we've aimed at doing is to give you a flavour of what's involved. There are quite a large number of books on the Z80 in particular, and on microprocessors in general, and we would suggest getting hold of one of these. Alternatively, elsewhere in this magazine is the start of a series on maching code programming.

The second section will move on to a brief description of the operating system for MARVIN that is pre-programmed into his EPROM.

Writing Z80 Programs

The nice thing about machine code programs is that they run the computer very fast and need a comparatively small amount of memory to achieve what can be a fairly sophisticated task. In general, machine code programming is much more appropriate to control functions because it enables you to tell the computer exactly how you want a particular task to be carried out.

Every silver lining has a cloud, and the cloud over using machine code is that a program consists of nothing but numbers, as has already been pointed out on page 35. However, common practice is to substitute mnemonics for the code when doing the writing, and convert the instructions into machine code using either a special program (an assembler) or a table and a great deal of hard work. Such is life For the sake of clarity, we will use mnemonics for the remainder of this article.

Getting Into The Z80

Internally, the Z80 CPU has seven eight-bit registers, A (the accumulator) and B,C,D,E,H,L. There are three pseudo-16-bit registers, made by pairing B and C,

have different machine code equivalents, not just the same instruction with a different register address to be loaded.

Contents of registers can also be transferred. Any eight-bit register can be loaded with the contents of

0000-07FF
0800-OFFF
User program. The operating system hands over to the routine at 0800 after reset and so this should contain the first instruction of your program.

RAM. The first 32 bytes from 8000 to 801F are used by the operating system and the stack extends down from 83FF. The rest is freely available.

Fig. 1 Memory map of MARVIN.

D and E and H and L. There are also the two 16-bit index registers, IX and IY. Each register can only be used with certain commands and it will pay you to make yourself familiar with the rules. All registers can be loaded directly with a number, and the mnemonic for this will be LD (reg), (number), where (reg) is the register to be loaded and (number) is the binary (or hexadecimal) number to be stored; for example, LD A, 23 stores 23 (hex) in the register A; LD HL, 1234 stores 1234 in the HL pair as a 16-bit number.

Remember that the above is written in mnemonic code, and that unless you have another micro to do the work for you, you will have to translate this into machine code before MARVIN will be able to understand what it means. Also worth noting is that the two instructions LD A and LD HL will

another. For example, LD B,D copies the contents of D into B. Sixteen-bit registers can only be copied by two operations on their component registers; to transfer HL to BC LD B,H then LD C,L.

You will very often need to operate with more numbers than the available registers can hold and so numbers must be transferred between RAM and the CPU registers. The accumulator or any 16-bit pair can be stored at a specific address. For example, the instruction LD (8234), A stores contents of A in RAM at address 8234. The instruction LD (8234), HL involves storing 16 bits so L goes into memory at 8234 and H at 8235.

Any of the other eight-bit registers can be stored at the location pointed to by the contents of HL: **LD HL,8349** then **LD (HL),E** puts the contents of E at 8349.

OUT (n),A Output accummulator contents to port n. $0 \le n < 10$. r is any of A,B,C,D,E,H,L. The contents of C register define the port. $0 \le C < 10$. lN r,(C) IN r,(C) r is any of A,B,C,D,E,H,L. The contents of C register define the port. $0 \le C < 10$. Load register r with the data on port C.

Fig. 2 The Z80's Input/Output instructions. Note that it is recommended that output is channeled through the operating system if you wish to operate on individual hits.

Another useful source of temporary storage is the stack. This is a 'pile' of 16-bit numbers in RAM onto which more can be added by the instruction **PUSH: PUSH HL** puts the contents of HL onto the top of the stack. The number on top can be retrieved by the instruction **POP**, eg **POP DE** removes the number from the top of the stack and puts it in DE. A special CPU register, SP, is used to point to the stack and is updated by each **PUSH** and **POP**.

Only simple arithmetic and logic instructions can be carried out. Any eight-bit number or register can be added to, subtracted from, ANDed with, XORed with, ORed with the accumulator and the result is stored in the accumulator, eg ADD A,27; SUB A,C; AND A,E; OR A,H; XOR A,255.

As far as 16-bit registers are concerned, any of them can be added to or subtracted from HL,IX,IY with the result being stored in HL,IX,IY. For example, **ADD HL,DE** adds the contents of HL to the contents of DE and stores the result in HL.

The order in which the code is carried out can be controlled by use of JP (equivalent to the BASIC GOTO) and CALL (equivalent to GOSUB). When using an assembler, various points in the code can be identified with labels by writing the label at the beginning of the line with no preceding gap and following it by a colon. This tells the assembler to assign the value of the program counter at that point to the label so that when the label is used in conjunction with IP instructions, the appropriate 16-bit address is assembled. Labels can also be used in conjunction with other instructions that require 16-bit addresses, for example, LD A. (LABEL). The instruction JR is used for local jumps within 128 bytes and assembles to a relative displacement instruction. RET is used to return from a CALLed routine.

Decision making in machine code is carried out by the use of flags. These are set according to the result of each logical or arithmetic operation. The most useful flag is called Z (the zero flag) and is set if the result of an operation is zero. It is also set if A equals B in compare instructions, eg CP A,B. There are several other flags indicating other conditions and you should refer to a book to find out what these are, and when they are set.

The flags are used in conjunction with JP, CALL, JR, RET

which can be made conditional on the state of a particular flag. For example, after executing the instructions CP A,3 then JP Z,FINISH the processor will only have gone to FINISH if A was equal to 3

The most useful instructions on MARVIN however are those involved with I/O. There are several to choose from, and Fig. 2 shows them. Note that it is best to avoid using the output instructions directly but to use the operating system output routines which will also correctly set the port masks (see below).

In order to follow the example program in Fig. 3 you will need to know one or two more things. An instruction called **LDIR** is used which shifts blocks of memory around. It takes a number of bytes from memory starting at the location defined by the contents of HL and copies them to memory commencing at the location defined by the contents of DE; the number of bytes it copies depends on the contents of BC.

DEFB is not a true Z80 instruction but one to the assembler. It is followed by a series

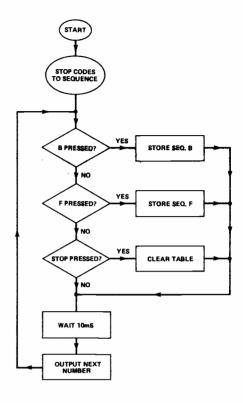


Fig. 3 An example program to drive a stepper motor. The two operating system routines used are 5, which reads the keyboard and returns a number at location 801BH, and 7, which outputs successive numbers in a sequence each time it is called. IX is the beginning of the table; IX + 0 is the table; IX + 1 is the position in the table of the first one to be output; IX + 2 is the first byte in the sequence, etc.

	ORG IR	800H STOP	Set start of prog. to 800H in memory Stop motor at beginning
NKEY:	DEFB	0F7.4	Instruct processor to execute op. sys. routine 4
	LD	A,(801BH)	Number of key returned to 801B — transfer to A
	CP	A,OBH	Compare content of A with OBH
	IR	Z,BAK	If comparison true go to routine at BAK
er.	CP	A,OF	Compare with 0FH
ric .	JR	Z,FWD	If true go to FWD
	CP	A,00	Compage with 00H
	JR	Z,STOP	If true, go to STOP
NEXT:	LD	BC,990	Start of 10 mS pause; for 10 mS put 990 in BC
	DEFB	0F7,5	Call op. sys. routine which waits 100+ 108C mS
	LD	IX,8020H	Set pointer to beginning of table
	LD	C,1	Sequence to be output from port 1
	DEFB	OF7,7	Call op. sys. routine to output next byte
	JR	NKEY	Return to start
BAK:	LD	DE,8020H	Start of sequence table in RAM
	LD	HL,BTAB	Point HL to table in ROM
	LD	BC,6	6 bytes to be copied
	LDIR		Copy the backward sequence to BAM
545	JR	NEXT	Goto NEXT
FWD:	ΓĎ	DE,8020H	Start of sequence in RAM
	LD	HL,FTAB	Point HL to table in ROM
	LD	BC,6	6 bytes to be copied
	LDIR		Copy the forward sequence to RAM
CTOD	JR	NEXT	Go to next
STOP:	LD	HL,8020H	Fill RAM sequence with 0s
	LD	DE,8021H	
	LD	BC,6	4 1 1 5 °C
İ	LD LDIR	(HL)O	
197	JR	NEXT	
FTAB:	DEFB	4,0,10,6,9,2	*
BTAB:	DEFB	4,0,2,9,6,10	
טואט.	END	7,0,2,0,0,10	· ·
	2110		

of eight-bit numbers which the assembler places directly in memory. This can be used in MARVIN programs to assemble the special instructions for calling the operating system routines which consist of two bytes: F7 (hex) followed by the number of the routine, eg DEFB F7,03.

An example of a typical MARVIN program is shown in Fig. 3. This program turns a motor forwards if key F is pressed, backwards if key B is pressed and stops it if key 0 is pressed. It uses several of the operating system routines described below.

A stepper motor is connected to output port 1 using power transistors so that to turn it forwards the sequence

10, 6, 9, 2

must be sent, one number every 10 mS. In order to turn it backwards the reverse sequence must be sent. The motor stops if nothing is sent.

The Operating System

The operating system has two tasks: it controls the system, and this involves such chores as dealing with start-up initialisation, dealing with interrupts, communicating with other systems, etc; the other task is to provide various useful routines for controlling MARVIN's peripherals.

When power is applied or the reset switch is pressed, the operating system first clears all ports and sets the interrupt vectors to the beginning of the user program. It also sets the stack pointer to the top of RAM (83FF). It then tests to see if the user EPROM socket contains a RAM IC or an EPROM. If it detects the latter then control is transferred to the program in the EPROM at 0800H. If it detects a RAM then it enters a routine which can receive data from a microcomputer and place it in the RAM. In order to be suitable for connection your micro must have an eight-bit user output port and either a separate user input port or a single handshake input line; Z80 PIO and, 6522 VIA are suitable. This facility is extremely useful for testing prototype programmes without having to blow an EPROM each time.

Interrupts

In order to define MARVIN's response to interrupts, the user program should place eight vectors in RAM to define the start of routines to deal with interrupts on

each channel. Interrupts can then be enabled by an El instruction and the appropriate routine will be called (with all registers and flags preserved) on receipt of an interrupt.

User-available routines include

the following:

Output Port Control Since the Z80 only provides for alteration of all eight output bits of a port at once, if the user wishes to change a bit or bits without affecting any others a note must be kept of how each bit has previously been set. The operating systems deals with this by storing masks of each output port in RAM and, if the user ensures ports are written to via the operating system routines, then the masks will be constantly updated. Routines are provided for the setting/resetting of individual bits as well as whole ports.

Outputting a sequence Certain devices such as stepper motors require a sequence of bytes to be output in order to operate. The operating system provides a routine which will output consecutive bytes of a sequence each time it is called. Timing If a real time clock is not available then the operating system is capable of generating pauses of between 100 uS and 0.65 secs to the nearests 10 μ S and also between 0.1 and 25 seconds to the nearest 0.1 seconds.

Peripheral Control Routines are provided to: 1. read a keyboard of up to 64 keys consisting of simple switches connected between an input and output port; 2. display alphanumeric data on a 7 segment display connected to an output port;

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The following will be available from ARK Electronics, 3 Barnhill, Pinner, Mid-dlesex, HA5 2SY (please note this change of address).

EPROM containing the monitor program, 4 MHz clock, £6.00; 3 MHz (or lower) clock £4.00;

Main board PCB, £6.00; Complete 4 MHz kit for the Main Board excluding the operating system EPROM £26.00.

I/O Board PCB £1.50; Interrupt Board PCB £1.50.

Because the remaining components for the I/O and interrupt boards are very easily obtainable, ARK have not judged it worthwhile making kits available from

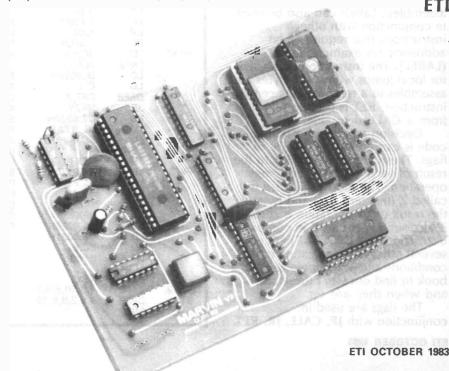
3. detect the last code sent by the MARVIN remote control; 4. send allophones to the MARVIN speech board; 5. output a frequency burst of between 40 Hz and 10 kHz.

The other peripherals avaiable (D/A, A/D, light dimmer) are accessed simply by writing to or reading the relevant port.

All the routines are accessed by 2 byte routines of the form: F7, nn where nn is the number of the routine in question.

Full details of exactly how to use all the routines are supplied with the operating system EPROM.

Readers who have been puzzled by the naming of MARVIN, or who have found little sense in the humour adopted in this project series (and throughout much of the rest of the magazine) are referred to 'The Hitch Hiker's Guide To The Galaxy' et seq., copies of which should be on sale from all leading component suppliers in the Alpha Centauri district.



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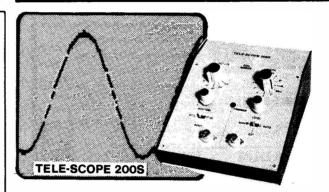
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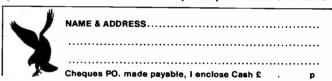


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DON'T SNEEZE!

There are places on this earth where a sneeze can be very expensive indeed — and where spotlessness will be only just clean enough. Stephen McClelland elucidates.

n anecdote, popular in the silicon chip industry, relates how, in the recent past, a certain chip company found its production going haywire. The devices it made suddenly became duds because of contamination of the otherwise ultra-clean process areas, but no one knew where the trouble lay. At length, after a massive investigation during which the factory was almost taken apart, the Company discovered to its considerable embarrassment that the person responsible for cleaning the operators' overalls had changed the washing powder. Contaminant had migrated from the freshly washed overalls into the process line, and so to the chips themselves.

Although an extreme case, the tale serves to illustrate how careful chip manufacturers have to be to ensure their production environment is flawless and the paranoia that descends when it isn't. Setting up these facilities, the cleanest places on the planet, is prodigiously expensive -

upwards of £300 per square foot.

Such facilities are now becoming necessary because the complexity demanded of silicon chips takes them into the VLSI (Very Large Scale Integration) domain. These chips have features, therefore, which are unprecedentedly small - about 1 micro metre (or 0.04 thousandths of an inch) in most cases. As a result even the most minute particles of dust are capable of settling on the silicon circuit during its sensitive process stages and causing havoc.

Indeed there is evidence to suggest that even the maximum pure air conditions presently achieved might not be clean enough for future chips under some conditions. But even to get to this state (dubbed Class 100 by the US because it contains a bare 100 particles per cubic foot in the critical size range) requires enormous efforts. Class 100 requires a clean-up factor of more than 100,000 times on atmospheric air (containing about 10 million particles per cubic foot).

Such clean rooms are generally maintained at positive atmospheric pressure (to prevent outside air-borne dirt from being driven in) with a wide host of complicated access doors and passages. In the cleanest facilities, floors and ceilings are both perforated to allow the filtered air to be pumped through them downwards in parallel vertical lines. The laminar flow creates a minimum of turbulence which might otherwise re-distribute the particles already

In addition, these areas need a formidable battery of support services. The water used to wash the silicon chips themselves must approach absolute purity — and the inadequacy of most conventional distillation techniques means that the water is usually the most expensive chemical the plant has to purchase. The gases used to process the silicon can also present a hazard — either because they are toxic, or flammable, or both. This is one reason why even small semi-conductor houses in California especially those located near the San Andreas fault maintain elaborate fire fighting teams.

But getting a clean room 'clean' is only half the story keeping it so is rather more difficult and research throws an interesting light on the most significant source of dirt people themselves.

A NASA study conducted by James Useller turned up some surprising conclusions. He found that one of the most destructive things you can do in a Class 100 environment is simply to write on an ordinary sheet of paper with an ordinary ballpoint pen — this alone can generate particles up to 20 micrometres in size. Stamping on the floor (whether due to a fit of pique or just through lack of exercise the study neglects to say) is almost as bad. Even workers properly clad — in astronaut-like boots, trousers, smocks and hats — can generate or redistribute particulate matter by merely moving about irregularly.

Normal breath, in fact, should produce no increase of atmospheric dirt but the best advice one can give to smokers is that they shouldn't breathe at all - NASA detected significant numbers of particles 20 minutes after the subjects had finished smoking. Personal hygiene is encouraged. Anti-social habits like scratching yourself (which releases dead skin cells) are not. Sneezing is singled out as being a big offender — it can push the particle count up by as much as 20 times. Even an overtly social act like pulling out a handkerchief to suppress it can spray the same amount of contamination into the air.

An equally insidious source of contamination is the purely chemical kind as the story at the beginning shows. Sodium ions (whether from sweat, chemicals or soap powder) can be lethal to many types of devices particularthe MOS (Metal-Oxide-Silicon) varieties. Some engineers have even suggested that MOS chip factories should never be built near sea coasts because of possible salt contamination.

Silicon chip companies are aware that the contamination risk will eventually become so strong even with conventional clean rooms that chip making will have to be taken — quite literally — out of human hands. IBM has already gone some way towards making an automatic production line that is enclosed completely in its own clean environment. Other companies are deterred by the enormous amount of investment required to overcome the tricky problems of silicon water handling. Ironically, micro-electronics, of all industries, might be very difficult ETI to automate fully.



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ETI October 1983

ZX80 TAPE MOD

When we published the article on modifying the ZX81 tape output to get reliable cassette operation, a plaintive cry went up: "What about my ZX80?". Ian Ridout to the rescue.

he predecessor to the ZX81, the ZX80, is still a popular machine especially if fitted with the replacement Sinclair ROM. However, like the ZX81, it suffers from unreliable SAVEing onto cassette tape and LOADing from tape.

A previous article in this magazine (February 1983) gave details of how to improve the reliability of SAVEing programs onto tape for the ZX81. This article gives details of the simple modifications required to allow the ZX80 to enjoy the same SAVEing reliability onto tape. The modification costs less than £1 to do and takes only a few hours.

If you have experienced difficulty with SAVEing programs onto tape with your ZX80, observe the following recommendations before implementing this modification:

● Make sure that the EAR socket on the ZX80 is connected to the EARPHONE socket on the cassette and likewise that the MIC socket goes to either the MICROPHONE or AUX socket on the cassette (we don't want to insult your intelligence, but you'd be surprised how often . . .);

• Remove all traces of the brown magnetic tape material from the heads in the cassette player by using cotton buds dampened (not dripping wet) in white or surgical spirit;

• Use computer tapes or the higher quality audio tapes;

• When SAVEing and LOADing, keep the cassette player as far as possible from the television because the television line-scan and framescan signals will be picked up by the cassette player;

On playing back from tape (ie LOADing) keep the volume as high as possible without the television picture breaking up. If the picture begins to break up, this indicates that the input level is overloading the computer circuitry and the playback volume on the cassette should be slightly reduced. Having

found the correct level, rewind the tape to the beginning and try to LOAD the program into the ZX80 again.

If these recommendations still fail to give you reliable SAVEing and LOADing then this article could well help you. The problem is probably due to the low signal level coming out of the MIC socket when SAVEing.

The tape system in the ZX80 is very similar to that in the ZX81, the major difference being the component numbering! As before, one IC output is for both the TV modulator and the tape out socket, via a simple filter with a peak at 3.4 kHz and a roll-off of 6dB per octave on either side of the peak. Like the ZX81 filter, the loss is —66dB at the pass frequencies, which leads to only 2 mV of signal at the tape output.

Circuitry Modification

The reasons behind choosing a FET for this modification were discussed in the previous article, so I won't repeat them here. The new circuit differs slightly from that used on the ZX81 to take account of the different PCB layout.

The DC biasing conditions of the FET are such that the source voltage should be between 1 volt and 3.5 volts and this is achieved by making the source resistance about 4k and the drain current about 0.5 milliamps.

C13 (47nF) and R34 (1k0) are retained in their original positions but C14 (47pF) is moved and R35 has to be changed in value only if a manual record-level tape recorder is used. For use with an automatic record-level machine R35 (1M0) is retained but one end has to be desoldered from the printed circuit

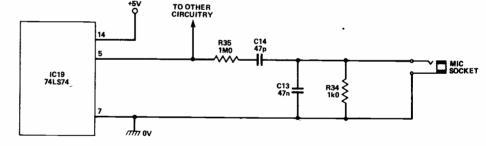


Fig. 1 Original tape-recording circuit.

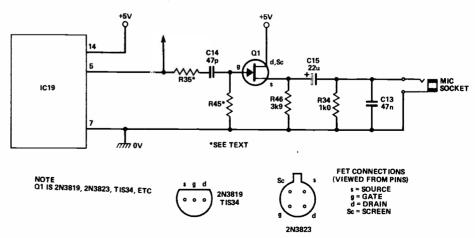


Fig. 2 New circuit; note the difference between this and the circuit published in February.



board. See Table 1 for the values of both R35 and the gate bias resistor that I have called R45.

Most machines used for storing programs on tape are of the automatic record level type. If, with the resistor values shown for R45 (39K), the recording sounds distorted on playback through the cassette loudspeaker, R45 should be reduced in value to 6k2 or 8k2. The sum of the values of R35 and R45 should be within the range 900k to 1M1 to preserve the filter characteristics.

Doing The Modifications

Remove the five white and two black plastic studs holding the bottom half of the case to the top half and to the keyboard. These are removed by first pushing the centre plastic pins through the outer part of the studs and then pulling the complete stud out of the case.

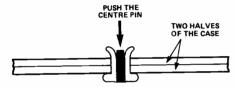


Fig. 3 How to get inside the ZX80.

Now remove the three plastic clips holding the PCB to the back half of the case by carefully squeezing them and pushing them

through the PCB.

For use with manual recordlevel machines, removė R35 (1M0) and insert one end of the new R35 (820k) into the left hand end of the position vacated by the old R35. For use with automatic record-level machines, desolder only the righthand end of R35 (1M0). The rest of these instructions apply irrespective

of the type of cassette machine to be used

Carefully remove C14 (47pF) and resolder it in series with R35 so that its right-hand end is soldered into the PCB hole from which the right-hand end of R35 was removed. The left-hand end of C14 should be soldered to the free end of R35 and trimmed off as short as possible.

Solder R45 (See Table 1 for value) in the position shown in Fig. 5. Solder the negative end of C15 (22µF, 16 volt) as shown keeping the lead short and leave its positive end unconnected for the moment.

If the metal cased 2N3823 is used, solder the drain and screen leads together and then cut one of them off. Solder the drain lead to the +5 volt PCB line shown. Connect the FET gate lead to the junction between C14 and R45. One end of a 3k9 resistor (R46) is soldered to the OV lead shown and its other end connected to the positive end of C15 and the source of the FET. It is important to check the connections to the FET and to make sure they are not touching each other.

Put the PCB and the back of the case together again, securing them as before, with the three pushthrough plastic studs inserted from the back.

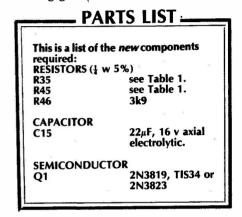
At this point test the modification by plugging in the television (tuned to channel 36) and the computer power. When the normal computer television picture appears, plug in the two cassette leads to the computer and the cassette, write a two or three line program and SAVE it. LOAD it into your ZX80 observing the suggestions earlier in this article.

Fault Finding

The FET gate should be at 0 volts, the drain should be at +5 volts and the source at about 2 volts (1V to 3.5V). If not, check the connectins and the layout.

SAVE a short program on to the cassette and listen to it through the cassette loudspeaker. If it sounds distorted, reduce the value of R45 as mentioned earlier.

See the February '83 issue of this magazine for a fuller fault finding guide.



TABL	E 1—	
	R35	R45
Manual Recorders Auto-level Recorders	820K 1M	220K 39K*
*	See text	

Table 1 Values of R35 and R45

BUYLINES -Nothing, but nothing should cause you any problems here. You don't even need a PCB!

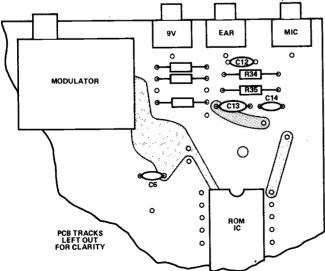
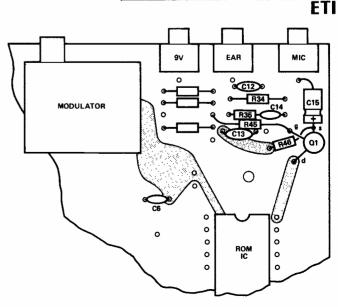


Fig. 4 Before (left) and after (right) the modification.



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CAR ALARM

Alarmed at the prospect of your car taking a walk? Ian Forster shows you how to protect it, or your house, a little better. Development by Phil Walker.

his multi-purpose alarm unit can be used in a car, or, if desired, in the home with the addition of a 12V power supply. The basic version provides for a fairly simple alarm that can be

triggered either by a negative-going or a positive-going pulse.

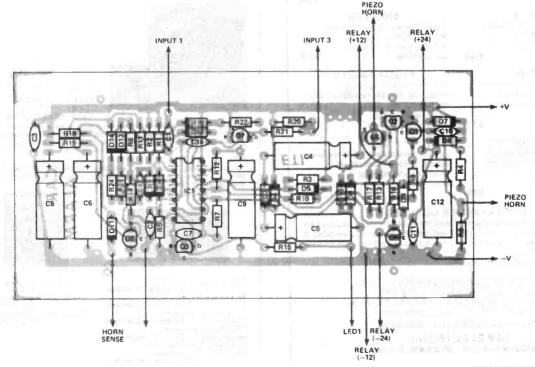
If the source of the alarm is removed, the unit will reset itself, as is required by law (and one's neighbours!). There is a delay of

approximately 16 seconds before sounding a piezo alarm, which could be used as a warning, and the main car horn will be sounded after about 24 seconds.

There seems to be a good

RESISTORS (all		C4, 6, 8, 9	33μ 16V axial	Q4, 6	BC182, TIP31,
R1, 2, 5	56K		electrolytic	0	BD131
R3	560K	C5	100μ 16V axial	Q5, 7	BC212
R4, 8	10k		electrolytic	D1-6	1N4148
R6	470k	C7	100n or 1μ	D7-10, 12-15	1N4148
R7	100k		unpolarised (see	D11	OA91
R9	1k0	540 44	text)	LED1	single LED
R10, 12	270k	C10, 11	100n ceramic or	MISCELLANICOLI	ie.
R11 R13	820k 18k	C12	polyester, 24V min	MISCELLANEOU RLA1	12V (or 24V, see
R14	33k	C12	100μ axial electrolytic, 24 min	KLAT	text) relay, NO
R15	680R	C13, 14	100n ceramic or		contacts
R16, 17, 18, 19,		C13, 14	polyester		Contacts
21	18k		polyester	Piezo tweeter or	piezo horn (see text).
R22	100k			normally open p	ush-button switch.
R23, 24	2k7	SEMICONDUC	TOPS	PCB, wire, etc.	
125, 24		IC1	4093BE		
CAPACITORS		Q1, 2	BC212		
C1, 2, 3	100n ceramic or	Q3′	BC182, TIP31,		italics are for the
7.7, -, -	polyester		BD131	extension option	s.

Fig. 1 Circuit diagram: the basic circuit is shown in black and the optional sections in blue.



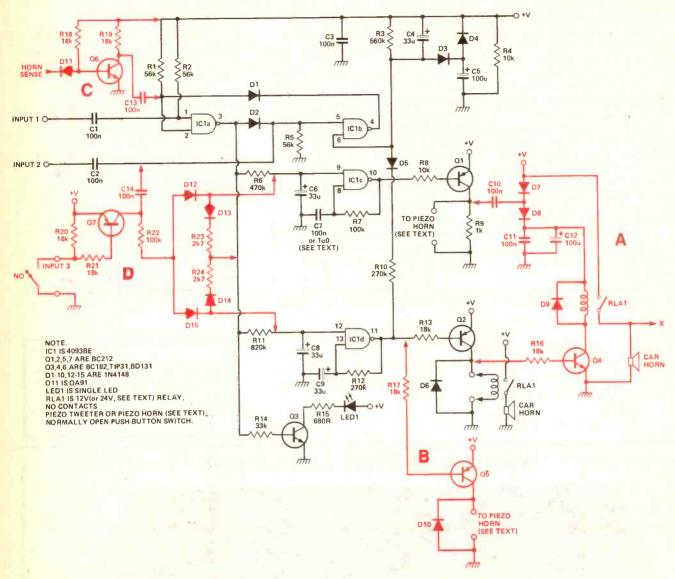


Fig. 2 Component overlay for the PCB.

HOW IT WORKS

The basic circuit is that of a latch, built round IC1a and IC1b, and two drivers for the audible alarms, built round IC1c and Q1, and IC1d and Q2. However, it's not quite that simple

On switch-on, C4 and C5 share current via D3 pulling one of the inputs of IC1b low, which disables the latch until C5 is charged and C4 discharged via R3: this prevents the circuit being immediately activated at switch-on. If any troubles develop in this respect, it may well be because the values of C4 and C5 are not correct, electrolytics having very wide tolerances. On switch-off, C5 is discharged via D4 and R4.

A negative-going pulse at INPUT1 or a positive-going pulse at INPUT2 will trigger the latch, causing the output of IC1 to go high. C6 charges via R6 and C8 via R11, and LED1 is lit via R14, Q3, R15.

When C6 reaches a sufficient voltage, IC1c will start to oscillate at a frequency determined by C7/R7. For use with a piezo tweeter as a horn, C7 should be

100n which will give an oscillation frequency of 3 kHz. This can be fed to a piezo tweeter via R8 and Q1, to make a very unpleasant sound in a would-be thief's ear! R9 is needed to discharge the tweeter because there is no DC path through these beasties, and it would otherwise just sit at around + V.

Similarly, when C8 reaches a sufficient voltage, IC1d will begin to oscillate at about 1.5Hz, and this will turn the car horn on and off via R13, Q2 and RLA1. D6 protects Q2 against back-EMF from the coil of RLA1. The output of IC1d is also used to pump down C4 (via D5 and R10) so that the latch will be reset after a period, but will retrigger almost immediately if the input conditions persist.

Circuit A allows a 24V relay to be used instead of a 12V one. C7 should be changed to 1u0 to lower the oscillation frequency of IC1d to 300 Hz. C10, D7, D8 and C11 and C12 form a fairly straightforward voltage doubler to provide the 24V necessary. Q4 is needed to

invert the output from Q2 and pull down rather than up.

Note that in either case, you connect the relay contacts to suit your car — we have shown how to connect them when your car switches on the positive line to sound the horn, but some (eg Minis) switch the negative side, the positive side of the horn being permanently connected to the 12V supply.

Circuit B can be used to substitute a self-oscillating piezo-horn for the piezo tweeter — this could be useful if you use a 24V relay with circuit A.

Circuit C passes a small current

Circuit C passes a small current through the car horn; if the connection to the horn is interrupted, the alarm will be triggered.

Circuit D is the fast-acting circuit; when the normally open external contact is closed, Q7 is turned on, and this charges C6 and C8 via R22, and D12 and D15, as well as latching the alarm in the usual way through C14. D13 and 14 and R23 and 24 are necessary to reset this circuit.

supply of 24V relays around at bargain prices, mainly because they're a lot less convenient for most circuits than 12V types. For this reason, the circuit can be adapted to drive a 24V type, as shown in circuit A (shown in blue on the main circuit diagram). This circuit has the disadvantage that you cannot use the piezo tweeter, and circuit B shows how to connect a self-oscillating piezo horn instead.

A common thieves' tactic is to cut the lead to the horn before attempting to break into the car itself. This can be foiled by circuit C, which will trigger the alarm if this is done - note that once the horn lead is cut, there is no way that it can be used, so just the warning siren will go off.

Finally, there may be some items that you may want to protect

with a fast-acting alarm, and circuit D provides for this: all that is needed is a set of normally open contacts that can be arranged so as to close.

The method you use to trigger the car depends on how your car is wired up. Most cars have courtesv light switches mounted in the door pillars, and these could be used. Another possibility is to use mercury switches to detect any motion or disturbance.

Construction And Setting Up

Construction of the PCB should present no problems, provided the usual precautions are followed. Things being what they are, it would also be best to make up your mind which options you want before building, though at a pinch

bits and bobs can be added later.

As mentioned in How It Works, should there be any problems with the circuit arming at switch-on, then C4 and C5 are the most likely

If you use circuit A with a particularly current-thirsty relay then it may be possible that R9, C10 and C12 will need revising (R9 should be reduced in value, C10 and C12 should be increased); Q1 may possibly need upgrading to a high gain medium power type and/or heatsinking, as might Q4.

Otherwise, your biggest headache will be the triggering switches. Unfortunately, we can't advise you generally on this because everybody's car or home will vary; but let us say that careful though put into this aspect will not be wasted.

=BUYLINES =

Nothing here should present any problems. A self-oscillating piezo-alarm is available from Maplin and the PCB is, ever, available through our very own PCB service.

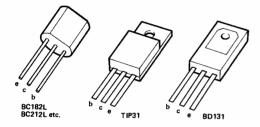


Fig. 3 Transistor pinouts.

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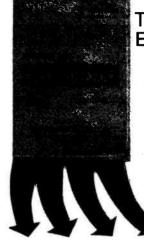
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HOW PERMANENT? IS PERMANENT?

With the silicon revolution in full swing, everybody from private individuals to the governments of nations are dependent on the use of magnetism for the storage of information. Is our faith in the technique misplaced? Vivian Capel investigates.

ome years ago it was reported that the BBC were considering whether or not to dispose of their vast library of sound recordings on disc after dubbing them on to tape. The decision was against, because although there would be considerable savings in space, magnetic recordings were deemed to be too ephemeral to trurst as the medium for preserving so many historic and unrepeatable sounds.

This decision would seem to be justified by the fact that on more than one occasion broadcasts have had to be cancelled because the tape had been inadvertently wiped. Imagine if this had happened to an historic only copy! Most users of magnetic storage for sound, video and computer programs will know that this is all too easily done!

Video recordings in particular would seem to be vulnerable. Each picture field with all its colour information and light and shade detail is stored in a single microthin magnetic diagonal line, much narrower than a human hair, across the width of the tape which itself is a thin plastic film. Compared to that a cine film seems positively robust.

As most readers are aware, erasure of a magnetic recording is usually done with a magnetic field. In modern equipment, this is nearly always an alternating field applied either from an erasing head or from a special erasing unit. In some older cheap reel-to-reel recorders erasure was achieved by bringing a permanent magnet into contact with the tape.

Quite fascinating stories have circulated which tell of a credit-card company that was almost put out of business when a workman walked through its computer centre with a magnet in his toolbox, thus erasing all the magnetically stored data. An even more interesting one concerns the Inland Revenue records that were wiped clean by a nearby airport radar! Hope springs eternal . . .

Another way that the magnetization of a tape can be destroyed is by heat. Apart from the effect of heat on the plastic substrate, above a certain temperature (known as the Curie point), a magnetic material will lose its ability to hold magnetization. This phenomenon is made use of in some brands of thermostatic soldering iron. Here, a disc made of magnetic material is placed in the bit of the iron. In the barrel of the iron is a small magnet, which, because it is attracted to the material in the bit, holds a contact shut. When the iron comes to the required temperature, which is also the Curie point of the bit, this attraction ceases, opening the contact and cutting off the heating current.

Now before everyone dashes out to dispose of their video recorders and floppy disc drives so as to get the best price before the rush starts, let us take a closer look at the

process of demagnetisation. A fully magnetised tape, like any other magnetised material, needs a certain minimum field strength applied to its surface to impress or remove magnetism. This field strength is known as the **coercivity** of the material. To understand how this works, you could think of a thug trying to get you to do something you didn't want to do — for example, hand over your money. If the thug applies enough coercing force, you must give way. However, your capacity to resist will depend on how strong you are. It's just the same with magnetic materials — some are much harder to magnetise (and to demagnetise) than others.

For audio cassettes a figure for coercivity of around 300 to 400 (ie 2.4 to 3.2 x 10⁴ A/m to our SI readers) oersteds is common, video tapes are usually somewhat higher. This means that a magnetic field of that order would be required to demagnetise a fully magnetised (or **saturated**) tape. Of course, tapes are not recorded into saturation otherwise the recorded signal would suffer distortion, so a normally recorded tape would be completely erased by a lesser field that that of the specified coercivity. Even so, it would take a field of at least 100 oersteds to do any damage to the recording.

So what sort of fields do we find around domestic equipment? External fields depend on the current flowing in the apparatus and the number of turns if a transformer, motor winding or other inductive component is involved. It also depends on the efficiency of the internal magnetic path. For example, a toroidal mains transformer is more efficient in containing the field through its core than a laminated type. Thus there is very little field external to a toroidal transformer. Equipment screening is another factor.



Magnetic tape - too ephemeral for the BBC.

A power drill running under full load will take a heavy current and the internal magnetic path is not particularly efficient taking in, as it must do, the rotating motor amature. So we can expect a sizeable external field. Surprisingly, the field at the casing of a domestic power drill under load has been measured at around 10 oersteds. This is well below that which could affect a recorded tape. House wiring and flexible mains leads also generate fields, but even when carrying a heavy current these are not great. The reason is that cable is reasonably straight and so constitutes only a single turn compared with the hundreds of turns of a transformer or motor windings. Further more, both live and neutral are contained within the same cable, and as these are carrying equal and opposite currents, there is a high degree of cancellation of the produced field. (For maximum cancellation the conductors would need to be tightly twisted.) So there is not much to worry about from these.

Permanent magnets are fairly common in domestic equipment — a few examples are in loudspeakers, tin openers, magnetic door catches, magnetic switches for burglar alarms, etc. Some of these produce fields of 1,000 oersteds and more, and could constitute a real hazard. Any such device coming into direct contact with a recorded tape or disc would certainly wipe that portion of the recording clean.

One factor which saves endangered recordings is that magnetic field is very strongly dependent on distance. For a single magnetic pole, the magnetic field would be proportional to the inverse square of the separating distance. However, magnetic poles come in opposite pairs, and this has the effect of making the field fall off even more quickly—the further you get away from the one pole, the more the field from the other pole tends to cancel out the field

altogether.

This has the consequence that the casing around a video cassette, for example, will be sufficiently thick to protect it from contact with most small magnets — but it's still probably not a good idea to have a magnetic catch on the door of the cupboard in which you keep your

tapes, just in case!

The situation is somewhat different with a floppy disc. This is contained in a protective packing similar to an ordinary record sleeve except that the disc is played inside the cover through a slot. The sleeve is there mainly to protect against finger marks and other minor handling hazards. It is not very thick, about 0.5 mm, so any magnet that was brought into contact with it would almost certainly wipe part of the information on the disc. Therefore, some care is needed in handling and storing these.

Then what about those stories of chain-reactions, with whole shelves of tapes being wiped out by a single stray field? It is possible for such a reaction to take place along the length of a single tape if the recording is of very low level. This was demonstrated some years ago by a team who were developing a method of recording very high frequency square waves with zero bias. The recorded signals were of very low amplitude but at one stage the recording level was accidentally increased to ten times that of normal. It was found that the previous 1,000 feet or so of recording head at that one point travelling backward. To verify that this in fact was the cause, the conditions were repeated and other possible factors eliminated. The result was the same: erasure of the entire reel.

This however, does not happen under normal circumstances. In fact, it is a common practice to erase part of a tape by re-recording it, while the remainder stays unaffected. Audio tape enthusiasts having open reel machines often eliminate clicks and bumps in amateur

productions by judicious use of a permanent magnet, and post-recorded fades can be made by sweeping a magnet over the particular length of tape while gradually raising or lowering it.

So with normal recordings the tape affected is only that portion which comes in close proximity to the magnetic field. As for several tapes being wiped by chain reaction, this is just a myth. The only way a number of tapes could be affected would be if there were a pervading field of such intensity as to exceed the tape coercivity at

the surface of the tapes themselves.

There are stories in circulation about flash bulbs being triggered off by radar installations, and demolition teams that won't use electrical detonators nearby; and indeed, directly in front of a radar dish a magnetic field of several thousand oersted can exist. This would certainly be enough to wipe any magnetic tape clean, but any person in the vicinity would already be experiencing a few problems on their own account! In any case, airports and other users of radar don't like bodies getting in the way, so the antennae are usually mounted well away from people.

However, the question of whether or not a strong electromagnetic radiation field could cause erasure is worth exploring. 3M, the tape manufacturers conducted some experiments to determine this in America. The object was to discover the effect of microwave energy. Reels of recorded tape were actually placed in a microwave oven and the power applied until the reels and the tape began to melt and burn. Those parts of the tape that were not physically damaged were examined and the recording was found to be unaffected. The tape had not demagnetised.

A further experiment was tried using radar. Reels of recorded tape were placed directly in front of a radar dish having a range of 250 miles, Two lots of tape were used, one placed at a distance of 18 feet, and the other much closer at 16 inches. These were scanned by the radar beam for 16 minutes, then removed and examined. It might be anticipated that the nearer tapes would have suffered from the magnetic field, but in fact both lots were unaffected. There was no physical damage, and the

recorded signal level was the same as before.

So, radar can be eliminated as a hazard for magnetic recordings, but there is another potential danger for tapes that are transported by air travellers, and also by air freight. Firstly, baggage, or packages that are sent through the post which for some reason may give rise to some suspicion, may be examined by means of X-rays. In other experiments by 3M, recorded tapes were exposed to X-rays of much higher level that those normally used for parcel examination. Again there was no ill effect and the



Floppy discs — the most vulnerable to demagnetisation.

recordings were intact, with no loss of signal level.

Secondly, at most air terminals, passengers are required to pass through a weapons detector with their hand luggage. These devices are magnetically operated, so what effect could they have on a recording? The majority are passive, that is they do not produce a magnetic field of their own but measure changes in the earth's magnetic field caused by ferrous objects. These pose no threat at all to recordings.

Other detectors are active. These produce a magnetic field in a doorway or other region through which the passenger must pass. Any metal object distorts the field, and the change is detected by instruments. Usually the field employed is quite low, in the region of 20 oersteds, which is insufficient to affect a magnetic recording. There are some detectors, though, that go up to 100 oersteds. Although below the coercivity of fully saturated tapes, they do constitute a hazard. While in most cases no damage may result, if there is reason to suspect that a high intensity field is in use it may be safer to advise the staff that you have recorded tapes, and request a visual examination instead.

Could, under normal circumstances, the temperature ever go sufficiently high to affect recordings? Certainly it's common experience that the temperature inside a car with its windows closed can soar to the unbearable - particularly in countries blessed with warmer climates than Britain. However, for iron oxide the Curie point is around 850°F (450°C) and physical damage to the tape substrate or case (or to the recorded itself) would occur long before this temperature was reached.

The Curie point for chromium dioxide is 250°F

(120°C) which, although still above boiling point and hence unlikely to be attained in a domestic environment, can still cause problems. This is because as the temperature rises towards the Curie point (remember that physical phenomena are governed by the absolute temperature, and although 50°C looks a long way from 120°C, the equivalents 323°K and 393°K look a lot closer) magnetic materials become much more susceptible to small magneitc fields. This principle was at one time used in the copying of videotapes: heat was used to transfer the magnetic pattern from the master tape to an intermedaite medium and from that to the copies.

So one possible effect of excessive heat is printthrough, ie signals from one layer of tape getting superimposed on an adjacent one to give pre- or post echo. This can and does happen at normal temperatures when thin (long playing) tapes are spooled up without playing, for long periods. High temperatures can therefore increase this risk. Print-through is also more likely in the presences of an external field which would be insufficient to erase the tape.

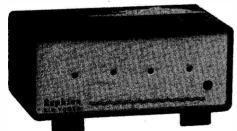
To sum up, there is not very much danger to magnetic tapes in most domestic environments apart from print through, provided the common sense precautions are taken. Obviously, if you allow a combination of hazard factors to occur together, the risk to the recording is increased commensurately.

I would add on a personal note that audio recordings made by me some 30 years ago have survived various hazards and sound as good today as they did on the day they were made.

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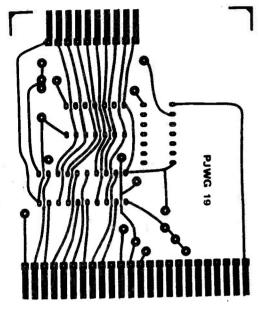
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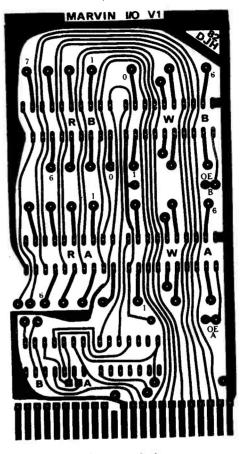
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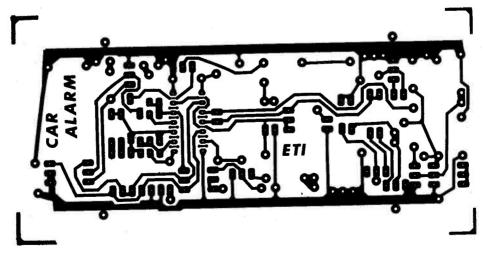
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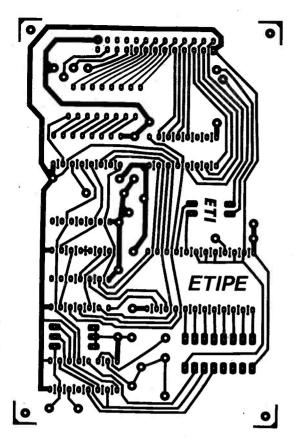
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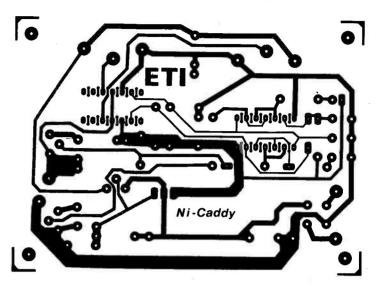
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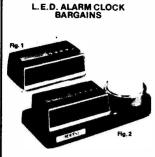
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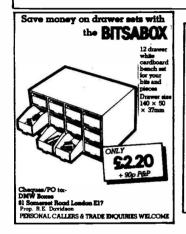
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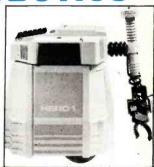
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