

**FREE
INSIDE**

8-PAGE CIRCUIT SUPPLEMENT

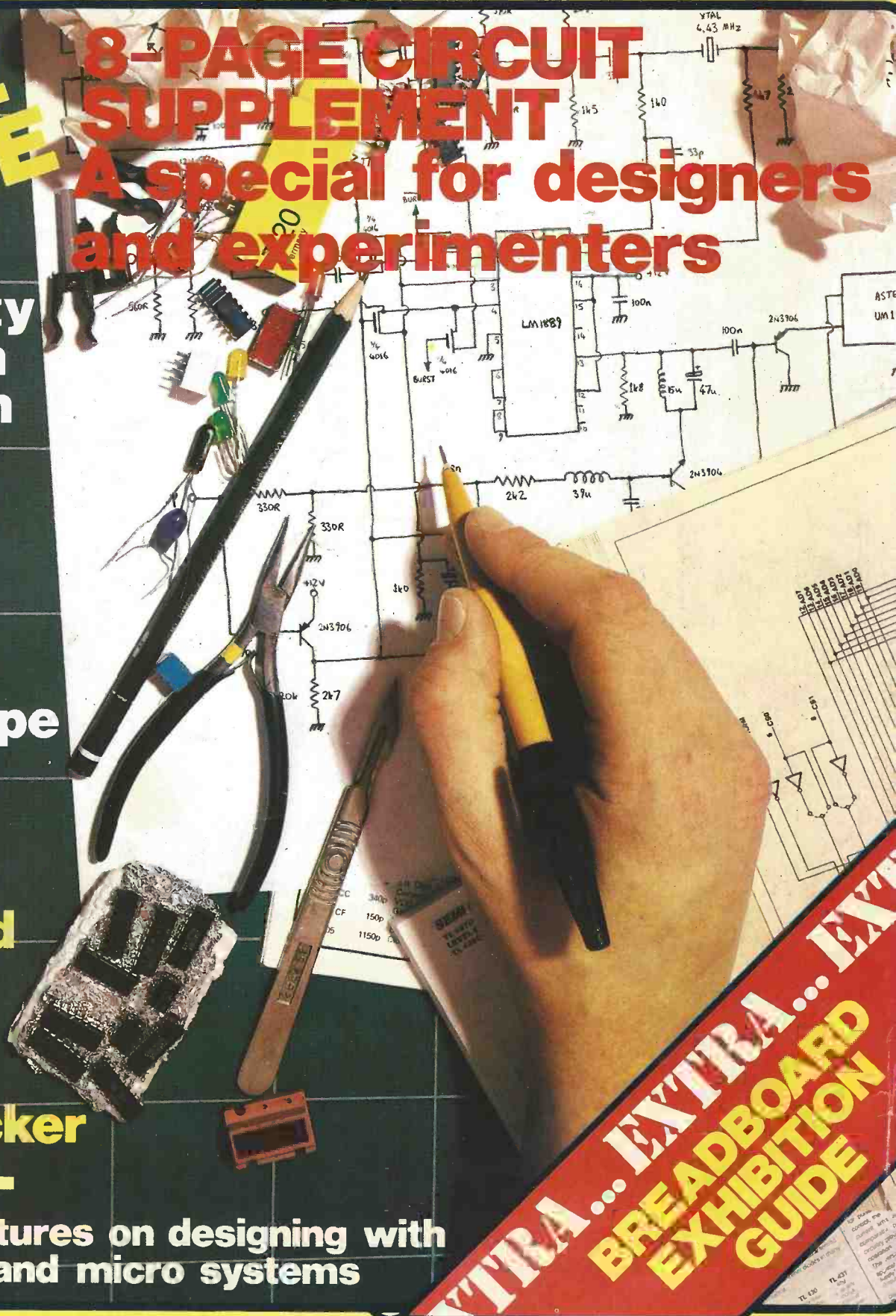
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of disco
lighting

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transistors and micro systems



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EXHIBITION
GUIDE**

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VERY FINEST
— MORE KITS
INSIDE BACK
COVER



T20 + 20 — Designed by Texas Engineers, this 20 watt amplifier gives Hi Fi performance at low cost. Many up-dated features and the ideal beginners kit. Complete kit £29.50 plus VAT (30 watt version — Complete kit £34.50 plus VAT)



LINSLEY HOOD 75 DE LUXE — 75watt amplifier with superb performance (less than .01% distortion). Easy construction with virtually no wiring. Complete kit £75.00 plus VAT.

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For over 2000 years man has entertained himself and his friends with music played upon instruments he has fashioned with his own hands. From the earliest pipes of hollow reed in the cradles of civilisation, the brazen trumpets of ancient Rome, to the subtle strings of renaissance Europe. Pleasure in the making — Pleasure in the playing and Pleasure in the listening.

Now — in the 1980's its the turn of the electronics age, the age of Powertran.

In our twelve years of research and development we have introduced probably the most comprehensive and sophisticated range of synthesisers and supporting equipment ever offered to the music making, home-constructor.

Each kit is a perfect example of how craftsman-made components, ingenious design technology, originality of concept — and rigid quality and price control — combine together in kits that are both fascinating and satisfying to construct. Our clear step by step instruction manuals ensure that the kits are well within the capability of the first time builder as well as the dedicated enthusiast.

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TRANSCENDENT POLYSYNTH — A four octave polyphonic synthesiser with outstanding design characteristics and versatility and performance to match.

Complete kit £275.00 plus VAT (single voice)
Extra voice (up to three more) £42.00 plus VAT

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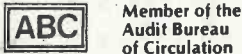
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FEATURES

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 Computing, hi-fi, test gear, big business, small business and funny business.
- ZOOM MICROPHONE** 20
 An acoustically cunning design from JVC will allow you to zoom your mike as well as your lens on a video camera.
- DESIGNER'S NOTEBOOK** 31
 Last month we explained all you needed to know about switched capacitor filters — now we have some applications.
- CIRCUIT SUPPLEMENT** 35
 Not only all our usual circuit features and projects, this issue: there's also this eight page supplement, culled from manufacturers' data sheets with the help of copious midnight oil.
- DESIGNING MICRO SYSTEMS** ... 46
 How to get information into and out of your computer is our topic this month, including a description of handshaking.
- BREADBOARD EXHIBITION GUIDE**
 Special pull-out supplement between pages 58 and 59.
- CONFIGURATIONS** 72
 Is there a dentist in the house? Ian Sinclair has a sawtooth. (We wish to assure our readers that the article is better than that joke).
- READ/WRITE** 83
 Matching a big preamp to a little amp, and a little preamp to a big amp, plus where to buy those elusive Curtis chips and the secret of Eric.
- AUDIOPHILE** 87
 On the subject of compliance, for which one dictionary definition is an 'unworthy submission': however, this Goldring cartridge is very worthy.
- TECH TIPS** 93
 More hints and tips from our readers.
- INDEX 82** 113

PROJECTS

- ELCB** 25
 Which stands for Earth Leakage Circuit Breaker, in case you didn't know; a very useful device for reducing the risk from electric shock.
- CORTEX PART 2** 55
 Descriptions of the remaining circuitry of our 16-bit marvel, plus constructional details of the main board for those who are into soldering in a big way.
- SPECTRACOLUMN** 65
 Not just your average sound-to-light unit; this model has a one kilowatt display. Build several and you won't have to worry about central heating this winter.
- SERVO ARM INTERFACE** 77
 Put muscles onto your microcomputer with part 2 of this project, wherein we give the complete details for construction and use.
- SIGNAL LINE TESTER** 97
 Don't get caught shorted or at a loose end: this tiny addition to your PA system will monitor cables and indicate short or open circuits.
- FOIL PATTERNS** 102



INFORMATION

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PCB SERVICE 99
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SWITCHES

TOGGLE: 2A, 250V
SPST 44p
DPDT 44p

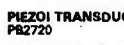
SUB-MIN TOGGLE
SPST on/off 85p
SPST c/over 85p
SPDT centre off 85p
SPDT biased both ways 105p
DPDT 6tags 75p
DPDT centre off 85p
DPDT biased both ways 145p
DPDT 3 positions on/on/off 185p
3-pole 2 way 205p

SLIDE 250V:
DPDT 1A 14p
DPDT 1A c/off 15p
DPDT 2A 13p

PUSHBUTTON 6A
With 10mm Button
SPDT latching 99p
SPDT unlatching 145p
SPDT moment 99p
DPDT moment 145p

Mini Non Locking
Push to Make 15p
Push to Break 25p

ETI PROJECTS
We stock the most of the parts



DIL SWITCHES

(SPST) 4 way 70p; 6 way 85p;
8 way 90p; 10 way 145p.
(SPDT) 4 way 190p.

ROTARY SWITCHES:
(Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way;
3 pole/2 to 4 way; 4p/2 to 3 way 45p

ROTARY: Mains DP 250V 4 Amp on/off 56p

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

WAFERS: (make before break) to fit the above switch mechanism.
1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6/2 way 85p
Mains DP 4A Switch to fit
Spacers 4p. Screen 6p

ROCKER: 5A/250V SPST 28p
ROCKER: 10A/250V SPST 38p
ROCKER: 10A/250V DPDT c/off 35p
ROCKER: 10A/250V DPST with neon 85p

THUMBWHEEL: Mini front mounting
Decade Switch Module 220p
B.C.D. Switch Module 275p
Mounting Chassis (per pair) 70p

VEROBOARD 0.1in

clad plain
2 1/2 x 3 3/4" 81p
2 1/2 x 5" 91p
3 3/4 x 3 3/4" 91p
3 3/4 x 5" 105p 87p
3 3/4 x 17" 300p 222p
4 3/4 x 17" 470p
Pkt. of 100 pins 50p
Spot face cutter 135p
Pin insertion tool 170p

VERO WIRING PEN & spoon 340p
Spares spoon 75p
Combs 6p

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

COPPER CLAD BOARDS
Fibre Single-sided S.R.B.P.
glass 220p
6" x 6" 90p 95p
6" x 12" 150p 195p

DIL SOCKETS
Low Wire Prof Wire Wrap
8pin 8p 25p
14pin 10p 35p
16pin 10p 35p
20pin 10p 35p
20pin 20p 80p
22pin 22p 65p
24pin 25p 70p
28pin 28p 80p
40pin 30p 90p

EDGE CONNECTORS
2 x 15 way 1.166
2 x 18 way 180p 195p
2 x 22 way 220p 235p
2 x 23 way 180p 195p
2 x 25 way 225p 220p
2 x 28 way 210p 210p
2 x 30 way 245p 245p
2 x 38 way 285p 285p
2 x 40 way 315p 315p
2 x 43 way 355p 355p
12 x 75 way 650p 650p

ANTEX SOLDERING IRON
C-15W 450p CX17W 475p
CCN-15W 485p CX25W 500p
Spares like, assorted sizes 85p
Solder 500 pins 325p
Iron stand with sponge 185p

VO Board

DIP Board 380p
Verob Strip 374p

PROTO DECS
Veroblock 405p
S-Dac 350p
Eurobreadboard 620p
Bimboard 1 675p
Superstrip SS2 1350p

DALO ETCH RESIST PEN
Plus spare tin 80p

ULTRASONIC TRANSDUCER
40KHz 325p

IDC CONNECTORS

Female Header Socket
10 way 80p
16 way 130p
20 way 145p
25 way 175p
34 way 225p
40 way 225p
50 way 235p
80 way 230p

EURO CONNECTORS
Female Socket
10 way 170p
2x32 A+B 255p
2x32 A+C 300p
2x32 A+B+C 380p
300p
380p
280p
400p

DIL (Headers)
14pin 40p
16pin 40p
24pin 85p
40pin 250p

ZIF DIL SOCKETS
24 pin 575p
28 pin 620p
40 pin 875p

D CONNECTORS: Miniature
9 way 15way 25way 37way
Plugs
Solder lugs 80p 110p 180p 250p
Angled Pins 160p 210p 250p 355p
W/Wrap
Sockets
Solder lugs 110p 160p 210p 350p
Angled Pins 165p 215p 290p 440p
W/Wrap
Covers 160p 180p 240p 420p
85p 95p 110p

25 way 'D' CONNECTOR
Jumper Lead Cable Assembly
18" long, Single End, Male 495p
36" long, Single End, Female 625p
36" long, Double Ended, M/F 1025p
36" long, Double Ended, F/F 1060p
36" long, Double Ended, M/F 995p

78H12 + 12V/5A 590p
78H8 + 5V to +2V/5A 590p
79H2 -2.2V to +24V/5A 685p

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0-500A
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-2.5V
0-50V AC
0-300V AC
"V"
"A"
48p each

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Contronics Parallel 36 Way solder 630
Contronics Parallel 36 way IDC 680

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CRYSTALS

32.768KHz 100
100KHz 235
200KHz 265
465KHz 370
1MHz 275
1.000MHz 275
1.28MHz 322
1.6MHz 395
1.8MHz 395
1.8432M 200
2.0MHz 225
2.4676M 205
3.2768M 150
3.5794M 95
3.6864M 300
4.0MHz 160
4.032MHz 290
4.80MHz 200
4.194304M 200
4.433619M 175
5.0MHz 180
5.168MHz 300
5.2428M 380
6.0MHz 140
6.144MHz 160
6.5536MHz 225
7.0MHz 150
7.168MHz 200
8.0MHz 180
8.0833M 395
8.8722M 175
9.000MHz 160
10.0MHz 175
10.24MHz 200
10.7 180
12.0MHz 175
12.5MHz 200
14.31814M 170
16.0MHz 200
18.0MHz 180
18.432M 180
20.0MHz 200
19.988MHz 180
20.0MHz 170
24.9300MHz 325
26.69M 180
27.848M 170
27.145M 175
48.0MHz 170
100.0MHz 295
116.0MHz 280

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RL6-141 7401i coil, 17V5-29V 250V 5A AC 222p

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Contronics Parallel 36 Way solder 630
Contronics Parallel 36 way IDC 680

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6V, 9V & 12V 70p

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PIEZEO TRANSDUCERS

PR2720 55p

TRANSFORMERS: Prim. 240V

0-6-0V; 9-0-9V; 12-0-12V 100mA 98p

pcb mounting: Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.16A; 2x12V-0.12A;
2x15V-0.1A
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A;
2x15V-0.2A

Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A;
2x15V-0.25A
12VA: 2x6V-1.3A; 2x9V-1A; 2x9V-0.8A;
2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A
24VA: 2x6V-1.5A; 2x9V-1.1A; 2x12V-1A;
2x15V-0.8A; 2x20V-0.6A
30VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A

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12V 7812 145p 7912 220p
15V 7815 145p 7915 220p
18V 7818 145p 7918 220p
1A TO220 Plastic casing
5V 7805 40p 7905 45p
12V 7812 40p 7908 60p
15V 7815 40p 7912 60p
18V 7818 40p 7915 60p
24V 7824 40p 7924 45p

100mA TO92 Plastic casing
5V 78L05 30p 79L05 60p
6V 78L06 30p 79L06 60p
8V 78L08 30p 79L08 60p
12V 78L12 30p 79L12 60p
15V 78L15 30p 79L15 60p

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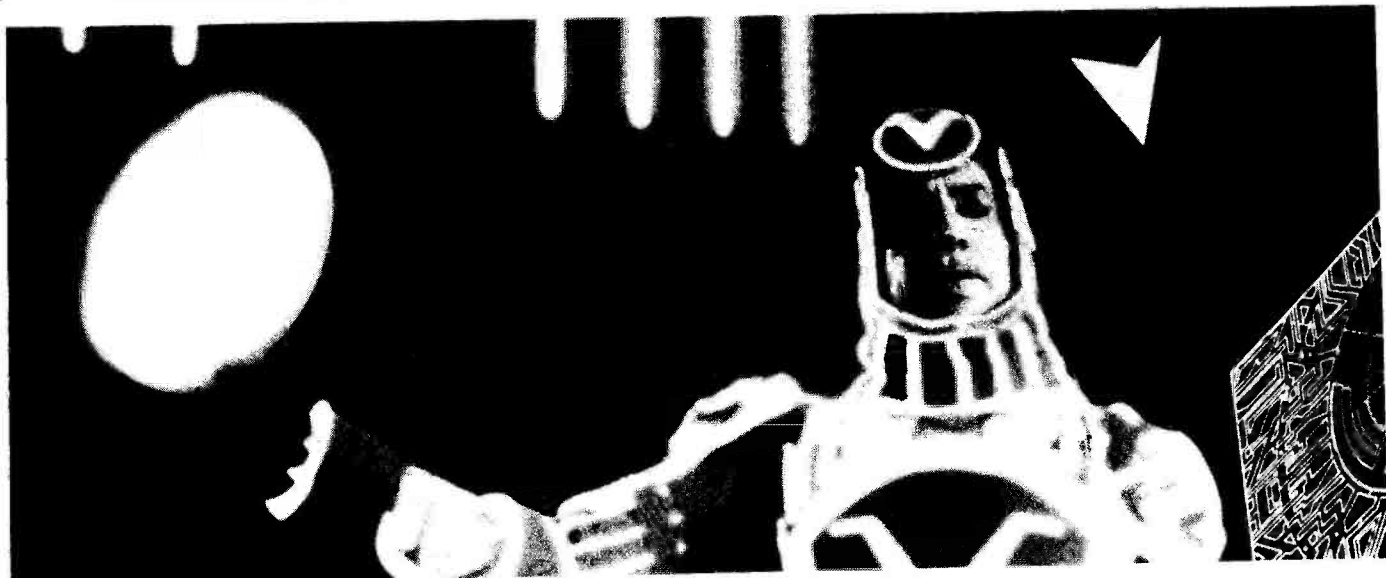
CMOS

4001	10	4075	13	4541	140
4002	12	4076	60	4543	80
4003	10	4077	13	4544	150
4004	12	4078	18	4548	40
4006	80	4081	13	4549	375
4007	14	4082	13	4553	240
4008	32	4083	14	4554	180
4009	24	4088	60	4555	36
4010	24	4089	125	4556	36
4011	10	4093	20	4557	320
4012	16	4094	70	4558	120
4013	20	4095	95	4559	395
4014	48	4096	70	4560	180
4015	48	4097	230	4561	104
4016	20	4098	75	4562	485
4017	32	4099	110	4566	185
4018	48	4180	95	4568	250
4019	28	4181	95	4569	175
4020	42	4182	80	4572	30
4021	40	4183	80	4580	460
4022	40	4174	80	4581	250
4023	13	4175	105	4582	98
4024	32	4194	105	4583	98
4025	28	4098	70	4584	68
4026	13	4409	780	4585	88
4027	20	4410	725	4597	330
4028	38	4411	675	4598	280
4029	48	4412	775	4599	280
4030	18	4415	440	4605	90
4031	125	4416	440	4606	90
4032	80	4422	770	4609	193
4033	125	4435	850	4610	215
4034	140	4440	880	4611	130
4035	45	4450	350	4612	140
4036	275	4451	350	4614	85
4037	115	4450	350	4615	110
4038	110	4500	675	4616	48
4039	250	4501	28	4618	48
4040	40	4502	80	4619	80
4041	40	4503	40	4620	80
4042	40	4504	75	4621	30
4043	40	4505	185	4622	30
4044	40	4506	35	4623	30
4045	105	4507	35	4611	194
4046	48	4508	130	4613	105
4047	40	4510	46	4617	75
4048	40	4511	46	4618	220
4049	25	4512	198	4619	90
4050	25	4513	198	4620	90
4051	45	4514	115	4621	90
4052	80	4515	115	4622	90
4053	80	4516	115	4623	90
4054	85	4517	275	4624	185
4055	85	4518	40	4625	185
4056	85	4519	30	4626	185
4057	1915	4520	80	4627	195
4058	435	4521	110	4628	240
4059	435	4522	125	4629	245
4060	485	4523	70	4630	245
4061	1185	4524	70	4631	245
4062	985	4527	70	4632	245
4063	85	4528	70	4633	245
4064	24	4529	150	4634	255
4065	245	4530	80	4635	300
4066	14	4531	130	4636	300
4067	14	4532	70	4637	300

NEXT
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electronics today

INTERNATIONAL



Walt Disney Productions

Well, there's this person called Sark, that's him up above with the electronic Frisbee, except he isn't really a person, he's a program, and a pretty evil one too, a really nasty piece of code. Then there's this other program, called Flynn, except he's really a person, and he's the good guy, but he's trapped with Sark inside a computer where he's fighting to the death against some video games that he wrote himself. That's Flynn's alter ego down below, called Clu, and he's driving around inside the computer in that art deco tank looking for Invader-like things to zap, except they zap him. Confused? You won't be after the next edition of ETI, where we'll be reviewing Tron, the big Christmas film from Walt Disney and a milestone in moviemaking. Sorry, I forgot about the Common Market and Eurometaphors: it's a kilometrestone

in moviemaking. Stuffed full of computer animation and other clever and unique techniques, plus a lot of video gaming mythology, this is great entertainment.

Almost as great, that is, as our extensive review of as many video games as we can get our hands on, in our 'Buyer's Guide to Conquering the Universe'. This will be just in time to help you make up your mind before the Christmas spending spree, and containing our maximum scores so you can pit yourselves against us. We'll also be presenting all our usual features plus a bumper collection of excellent projects, including a digital stage lighting dimmer and a programmable power supply. You can't afford to miss the January edition of ETI, on sale December 3rd.

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



Walt Disney Productions

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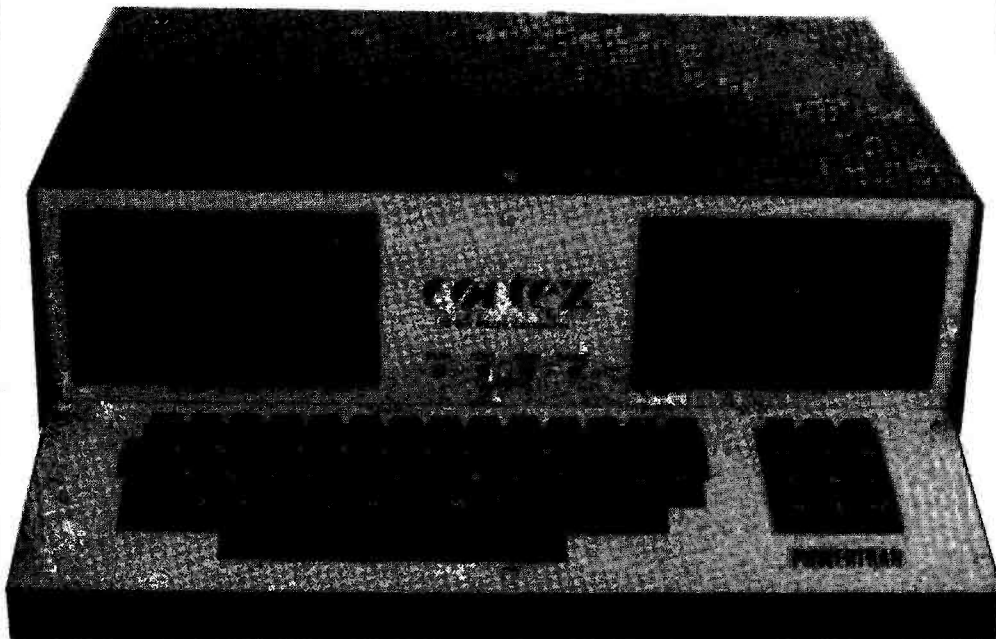
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	BIT	ON	DATA	RENUM	NEW
FUNCTIONS	CRB	GOTO	READ	BOOT	END
ABS	CRF	GOSUB	RESTOR	GRAPH	CRB
ADR	MEM	POP	RETURN	TEXT	CRF
ASC	MWD	REM	STOP	PLOT	MEM
ATN	LEN	FOR	TIME	UNPLOT	MWD
SIN	MCH	NEXT	WAIT	COLOUR	BASE
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DIGEST

Will Industry Standardise on the 3" Floppy?

Hitachi think it will, and they have launched a new disc drive on to the UK market to cater for the projected demand. Their product is called the Model HFD 306S, and it's pretty small as you can see from the photograph. The recording speed, recording capacity per track and other specifications are claimed to be exactly similar to those of a standard 5¼" floppy disc driver, so that existing disc controllers can be used to handle it. Single and dual drive units will be available, and they will accept single or double density double-sided discs.

The disc itself will be housed in a rigid plastic case with a sliding metal shutter to protect it

against contamination. While prices have yet to be decided, Hitachi say that both the drive units and the discs will be considerably cheaper than the 5¼" equivalents. How long this unit will take to find its way on to the hobbyist scene remains to be seen, but if it lives up to its maker's claims, we look forward to its arrival.

Meanwhile, four other manufacturers — Dysan, Tabor, Shugart and Verbatim — are trying to establish an industry standard for three to four inch discs. Their idea is to create a standard that will accommodate future technological advances rather than just accepting and standardising what is around at the time.

Pac-Man Champ

The Under-25 UK Pac-Man Champion, 16-year-old Craig Heap, with BBC TV

presenter John Craven, and Pac-Man (he's the furry one), photographed at the National Finals of the UK Pac-Man Championship held at the Barbican Centre, London on 30 August 1982. Craig's winning score was 14,174.



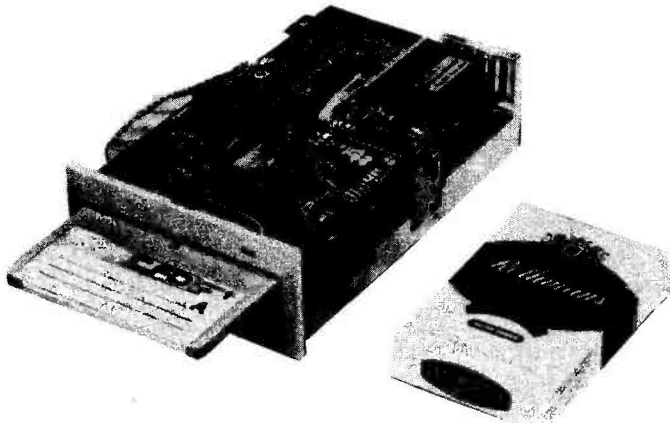
Scope for a Multiplexer?

A multiplexing device which converts a general-purpose single- or dual-channel oscilloscope into an eight-channel instrument has been developed by GSC. The new Model 8001 multiplexer which functions in the same way as a simple logic analyser minus its memory, and allows simultaneous events on different channels to be compared and displayed in direct relationship to one another. The UK price is £225.

The instrument allows oscilloscope users to view events occurring synchronously or asynchronously, and the user can observe all eight channels at once or one of two 4-channel combinations. Details from Gopal Specialties Corp, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

Easy-To-Use Fuse

A new high performance, low profile fuse mounting system is now available from Littlefuse-Olvis. Designated OM-NIBLOCK, the system provides fuse mountings for three different terminal styles, comprising solder type and quick connect blade type for 0.25" (6.35 mm) and 0.187" (4.78 mm) receptacles. These low height fuse mountings feature a one-piece, high amperage, self-aligning fuse clip/terminal design which eliminates resistance build-up and allows for operation at high current levels of up to 30 amps. They come in one through 12 pole units with individual pole barriers to prevent clip damage and provide electrical protection. Standard colour is grey but optional colours are available to special order including blue, green, red, white, black or yellow. In addition, two different style clip types can be supplied for circuit identity or polarisation as well as an anti-rotation boss device for single pole units only. For further information contact Littlefuse-Olvis, Crowther District 3, Washington, Tyne & Wear NE38 0AH.



Doctoring Your Memory

New from Dataman Designs is the Microdoctor; it can be plugged into your micro in place of the MPU (or clipped in over the MPU with the latter in DMA or RESET mode). The Microdoctor will 'look' around in address space, and report what it finds via the printer. Memory map, data tables, peripheral driving routines can all be located, and if your system is Z80-based, the disassembler can be used to check them. All form of memory, including dynamic RAM can be checked. The Microdoctor costs £295 plus VAT from Dataman Designs, Lombard House, Cornwall Road, Dorchester DT1 1RX, or from retailers.



Big Ni-Cads

The new LS range of nickel cadmium general purpose cells from Chloride Alcad Limited, of Redditch, will provide standby power where essential loads are required to be maintained for 24 hours or longer. Ampere hour capacities range from 525 to 1,300 and a battery capacity of several thousand ampere hours can be provided if cells are connected in parallel. Chloride Alcad Limited, Union Street, Redditch, Worcestershire B98 7BW, England. Tel: 0527 62351



MULLARD SPEAKER KITS

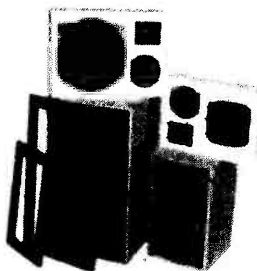
Purposefully designed 40 watt R.M.S. and 30 watt R.M.S. 8 ohm speaker systems recently developed by MULLARD'S specialist team in Belgium. Kits comprise Mullard woofer 18" or 5"1 with foam surround and aluminium voice coil. Mullard 3" high power domed tweeter. B.K.E. built and tested crossover based on Mullard circuit, combining low loss components, glass fibre board and recessed loudspeaker terminals. SUPERB SOUNDS AT LOW COST. Kits supplied in polystyrene packs complete with instructions.

8" 40W system - recommended cabinet size 240 x 216 x 445mm
Price £14.90 each + £2.00 P & P.

5" 30W system - recommended cabinet size 160 x 175 x 295mm
Price £13.90 each + £1.50 P & P.

Designer approved flat pack cabinet kits, including grill fabric. Can be finished with iron on veneer or self adhesive vinyl etc.

8" system cabinet kit £9.00 each + £2.50 P & P.
5" system cabinet kit £7.00 each + £2.00 P & P.

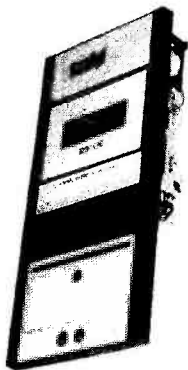


STEREO CASSETTE TAPE DECK MODULE.

Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.

Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. Input Sensitivity: 100mV to 2V. Input Impedance: 68K. Output level: 400mV to both left and right hand channels. Output Impedance: 10K. Signal to noise ratio: 45dB. Wow and flutter: 0.1%. Power Supply requirements: 18V DC at 300mA. Connections: The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). Dimensions: Top panel 5 1/2" x 11 1/2". Clearance required under top panel 2 1/2". Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.

Price £28.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) £3.50.



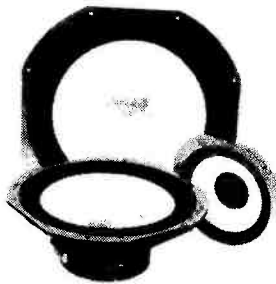
6 piano type keys

NEW RANGE QUALITY POWER LOUD-SPEAKERS (15", 12" and 8"). These loudspeakers are ideal for both hi-fi and disco applications. Both the 12" and 15" units have heavy duty die-cast chassis and aluminium centre domes. All three units have white speaker cones and are fitted with attractive cast aluminium (ground finish) fixing escutcheons. Specification and Price:

15" 100 watt R.M.S. Impedance 8ohm 59 oz. magnet. 2" aluminium voice coil. Resonant Frequency 20Hz. Frequency Response to 2.5KHz. Sensitivity 97dB. Price £32 each. £3.00 Packing and Carriage each.

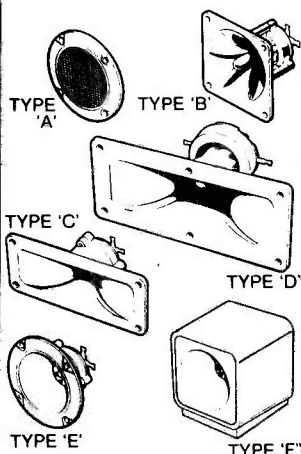
12" 100 watt R.M.S. Impedance 8 ohm, 50 oz. magnet. 2" aluminium voice coil. Resonant Frequency 25Hz. Frequency Response to 4KHz. Sensitivity 95dB. Price £23.70 each. £3.00 Packing and Carriage each.

8" 50 watt R.M.S. Impedance 8 ohms, 20 oz. 1 1/2" aluminium voice coil. Resonant Frequency 40Hz. Frequency Response to 6KHz. Sensitivity 92dB. Also available with black cone fitted with black metal protective grill. Price: White cone £8.90 each. Black cone/grill £9.50 each. P & P £1.25 each.



PIEZO ELECTRIC TWEETERS - MOTOROLA

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



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. Price £3.45 each.

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TYPE 'C' (KSN6016A) 2" x 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. Price £5.45 each.

TYPE 'D' (KSN1025A) 2" x 6" wide dispersion horn. Upper frequency response retained extending down to mid range (2KHz). Suitable for high quality Hi-fi systems and quality discos. Price £6.90 each.

TYPE 'E' (KSN1038A) 3 3/4" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. Price £4.35 each.

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

U.K. post free for SAE for Piezo leaflets.



1000 MONO DISCO MIXER

A superb fully built and tested mixer/pre-amp with integral power supply. 4 Inputs 2 turntables (ceramic cartridge). Aux. for tape deck etc., plus Mic. with override switch, all with individual level controls. Two sets of active tone controls (bass and treble) for Mic. and main inputs. Master volume control. Monitor output with select switch and volume control.

Outputs Main 750 mV Monitor 500 mV into 8 ohms. Supply 220/240V AC50/60Hz. Size 22 1/2" x 4 1/2" x 2 1/2" price £39.99 + £2.50 P&P

1K.WATT SLIDE DIMMER

- Controls loads up to 1KW
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- Innumerable applications in industry, the home, and discos/theatres etc.

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BSR P256 TURNTABLE

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

Price: £28.50 + £2.50 P&P



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Power Amplifier Modules with integral toroidal transformer power supply, and heat sink. Supplied as one complete built and tested unit. Can be fitted in minutes. An LED Vu meter is available as an optional extra.

SPECIFICATION:

Max Output Power: 110 watts R.M.S. (OMP 100) 310 watts R.M.S. (OMP 300)
Loads: Open and short circuit proof. 4-16 ohms.
Frequency Response: 20Hz - 25KHz ±3dB.
Sensitivity for Max. Output: 500mV at 10K (OMP 100) 1V at 10K (OMP 300)
T.H.D.: Less than 0.1%
Supply: 240V 50Hz
Sizes: OMP 100 380 x 115 x 72mm
OMP 300 460 x 153 x 66mm
Prices: OMP 100 £31.50 each + £2.00 P&P
OMP 300 £89.00 each + £3.00 P&P
Vu Meter £9.50 each + 50p P&P



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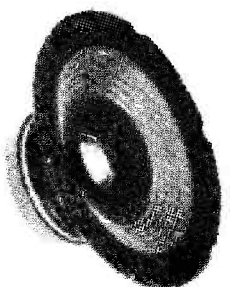
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Recommended Cab-size 26" x 13" x 13"
Fitted with attractive cast aluminium fixing escutcheons and mesh protective grills which are removable enabling a unique choice of cabinet styling. Can be mounted directly on to baffle with or without conventional speaker fabrics. All three units have aluminium centre domes and rolled foam surround. Crossover combines spring-loaded loudspeaker terminals and recessed mounting panel.
Price £22.00 per kit + £2.50 postage and packing. Available separately, prices on request.

12" 80 watt R.M.S. loudspeaker.

A superb general purpose twin cone loudspeaker. 50 oz. magnet. 2" aluminium voice coil. Rolled surround. Resonant frequency 25Hz. Frequency response to 13KHz. Sensitivity 95dB. Impedance 8ohm. Attractive blue cone with aluminium centre dome.
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Alpha Numeric Keyboard Full size 55 key non encoded keyboard with the commonly required functions in a Qwerty array. Matrix output via a 16 pin DIL socket.
Size: 350mm x 100mm x 2mm. Price: £13.99 + 50p p&p





Flashy New Portable

A new portable computer is being introduced into the UK by Epson, a Japanese manufacturer well known for its dot matrix printers and LCD displays. The computer, the HX 20, is designed to be used anywhere, anytime. About the size of an A4 notepad, it is claimed to offer computing power and capabilities comparable to many desk-top computers.

Language is an extended version of Microsoft BASIC, operating from a 32K RAM (expandable to 72K). Standard memory is 16K, expandable to 32K, but just under 4K is taken up by the operating system, leaving 12.6K and 28.6K respectively. Keyboard is full size ASCII-encoded, with 10 special function keys.

To those of you who remember as far back as October, the LCD display may look familiar. It can display four lines of 20 characters at any one time; however, there is a virtual screen

area of 255 lines by 255 characters that the real screen can be used to window. There is scope for the use of a CRT as a monitor.

Finally, there are the integral micro-cassette tape deck and dot matrix printer — fairly standard items in themselves but useful to have on board. The whole system is powered by four nicads that give a total typical operating time of 40 hours, and are rechargeable from the household supply.

The HX 20 is expected to be hitting the shops around the new year at a cool £500 or so.

Shorts

- From November 1st, viewers in the LWT and Thames area will be able to receive a 100-page local teletext service. There are already local services operating in the STV and Channel areas.
- Just published by Northwood Books: Cipher Systems, the Protection of Communications, by Henry Becker and Fred Piper. It's all about cryptology, and no, you should be able to read ETI without it.
- Over fifteen million US homes will have roof-top direct broadcast satellite terminals by the end of the decade, predicts a report from International Resource Development Inc. The report goes on to say that the likely price will be \$350-\$500, and that only the largest equipment manufacturers will be able to compete at this cut-throat price.
- The dotty display (made by Epson) featured in Digest, October is available from Norbain Displays Ltd, Norbain House, Arkwright Road, Reading, Berks, RG2 0LT, and from Datic Ltd, Tudor Road, Altrincham, Cheshire WA14 5TN.
- While we're on the topic of Norbain, they tell us that they have started selling Vactec discrete phototransistors, photodarlingtons, and matched GaAs LED/sensor pairs.
- Sifam have launched a new range of test equipment including a low-cost DMM and a digital logic probe. Sifam Ltd, Woodland Road, Torquay, Devon TQ2 7AY.

- Ross Electronics, 49/53 Pancras Road, London NW1 2QB have just issued a new catalogue, containing their ranges of microphones, leads, intercoms, headphones, multimeters, cassette tapes and other goodies.
- Another new catalogue, this time from Draper Tools. At £6.50, it's a bit pricey for the hobbyist (the Ross cat is free).
- Why can't all suppliers make their catalogues free — there are even some people who think their's is a magazine, believe it or not. Luckily, Bernard Babani Ltd have resisted the urge to turn their catalogue into a book, even though they publish plenty of the latter in subjects that would be of interest to ETI readers. Oh yes, the cat is free, from Bernard Babani Ltd, The Grampians, Shepherds Bush Road, London W6 7NF.
- Thandar have introduced a prescaler for use with the TF100 frequency meter. It will extend the upper frequency limit of the counter to 1GHz. Called the TP1000, the unit costs £65 plus VAT.
- Philips have launched a twice-yearly magazine for business systems users; it's called 'Connections', but, so far as we can see, it doesn't have anything to do with either James Burke or John Julius Norwich.
- Crunchie bars to be computerised — official. Ferranti Computer Systems will be supplying the hard and software to monitor the production line of this computerised confectionery.

- Is electronics all hot air? Cooper Tools have just unveiled a new soldering or desoldering tool that uses hot air rather than a bit to heat the job. Cooper Tools Limited, Sedling Road, Wear, Washington, Tyne & Wear NE38 9BZ.
- NEC Electronics Ltd have developed a 1 megabit mask ROM; the device should be available in the UK this autumn.
- FREDs (fast recovery epitaxial diodes — bet it took quite a lot of head-scratching to think of a product with that acronym) are being produced by Siemens Ltd. Reverse recovery times are claimed to be better than 35 nS.
- Yet another catalogue, this time from Aries Electronics, Eastways, Witham, Essex, CM8 3YQ; this one's full of sockets and DIP switches and jumpers.
- British Telecom have placed a firm order for 8,600 Cardphones (the type that uses bits of plastic rather than real money). It seems that the old style of 'phones can't take the money off you fast enough.....
- Read/Write ROM? Surely some mistake? No, the unit in question is from Camel Products, and is a two kilobyte RAM with battery support (for when your computer is switched off) and function switches so that the memory can be written to, then further write operations locked out. The battery allows several years of data retention. It's available for £29.95 inclusive, from Cambridge Microelectronics Ltd, One Milton Road, Cambridge CB4 1YU.

Inexpensive 'Scope

A 5 MHz oscilloscope for £115.72 plus VAT? New, via Verospeed, from Trio is the CO-1303D with DC to 5 MHz bandwidth and a sensitivity of up to 10 mV per division. With direct access to the deflection plate terminals, the 'scope can be used at higher frequencies. There is also a 10 MHz dual-beam version at £249.65 plus VAT. Details from Verospeed, Stanstead Road, Boyatt Wood, Eastleigh, Hants SO5 4ZY.

Digital Noise Source

Using entirely digital techniques, the DNS03 digital noise source developed and manufactured by Marconi Space and Defence Systems produces a true random digital output. The device, produced as a metal case thick film hybrid measuring 1.3" x 1.0" x 0.2", is extremely versatile and is claimed to overcome the problems of existing noise-sources based on noise diodes.

The device will operate at any supply voltage between 4 volts and 15 volts and typical consumption at 5 volts is 2mA. A disable control reduces this consumption yet further permitting its use in battery powered equipments. The hybrid will operate over the full military temperature range of -40°C to 125°C. For further information contact: Marketing Department, Military Communications Division, Marconi Space and Defence Systems, Brown's Lane, The Airport, Portsmouth, Hampshire, PO3 5PH.

Computer Talk

Talking computers, what will they think of next? Using the Votrax SC-01 IC, the ADS Synthetalker is an IEEE 696/S-100 compatible speech synthesis board. Available from Appledore Electronics, you have the choice of bare board and IC, or kit, or fully assembled and tested versions. Details and data are available from Appledore Electronics (see ads index).

Another entry into this field is from DCP Microdevelopments Ltd, who have introduced a speech unit for the ZX81. Designated the DCP Speech Pack (hard to remember, that one), it plugs straight into the back like so many of the Sinclair add-ons, and costs a princely £49.95 including VAT and p&p. (A Spectrum adapter is available for £2.95.) DCP Microdevelopments Ltd, 2 Station Close, Lingwood, Norwich NR13 4AX.

(PS: Neither of these suppliers mention whether their units have an American or English accent!)

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Quite Dishy

A new small-dish aerial hoisted on to the roof of a British Telecom building in the City of London, will be the first to be shared between a number of users. The aerial and its associated equipment will be used in further trials of British Telecom's SatStream — a satellite-based X-Stream digital service which is to be offered to UK businessmen in 1984 to provide specialist private communications within the UK and to Europe. It will subsequently serve in this location as one of the first SatStream small-dish terminals in commercial service. SatStream will offer three main benefits to its users:

- flexibility: service can be introduced at very short notice and expanded or reconfigured equally quickly
- diversity: digital operation allows many different services, such as speech, telex, facsimile or data, to be integrated on the same transmission path while advanced services can be added quickly at comparatively little extra cost
- multi-destination broadcasting: of particular advantage for one-way information flow, such as news dissemination to branch offices for local distribution.

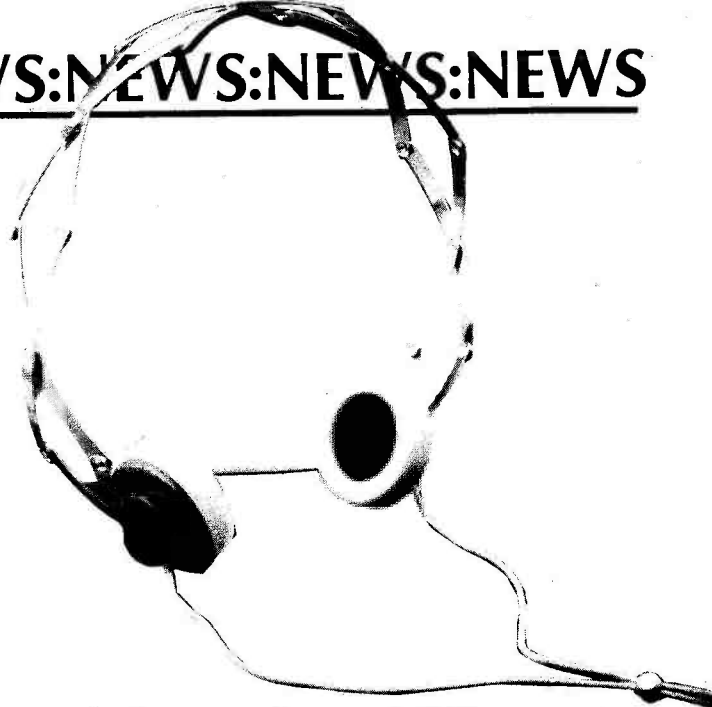
Trials of SatStream began last year with the aim of proving the service, and of creating a solid base of installation and operational experience on which British Telecom can draw when establishing a commercial service early in 1984. To provide such a service, small-dish aerials, from 3.7 to 5 m (12 to 17ft) in diameter, would be installed at rooftop level on or near customers' premises. While a single terminal may be dedicated solely for a particular customer's use, it is pro-

bably that in City centres where demand is likely to be concentrated they will be shared between several users. This would help to spread the cost.

The new 3.7 m aerial hoisted into position last weekend will provide British Telecom International — the division of British Telecom marketing SatStream — and its users with valuable first-hand experience of shared use. Trials are expected to start in a few weeks' time. The first organisations taking part will be mainly multinational, engaged in news dissemination and in the oil and chemical industries. They will use the dish aerial simultaneously to communicate between offices in London and in other European cities. Experimental activities are likely to include video-conferencing and integration of a variety of services. Each user will have its own dedicated link to the aerial.

The trials will be conducted using Europe's orbital test satellite (OTS). When they are completed, the equipment will be modified to enable the aerial to work to one of the satellites to be used for commercial service — the European Communications Satellite (ECS) or Telecom 1, a French government project. It will then serve as one of SatStream's strategically located earth stations.

The first small-dish trials involved an international newspaper, providing a digital link used to transmit facsimile pages for printing its European edition. More recently small-dish terminals were installed at University College, London, and at Cambridge and Loughborough universities, for Project Universe, and experiment in computer communications by satellite.



New 'Phones from AKG

The 'phones pictured above are the K1 (yes, they really do fold up like pieces of garden trellis); they're claimed to give hi-fi performance and should sell for around £17.25 inc VAT. The K4

phones are the super-fi versions, and have a slightly more conventional headband. However, they'll set you back about £62. AKG Acoustics Limited, 191 The Vale, Acton W3 7QS.

First Plastic Packaged 10-Bit A/D Converter?

Ferranti Electronics has introduced the ZN432E — believed to be Europe's first 10-bit converters to not need a ceramic package, with the attendant expense of both ceramic and gold materials. Now Ferranti Electronics has developed a new moulded packaging technique which results in the price of the ZN432E being less than half that of its ceramic equivalent.

The ZN432E operates over the commercial temperature range (0-70°C) and is available in a 28-pin D.I.L. moulded

package. A conversion time of 20µs is guaranteed, with no missing codes. The device is TTL/CMOS compatible and includes an on-chip 2.5 volt reference.

Full details of this and all of the Ferranti Electronics range of monolithic data converters can be obtained from the Publicity Department, Ferranti Electronics Limited, Fields New Road, Chadderton, Oldham, Lancashire, OL9 8NP. Tel: (061) 624 0515.



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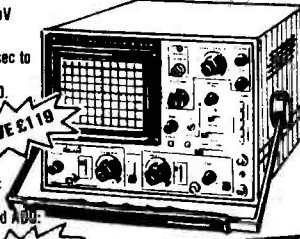
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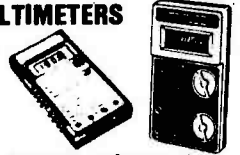
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(SW = slide switch; PB = push-button; RS = rotary) (models * with carry case)
UK C/P 65p all models



*KD25C 13 Range 0.2A DC 2 megohm (SW) **£26.50**
*KD30C 26 Range 1A AC/DC 200 megohm (RS) **£37.50**
*KB55C 28 Range 10A AC/DC 200 megohm (RS) **£41.50**
*B01 28 Range 2A AC/DC 20 megohm (PB) **£36.50**

168mm 16 Range 10A DC (NO AC) 2 megohm plus Hfe (TRANSISTOR) tester (RS) **£43.50**
180mm 30 Range 10A AC/DC 20 megohm plus Hfe Tester (RS) **£48.95**
*DM2350 21 range miniature auto ranging (SW) **£35.00**

OSCILLOSCOPES (UK C/P Single trace £3 ea. Safran £3 ea. Dual trace £4 ea. SC110 £1 ea.)



HM307 Single trace 10MHZ 5mV/0.5 micro sec. Plus built in component tester 8 x 7 cm display (HAMEG) **£158.70**
Optional Case **£18.40**
3030 Single trace 15MHZ 5mV/0.5 micro sec. Plus built in component tester 95mm tube. Trig. to 20MHZ (CROTECH) **£172.50**

HM203/3 Dual 20MHZ: Trig. to 30MHZ 5mV: 0.5 micro secs. 8 x 10cm display (HAMEG) **£253.00**
HM203/4. As above but 2mV + Algebric add (HAMEG) **£276.00**
CS1562A Dual 10MHZ 10mV. 1 µ sec. 140mm tube (TRIO) **£276.00**
3131 Dual trace 15MHZ trig. to 35MHZ 5mV: 0.5 micro sec. 130mm tube plus component tester. **£276.00**

3034 Battery-mains dual trace 15MHZ trig. to 20MHZ in Nicado. 5mV 0.5 micro secs (CROTECH) **£414.00**
(Eliminator charger optional **£36.00**)
HM204 New model with component tester Dual 20MHZ delayed sweep: trig to 40MHZ. 5mV 0.1 micro sec: 8 x 10cm display (HAMEG) **£419.75**
(Optional case **£21.85**)
SC110A New model 10MHZ battery portable. 10mV 0.1 µsec 2" trace. All facilities (THANDAR) **£171.00**

(OPTIONS):
Carry case **£6.84**
AC Adaptor **£5.60**
Nicads **£8.63**
CS1577A Dual 35MHZ. 2mV 0.1 µsec. Single sweep facility. 140mm tube (TRIO) List price **£540.00** Our price **£475.00**

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HM705 Dual 70MHZ delayed sweep: Single sweep: Delay line: Trig to 70MHZ: 2mV/0.1 micro sec. 8 x 10cm display (HAMEG) **£667.00**
CS270 70MHZ 4cm 8 trace List **£965.00** Our Price **£918.85**

Also stocked
Trio Dual 100MHZ Thandar Channel logic analyser 6SC 8 Channel scope adaptor.
Safran all models 5mV sens. 0.5 micro sec 0.4 x 8cm display.
DT410 Dual 10MHZ **£205.85**
DT415 Dual 15MHZ **£217.35**
DT420 Dual 20MHZ **£226.85**
- Scope probes all models - see below

DIGITAL MULTIMETERS

All models complete with leads and batteries

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TM353 LCD 27 range 2A AC/DC basic 0.15% (Sinclair) **£86.25**
2015A LCD 31 range 10A AC/DC basic 0.1% (Sabtronics) **£89.50**
TM351 LCD 29 range 10A AC/DC basic 0.1% (Sinclair) **£113.85**
2001 LCD 28 range plus 5 range capacitance meter 10A AC/DC basic 0.1% (Pantec) **£108.00**
TM451 4½ digit LCD every facility and function 0.02% basic (Thandar) **£171.00**
1503A 4½ digit LCD 30 ranges 10A AC/DC MHz counter 4 KHZ osc. 0.05% basic (Thurby) **£171.00**
1503HA As above but 25A and 0.03% basic **£189.75**

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I1T02 14 range 2K/Volt pocket **£5.85**
ST13 11 range pocket 4K/Volt **£8.50**
NH56R 22 range pocket 20K/Volt **£10.95**
YN360TR 19 range plus Hfe test 20K/Volt **£12.95**
KRT5001 16 range 10 amp DC range double 50K/Volt **£16.50**
ST303TR 21 range plus Hfe Test 20K/Volt **£16.95**
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LAG125 As LAG120A but 0.02% dist. (LEADER) **£273.00**
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RF (All with In/Ext mod. variable output)
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LG617 100KHZ - 150MHZ (450MHZ harm) LEADER **£71.30**
FUNCTION (All Sine/SQ/Triangle/TTL etc.)
5020A 1HZ - 200KHZ (SABTRONICS) **£90.00**
TG100 1HZ - 100KHZ (THANDAR) **£90.85**
TG102 0.2HZ - 2MHZ (THANDAR) **£166.75**
PULSE
TG105 5HZ - 5MHZ Various outputs (THANDAR) **£97.75**
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LTC907 Signal injector/tracer and transistor checker **£173.65**

FREQUENCY COUNTERS (All models battery operated)

(UK C/P £1)
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Max 50 50MHZ 8 digit LED Pocket (GSC) **£56.35**
Max 550 8 digit LED Pocket (GSC) **£97.75**
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Max 100 5HZ-100MHZ 8 digit bench LED (GSC) **£97.75**
9610B 9 digit LED 3 range 600MHZ. 8 bench (SABTRONICS) **£113.85**
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TF40 8 digit LCD 40MHZ (THANDAR) **£126.50**
TF200 8 digit LCD 2 range 200MHZ (THANDAR) **£166.75**
Thandar precaters for any counter up to 200MHZ
TP600 600MHZ **£43.13**
TP1000 with P/S 1GHZ **£73.00**
OPTIONS
TF series carry case **£8.84**
8 adapters (TF Series) **£5.60**
8 Series AC adaptors **£5.60**
All models probe kits **£7.95**

SCOPE ADD ON UNITS

LTC905 Semiconductor curve tracer (Ilus)(LEADER) **£95.45**
(UK C/P 65p)
HZ65 Component tester (HAMEG) **£27.95**
(UK C/P 65p)

LOGIC PROBES/MONITOR

Sabtronics LP10 10MHZ probe **£28.50**
GSCLP2 1.5MHZ probe **£18.95**
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THD (1KHz at 100W)	0.004% typ.
SNR	120dB
Slew rate	>30 V/ μ S
Gain	\times 23
Rin	30K
V_s max	\pm 70V



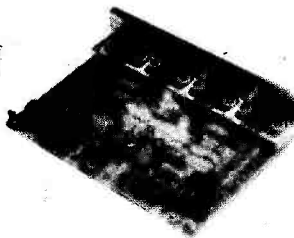
PFA100 120W into 8 Ω

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PFA200 Specification

Bandwidth	10Hz-100KHz \pm 1dB
Output Power into 8 Ω	150W ($V_s = \pm$ 60V)
THD (20Hz-20KHz)	<0.006%
THD (1KHz at 150W)	0.002% typ.
SNR	120dB
Slew rate	>30 V/ μ S
Gain	\times 23
Rin	30K
V_s max	\pm 70V



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TR 250	Toroidal Transformer 250VA	25.43	3.81	29.24	3.35	
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CPS 250D	Dual Power Supply	39.43	5.91	45.34	3.65	
TS 70	Thermal Switch 70°C	1.92	0.29	2.21	0.02	
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4002 13p	7401 13p	74174 50p	74LS163 35p	0-2"	Bar Graph 295p	IN4007 6p
4008 60p	7402 13p	74175 50p	74LS164 45p	Red 10p	5"	IN5401 13p
4007 13p	7403 13p	74180 50p	74LS165 50p	Green 14p	Common Anode	IN5404 16p
4008 50p	7404 13p	74190 60p	74LS168 60p	Flashing 80p	L.H. decimal point	IN5406 16p
4010 30p	7405 14p	74191 60p	74LS169 80p	Rectangular 82p	Red 150p	IN4148 3p
4011 13p	7406 20p	74192 70p	74LS170 70p	LEDs	Green 248p	IN914 3p
4012 13p	7407 24p	74193 60p	74LS173 40p	Red 22p	Yellow 280p	IN916 3p
4013 22p	7408 14p	74194 60p	74LS174 45p	Green 26p	Common Cathode	BZY88C2V7 8p
4014 50p	7409 14p	74195 48p	74LS175 45p	Yellow 22p	R.H. decimal point	BZY88C3V3 8p
4015 45p	7410 14p	74196 48p	74LS181 110p	Bi-Colour 22p	Red 150p	BZY88C3V6 8p
4016 25p	7411 14p	74197 50p	74LS180 45p	Red/Green 80p	Green 248p	BZY88C4V7 8p
4017 40p	7412 18p	74221 75p	74LS191 45p	0-125"	Yellow 280p	BZY88C6V8 8p
4019 35p	7413 22p	74279 40p	74LS192 45p	Red 11p	3"	BZY88C8V2 8p
4020 48p	7414 26p	74290 60p	74LS193 45p	Green 12p	Red 127p	BZY88C12 8p
4021 46p	7415 18p	74298 60p	74LS194 50p	Yellow 12p	Green 196p	BZY88C15 8p
4022 55p	7417 22p		74LS196 35p			BC107 11p
4023 13p	7420 15p		74LS197 50p			BC107A/B 11p
4024 42p	7421 20p		74LS240 70p			BC108A/B/C 11p
4025 13p	7422 20p		74LS241 70p			BC109A/B/C 12p
4027 28p	7425 20p	TTL LS	74LS244 70p			BC182 9p
4028 40p	7426 27p	74LS00 14p	74LS245 80p	LINEAR	TOGGLE SWITCHES	BC183 9p
4029 60p	7427 15p	74LS01 14p	74LS247 60p	AM2533 280p	SPDT 48p	BC184 9p
4030 13p	7428 18p	74LS02 14p	74LS249 40p	LM324 45p	on/none/off	BC212 9p
4035 66p	7429 18p	74LS03 14p	74LS251 40p	LM339 65p	SPTD 52p	8CY70 17p
4040 50p	7430 15p	74LS04 14p	74LS253 35p	LM358 75p	on/off/on	BCY71 18p
4042 40p	7431 18p	74LS05 14p	74LS256 55p	LM3900 55p		BCY72 18p
4044 46p	7432 18p	74LS08 14p	74LS257 40p	LM317 200p	DPDT 56p	BFY50 28p
4047 50p	7433 18p	74LS09 14p	74LS258 40p	MC1438 810p	on/none/off	BFY51 28p
4049 20p	7434 18p	74LS10 14p	74LS259 65p	MC1458 40p	DPDT 60p	BFY52 28p
4050 20p	7435 18p	74LS11 14p	74LS260 30p	MC1488 61p	on/off/on	TIP29/A 30p
4051 50p	7436 18p	74LS13 21p	74LS266 22p	MC1489 80p		TIP30/A 35p
4052 60p	7437 18p	74LS14 21p	74LS273 60p	MC3418 810p		TIP31/A 45p
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4067 447p	7440 16p	74LS17 14p	74LS283 40p	TBA800 88p		TIP42/A 50p
4069 13p	7441 15p	74LS18 14p	74LS284 40p	TBA810 95p		2N708 24p
4070 13p	7442 24p	74LS19 14p	74LS290 34p	TBA820 90p		2N918 26p
4071 13p	7443 18p	74LS20 14p	74LS293 34p	TCA940 175p		2N2218/A 26p
4076 50p	7444 24p	74LS21 14p	74LS295 52p	TDA1170 250p		2N2219/A 28p
4081 13p	7445 50p	74LS22 22p	74LS299 111p	TDA2002V 250p		2N2221/A 24p
4086 45p	7446 68p	74LS23 14p	74LS300 30p	TDA2020 320p		2N2222/A 28p
4093 30p	7447 55p	74LS24 14p	74LS302 30p	TL071CP 32p		2N2904/A 28p
4098 70p	7448 55p	74LS25 14p	74LS303 30p	TL072CP 53p		2N2905A 28p
4503 42p	7449 22p	74LS26 14p	74LS304 30p	TL497 300p		2N2906A 28p
4510 52p	7450 15p	74LS27 14p	74LS305 30p	UA741 18p		2N2907A 28p
4511 45p	7451 15p	74LS28 22p	74LS306 30p	UA747 70p		2N3053 28p
4512 50p	7452 25p	74LS29 14p	74LS307 30p	UA7805 45p		2N3055 48p
4516 60p	7453 15p	74LS30 14p	74LS308 30p	UA7812 45p		2N3442 130p
4518 40p	7454 15p	74LS31 14p	74LS309 30p	UA7905 54p		2N3715 57p
4520 60p	7455 15p	74LS32 14p	74LS310 30p	UA7912 54p		2N3716 65p
4528 64p	7456 45p	74LS33 14p	74LS311 30p	UA723 37p		
4539 64p	7457 45p	74LS34 44p	74LS312 30p	ULN2003AN 100p		
4555 45p	7458 45p	74LS35 40p	74LS313 30p			
4566 45p	7459 25p	74LS36 35p	74LS314 30p	Bridge Rectifiers		
40014 50p	7460 26p	74LS37 30p	74LS315 30p	50v 1.5A 23p		
40085 70p	7461 26p	74LS38 14p	74LS316 30p	200v 1.5A 22p		
40097 60p	7462 26p	74LS39 19p	74LS317 30p	400v 1.5A 30p		
40098 80p	7463 26p	74LS40 19p	74LS318 30p	600v 1.5A 32p		
40161 55p	7464 26p	74LS41 14p	74LS319 30p	800v 1.5A 35p		
40163 55p	7465 26p	74LS42 40p	74LS320 30p			
40175 60p	7466 26p	74LS43 44p	74LS321 30p			
40193 60p	7467 26p	74LS44 44p	74LS322 30p			
	7468 26p	74LS45 14p	74LS323 130p			
	7469 26p	74LS46 44p	74LS324 130p			
	7470 26p	74LS47 44p	74LS325 130p			
	7471 26p	74LS48 44p	74LS326 130p			
	7472 25p	74LS49 19p	74LS327 130p			
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	7474 22p	74LS51 14p	74LS329 130p			
	7475 23p	74LS52 14p	74LS330 130p			
	7476 22p	74LS53 14p	74LS331 130p			
	7477 22p	74LS54 14p	74LS332 130p			
	7478 22p	74LS55 14p	74LS333 130p			
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	7480 22p	74LS57 14p	74LS335 130p			
	7481 45p	74LS58 14p	74LS336 130p			
	7482 47p	74LS59 14p	74LS337 130p			
	7483 47p	74LS60 14p	74LS338 130p			
	7484 60p	74LS61 14p	74LS339 130p			
	7485 60p	74LS62 14p	74LS340 130p			
	7486 25p	74LS63 14p	74LS341 130p			
	7487 25p	74LS64 14p	74LS342 130p			
	7488 26p	74LS65 14p	74LS343 130p			
	7489 26p	74LS66 14p	74LS344 130p			
	7490 26p	74LS67 14p	74LS345 130p			
	7491 45p	74LS68 14p	74LS346 130p			
	7492 38p	74LS69 14p	74LS347 130p			
	7493 28p	74LS70 14p	74LS348 130p			
	7494 28p	74LS71 14p	74LS349 130p			
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	7496 45p	74LS73 14p	74LS351 130p			
	7497 45p	74LS74 18p	74LS352 60p			
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	7500 45p	74LS77 18p	74LS355 60p			
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	7502 45p	74LS79 42p	74LS357 30p			
	7503 45p	74LS80 30p	74LS358 30p			
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	7551 45p	74LS128				

THE ZOOM MICROPHONE

Zoom lenses have been around a long time and are standard issue on video cameras; but matching zoom microphones? How can such a thing be possible, you ask — and Vivian Capel answers.

Video sound is not much to write home about at present. This is because the track is recorded in linear fashion along one edge of the tape, unlike the video tracks which are laid down at a high writing speed diagonally across the tape by heads on a rotating drum. Slow tape speed means a low writing speed for the sound track, so it produces a poor frequency response and noise factor.

Efforts are being made to counter this, and there is a report that Sony have a prototype Beta recorder that modulates the sound on a low-frequency FM carrier and records it along with the video signal. As low recorded frequencies penetrate deeper into the tape coating, while high frequencies remain near the surface, the sound and vision recorded signals are physically separated and so do not interact. It seems that the existing audio linear track is retained so that the tapes will be compatible and will be playable on existing machines. There is little doubt that, not wanting to be outdone, the VHS camp will do something similar, so it looks as if video sound will be much improved in the new generation of machines.

Microphone Characteristics

All video cameras have zoom lenses and, to be realistic, the sound should change according to the lens setting. At the wide-angle setting, we should hear the general sounds of the surroundings, but at maximum telephoto, the ambient sound should diminish and the sounds originating in the field of view should stand out. As the lens zooms in, the transition should be gradual between the two different acoustics.

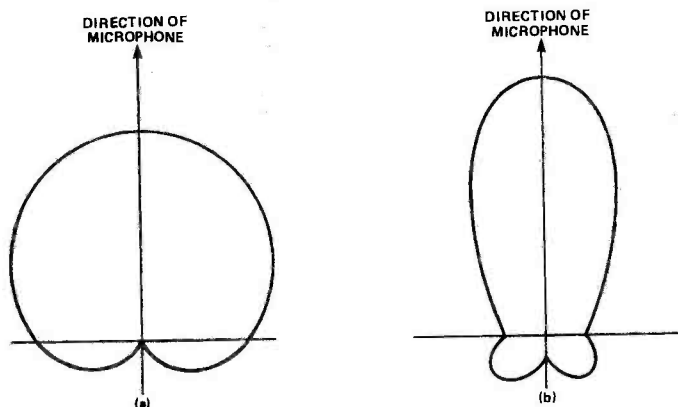


Fig. 1 Cardioid polar response (a) and super-directional response (b) obtained from a pair of out-of-phase cardioids. The response is at a nominal 1 kHz and changes for other frequencies.

In practice, nothing happens to the sound field at all, because the microphone is fixed to the camera and is not affected by anything done to the zoom lens. Professional camera teams overcome this by following the changes in the field of view with a microphone on a boom. Keeping the microphone out of camera shot is one of the ever-present problems.

Most video camera microphones are of the omnidirectional type; they pick up sound equally from all directions. These are used because they are less prone to handling noise than the directional type, although the latter could be used to advantage if shock-proof mountings were employed.

To overcome the incongruity of a fixed sound acoustic at different zoom lens settings, JVC have produced a breakthrough in the field of microphone technology; a microphone that zooms with the lens and gives an appropriate acoustic for all settings. Before we can understand just how it works, we must consider the elements of microphone polar response.

Omniscient?

An omnidirectional microphone has a diaphragm which is exposed to the environment at the front, but sealed at the back by an airtight chamber. Pressure fluctuations produced by the sound wave exert force in all directions (not merely along the axis of propagation) and this leads to pressure differences across the diaphragm that make it move backward or forward in sympathy, irrespective of the direction of the sound source.

Direct particle velocity, caused by the backward-and-forward movement of air molecules along the axis of propagation, has little effect on the diaphragm because of the damping effect of the trapped air. There is a small effect though, and this gives the omni microphone a not quite equal response all around it, but the deviation is small enough to ignore for most purposes.

The Heart of the Matter

If vents are made in the rear chamber, local air pressure can reach both sides of the diaphragm so the microphone is not pressure sensitive. However, the damping has been removed, so it is sensitive to particle velocity.

Also there is a secondary effect due to slight pressure differences that exist because of the phase difference between sounds arriving at the front and rear of the diaphragm. This is dependent on frequency, and when the physical path through the vents to the rear of the diaphragm equals a wavelength, there is pressure cancellation. At half a wavelength there is reinforcement,



This picture shows the MZ-500 zoom microphone attached to the JVC GX88E video camera. The mike also fits the GX77 and S100 cameras from the same company.

and below this the phase difference decreases all the way down. If the main force on the diaphragm were the pressure differences, as is sometimes erroneously stated, there would be a high peak in the treble frequency response with continual downward slope toward the bass.

Being sensitive to direct particle velocity yet relatively insensitive to pressure, the microphone responds in a directional fashion, favouring sounds coming from the front. The variation of output with angle of incidence, θ , is proportional to $1 + \cos \theta/2$; plotting a polar response curve gives a heart shape (Fig. 1a), hence the term *cardioid* which is used to describe microphones of this type.

If we were to place two cardioid units back-to-back we would have an omni-directional response. There seems little practical point in doing this, but as we shall see later, it does have an application.

Super Directivity

A marginal improvement in directivity can be obtained by modifying the vents to produce the hypercardioid, which has less response to sound from the sides, but a pair of small lobes with a high-ish response at the rear (Fig. 1b).

It is sometimes convenient to use a distance factor to describe directional microphones. This is the scaled distance from a wanted source at which the microphone will give the same results as an omni in terms of proportion of wanted to ambient sound. A cardioid can be placed 1.75 times further from the source than an omni, and a hypercardioid, two times.

For greater directivity, there is the gun microphone, which relies on interference and cancellation of sound waves coming from the sides. It is only effective down to the frequency at which a half-wavelength is equal to the length of the tube. Short tubes are not particularly

directional other than at the high and mid-high frequencies, while long ones are unwieldy when fixed to a camera and could intrude on the camera shot. Distance factors of around three times are obtainable, depending on length.

1 - 1 = ?

Supposing we mount two cardioid capsules one behind the other and connect them in opposite phase. Sound waves coming from the sides affect both equally so their electrical signals cancel and there is no output.

For sounds arriving from the front, there is a phase delay between the outputs from the two units. When the microphone spacing is equal to a half wavelength, the outputs reinforce to produce a maximum signal. At shorter wavelengths (higher frequencies) the net output drops towards complete cancellation at a one wavelength spacing. At lower frequencies (longer wavelength), output slowly falls linearly to zero at zero frequency (see Fig. 2). This double microphone is super-directional with similar polar response to the gun and the net output varies as $(1 + \cos \theta) \cos \theta$. However there are two major snags. One is that the capsules must be closely spaced as this establishes the upper frequency limit above which the output drops rapidly. Moving-coil units are too bulky to get close enough, but electret capsules are quite suitable. Closely spaced anti-phase units, though, tend to give low output.

The other snag is the falling low-frequency response. This can be equalised electronically, but the amount of lift needed at the lower end will greatly emphasise thermal and handling noise.

Fiddling With Phase

However, it is possible to trade directivity for response at low frequencies. This would then be no worse than a gun microphone in which low frequency directivity reverts to just that of the cardioid unit at the bottom of the barrel. This can be done by combining the signals from the two capsules through a frequency-dependent phase-processor. At the highest frequencies, the units are in anti-phase and function as described to give maximum directivity. They continue in this fashion down to the mid-frequency range, when the phase begins to rotate until in the bass region the capsules are in phase.

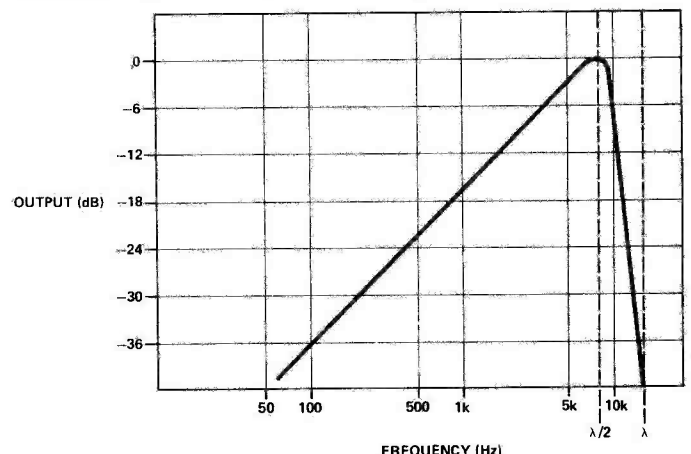


Fig. 2 The frequency response for a pair of out-of-phase cardioids (mounted in line) peaks at the frequency at which the half-wavelength equals the spacing between them. Below, it decreases at 6 dB/octave, requiring high gain at low frequencies to equalise. Above, the response drops rapidly to zero at the frequency corresponding to a one-wavelength spacing.

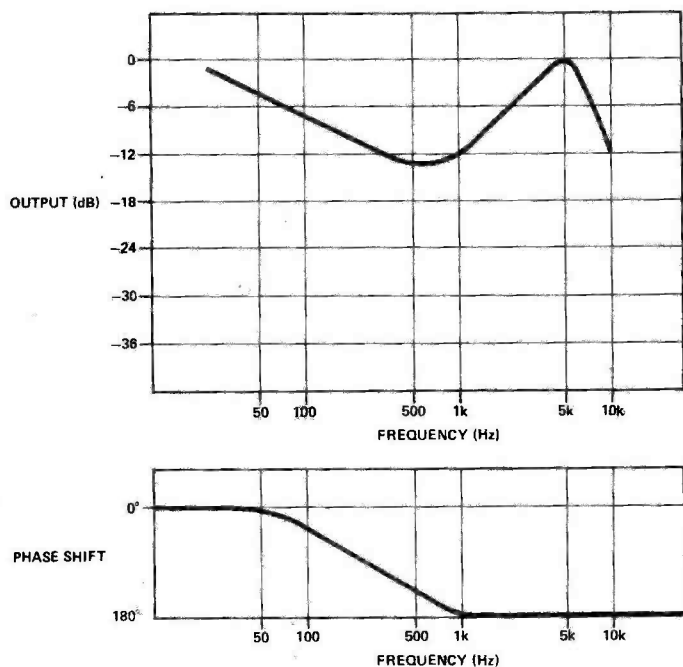
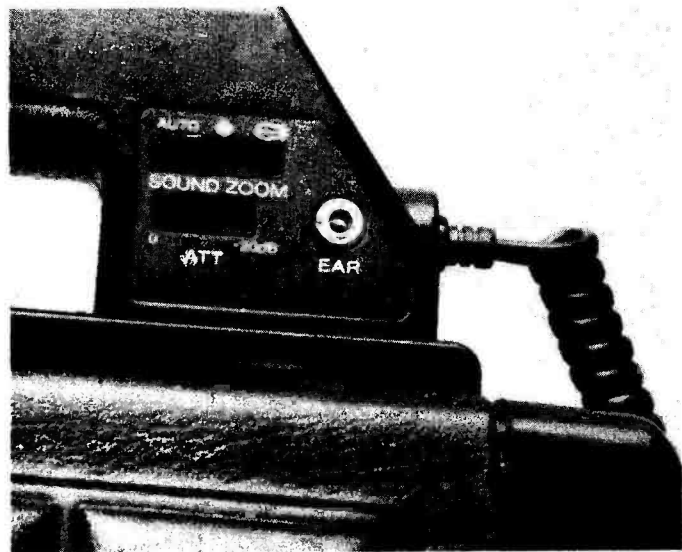


Fig. 3 The response of a cardioid pair when the phase is progressively rotated from 180° to 0° below the mid-range. The bottom chart shows the phase rotation.

Directivity is maintained down to the phase change point and then it degrades until it is that of a cardioid in the bass register. Figure 3 shows the frequency response, which falls from the treble to mid-range, then picks up to full amplitude again in the bass. The other graph indicates the phase change. This can be equalised without too much trouble, as no boost is required in the low frequencies, and so handling and thermal noise are not accentuated.

This principle is used by JVC, and the mid-frequency phase-change point is around 500 Hz. By using a potentiometer in the adding circuit, the polar response can be continuously varied. When at maximum, both outputs are combined to give the super-directional characteristic; when turned fully down, the second capsule is off, and only the first works to give a normal cardioid response.

While this would give a useful acoustic variation, it is not enough for the purpose of changing to correspond



Close-up of the S100 camera controls, showing the auto, omni and super-directional settings.

with a wide change of zoom lens setting. Earlier, though, we saw how an omni pattern could be obtained by mounting two cardioids back-to-back. Hence in the JVC microphone, a third unit is introduced directly behind the second and facing forwards. Thus we have all the necessary elements for the maximum possible change in polar response, from omni right through to super-directional.

Control is effected by a pair of ganged potentiometers with centre taps, which neatly avoids the use of multiple-ganged components. The operation can be seen by reference to the circuit diagram (Fig. 4). To make life easier, we will consider the two extreme potentiometer positions, A and C, and the intermediate position B. At A, the adder receives the full output from the third capsule, and also that of capsule no. 2. Signals from capsule no. 1 pass through the opposite side of the pot to earth via the centre tap. With only capsules 2 and 3 'live', the result is the omni-directional response.

Moving to the B position, the wiper is earthed through the centre tap, so the adder never receives the output from capsules 1 or 3, leaving number 2 on its own to provide the cardioid pattern. In the position C, the adder receives output from capsules 1 and 2, which produces the super-directional characteristic.

In addition to changing the outputs between the three

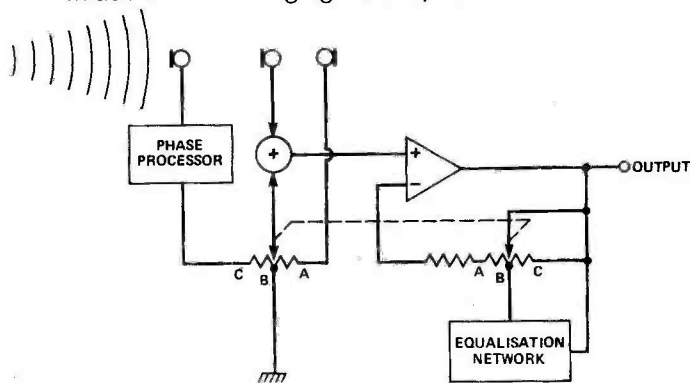


Fig. 4 Block diagram of the JVC zoom microphone.

capsules, it is also necessary to vary the gain so that maximum gain is obtained for close-ups with the super-directional pattern, and to take the equaliser out of circuit for cardioid and omni operation. All this is done by the second potentiometer which is connected in a negative feedback loop across the preamplifier.

In position A the potentiometer is shorted out and so is the equalisation network, so the amplifier is at minimum gain and the frequency response is flat: these are the conditions required for the omnidirectional operation. When in the central B setting, the gain is increased but the frequency response is still flat. When at the opposite extreme, position C, there is maximum resistance in the loop and hence minimum feedback and maximum gain. The equalisation network is now in circuit, so we have the required circuit conditions for the super-directional characteristic.

Of course there are an infinite number of intermediate positions afforded by the potentiometer, so an acoustic is obtained which is appropriate for all zoom lens settings. The control is linked to the lens control, so the setting is automatic and the user needs to give no thought to it.

The microphone described (type MZ-500) has been specifically designed for the S100 and GX77/88 colour cameras, but undoubtedly it, or future versions of the principle, will find an application in many audio fields where a continuously variable polar response between two extremes is required.

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4015	0.49
4016	0.19
4017	0.37
4018	0.87
4019	0.41
4020	0.49
4021	0.89
4022	0.85
4023	0.16
4024	0.31
4025	0.16
4026	1.29
4027	0.23
4028	0.49

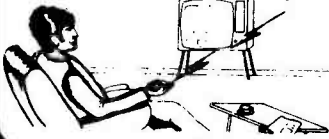
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EARTH LEAKAGE CIRCUIT BREAKER

Earth-fault currents from mains-operated equipment can kill you. Circuit breakers have featured in house-mains installations for some years: now this portable ELCB lets you take your protection anywhere. Design by Phil Walker.

If a fault occurs in a piece of mains-operated equipment, any external metal parts may be placed at earth potential. Should you complete a path to earth from the appliance, the statisticians could well be chalking up another death from electrocution. A more subtle but equally lethal danger is caused when inflammable material creates the path to earth — current flowing to ground might then generate enough heat to start a fire.

Even if no faults are present, building, servicing or tinkering with mains equipment is a dangerous pastime. One slip with a screwdriver . . . Our easy familiarity with electricity not only breeds contempt but a steady stream of fatalities. Many of these could be avoided if earth leakage circuit breakers were used more often (in an ideal world, of course, they'd be built into every piece of mains equipment by the manufacturer).

Your home may have ELCBs fitted at the fusebox, or you may have installed special ELCB sockets such as the MK Sentrysocket. But for portable protection and peace of mind, we've designed this earth leakage circuit breaker (or residual current device, as they're sometimes known), which can sense earth-leakage currents of about 25 mA and disconnect the mains within about 40 ms. The device relies on the fact that a fault current flowing to earth will cause a difference between the currents flowing in the live and neutral lines (Kirchhoff rules OK). The current difference is sensed and trips out a relay.

Standard Solution?

Curiously, we could find no legislation or regulations governing the specification of ELCBs in this country, despite calls to the British Safety Council, IEE, etc; although foreign standards *do* exist and provide a useful guideline. There is a British Standard in preparation, but it has yet to be made public. Hence our project has a disconnection time of less than 50 ms, and is built into a plastic box using nylon bolts so as to provide double insulation between the outside of the case and the circuitry.

The ELCB is designed to be plugged into a normal 13 A wall socket. Any normal household or small workshop device may then be plugged into the integral socket. The ELCB continuously monitors the current flowing to and from the device along the live and neutral wires; if at any time the amount of current flowing in these wires differs by more than a (small) pre-set amount, the ELCB will assume there is a fault and quickly disconnect the power from both lines. Thus any current flowing to earth (possibly via you) will trip the device, as will an



IMPORTANT!

Used properly, this project could help to make your home a safer place by providing added protection against electric shock. However, this doesn't mean that you can forget about all the precautions that you would normally take, because, like any piece of safety equipment, you shouldn't trust it to be your sole protection from the great hereafter. Belt and braces is the order of the day where human life is concerned! In any case, it won't protect you against shocks from most types of high-voltage generator or from a shock between live and neutral. Nevertheless, this device will considerably improve protection against the most common electric shock, from live to earth.

accident like running an electric mower over the power cable.

The particular method of fault detection we used ensures that the very hazardous condition of a person's body making contact between the mains supply and an independently earthed object can be acted upon immediately; it is also independent of the integrity of the mains earth supply at the normal outlet. The trip point of the device is set so that a net out-of-balance current of about 25 mA will trigger it.

The Current Transformer

The transformer used to sense the difference between the live and neutral currents, T1, can be made

from a standard toroidal transformer with extra windings added, and what would normally be the primary used as the secondary. We used a miniature 10 VA transformer supplied by RS Components, but this type is potted, and to accommodate the extra windings we had to drill through the potting in the middle. A better approach would be to use a type that is tapped, such as the OT 226 made by ILP. In any case, ILP products are more readily available to the home constructor.

With the transformer we used, we found that a primary consisting of a single pass of both mains input wires through the centre of the

transformer was quite sufficient. What would normally be the 110 V primary winding was used as the secondary. (The mains input wires should be passed through in the same direction).

If you use the ILP transformer, two passes of the mains input wires may be necessary to achieve the required sensitivity (note that the transformer is operated as a current transformer and not a voltage transformer), as the OT 226 has only a 240 V primary. If you use a similar transformer with a 110 V primary, a single pass may be sufficient for the primary. **In any case, the test winding conductor must have the same number of**

turns as the other new primaries. To find out if the transformer is working satisfactorily, follow the procedure given in the setting up section.

The transformer must be a toroidal type to avoid spurious tripping. We tried using the older laminated type, but we found that it was much too sensitive to fluctuations in the ambient magnetic field; obviously a severe disadvantage!

The Relay

Because the relay is central to the operation of the ELCB, it is vital that it is of the highest quality. In particular, the relay drop-out time should be a maximum of 30 milliseconds, and together with a maximum possible delay of 10 milliseconds from the electronics, this will guarantee a maximum operating time of 40 milliseconds (two whole mains cycles). The current switching capacity of the relay should not be exceeded at any time, as this could damage the contacts and increase the switching time, so it's best to use a relay that is capable of switching the full 13 A maximum that you will ever draw from a socket. Alternatively, if you do use a relay with a lower current switching capacity, then we advise including a fuse in the current path, shown as FS2 in the circuit diagram. Apply a de-rating factor of at least 50% to inductive loads, eg electric motors: if you are using an electric drill with a 500 W motor, then the relay should be capable of switching at least 4 A.

Construction

Assembly of the PCB should be quite straightforward provided that component polarities are carefully observed. Before assembling it into the case, attach short lengths (about

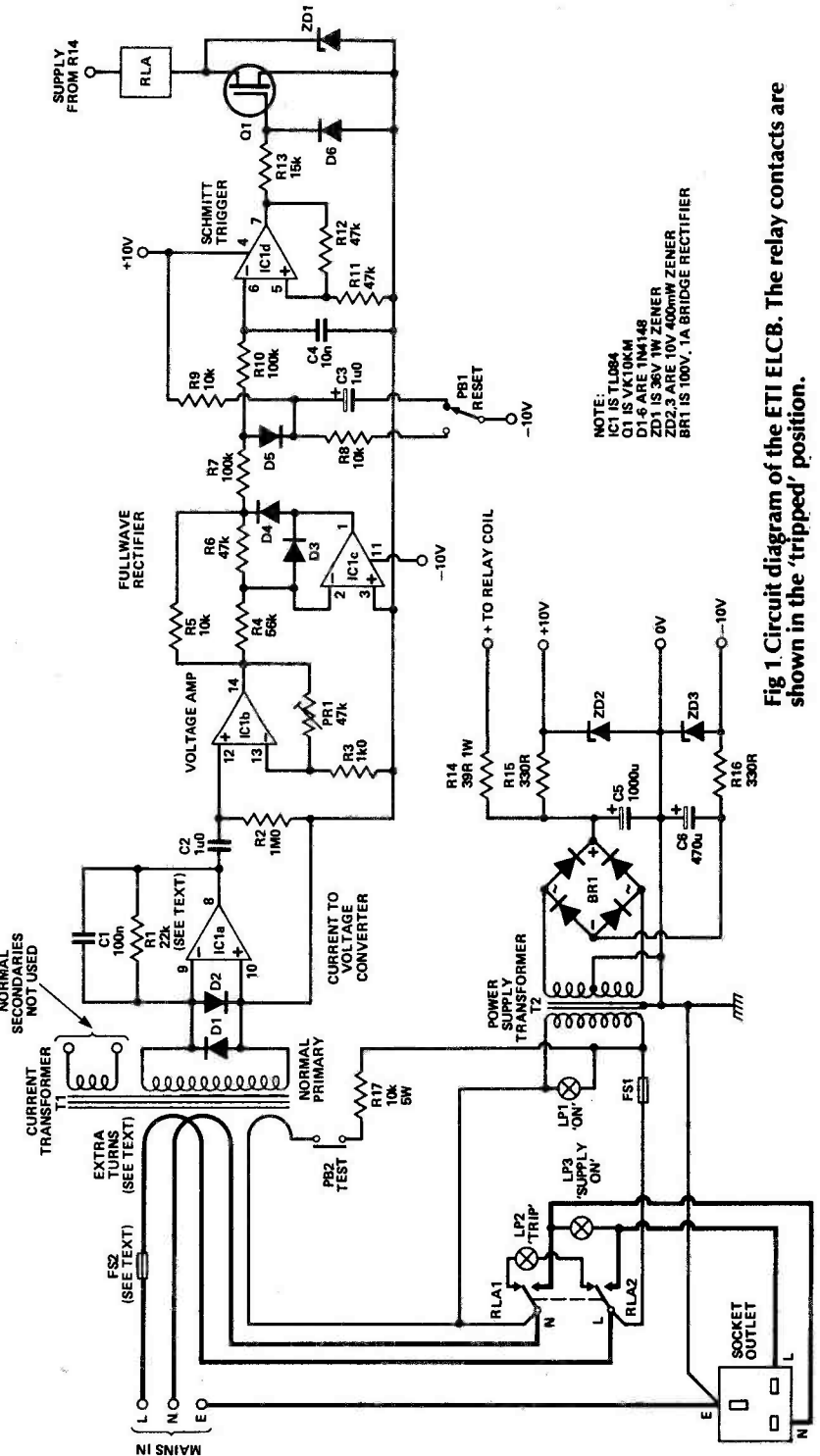


Fig 1 Circuit diagram of the ETI ELCB. The relay contacts are shown in the 'tripped' position.

HOW IT WORKS

The live and neutral mains wires from the mains supply pass through the centre of the current transformer T1 (twice — see later) in the same direction to form the primary. As the current flow through these wires is in opposition, the net current in T1 primary is zero under normal conditions. Any unbalance in these currents caused by a fault condition will result in a current flowing in the secondary side (the original primary) of T1.

By normal op-amp action in IC1a, the output of IC1a will change in voltage in such a way that all the current will be shunted away via R1 and C1 and the voltage at the inverting input will remain constant. This is equivalent to a very low resistance across the output of T1, and sets up the correct conditions for current transformer operation. D1 and D2 are present purely to prevent damage from very large currents that might be caused by a short circuit, for example. The output of IC1a is a voltage which is proportional to the input current, and this is further amplified by IC1b before being full-wave rectified in IC1c.

When the input to IC1c via R4 is positive the output of IC1c will be

negative, D4 will be non-conductive and the inverting input of IC1c will be 0 V due to op-amp action via D3. The output from this part of the circuit (junctions of R5, R6, R7, D4) will be positive.

When the input to IC1c is negative the output of IC1c will be positive, D3 is now non-conducting and the inverting input of IC1c will again be held at 0 V, but this time via R5 and R6; the output from the circuit will again be positive. The values of R4, 5 and 6 are chosen to give approximately equal response for positive and negative inputs.

The output from the rectifier circuit passes via R7 and R10 to the inverting input of IC1d. This section of IC1 is connected as a Schmitt trigger. Its function is to stay in one of two states until the input reaches a voltage level sufficient to change it to the other.

At switch-on, if PB1 is operated, C3 (via D5 and R8) holds the input to IC1d low and sets it to the 'on' state. C3 then charges via R9 and will have no further effect until PB1 is operated or the unit switched off and on again. If at any time the output of the rectifier circuit goes positive enough, IC1d output will change to the 'off' state and stay there until it is reset or the whole unit is

disconnected from the mains and reconnected again. The output of IC1d drives Q1 via R13 and D6. These latter components are present to prevent damage to the gate of Q1, from positive and negative voltages. Q1 is a MOS device which has a resistance as low as 5 ohms when fully on. This activates the relay via R14 from the raw supply rail.

The transient voltage spike, which occurs when the relay is switched off, is absorbed by ZD1. This is somewhat different to the normal mode of diode suppression but has the advantage that the flux in the relay core will collapse more rapidly and speed up release, as there is a higher voltage across the coil than would be the case with a simple diode.

The power supply circuitry is straightforward. T2 is a normal mains transformer giving 12-0-12 V AC output. This is rectified by BR1 and smoothed by C5 and C6. The voltages across C5 and C6 are about 18 V and this is regulated to give +10 V and -10 V supplies for the quad op-amp, IC1. R14 provides power to the relay coil and is present to drop some of the difference between the 18 V on C5 and the 12 V required by the relay.

15 cm) of thin flexible wire to connect to the transformer, relay coil, reset switch and current transformer.

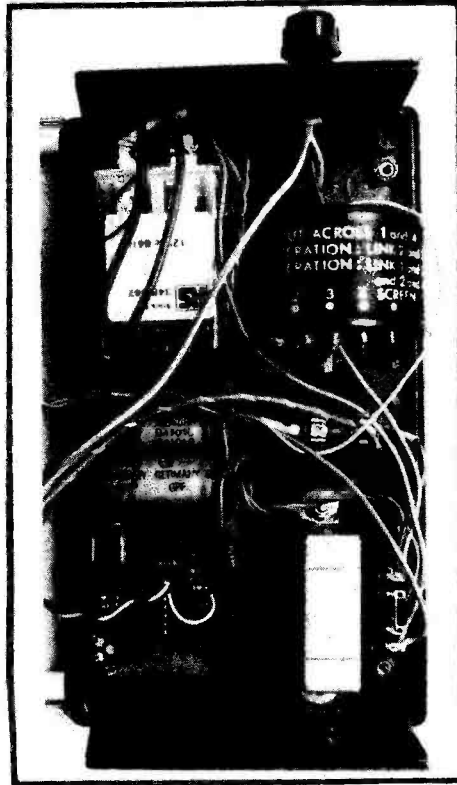
Before fitting the relay into the box base, it will be helpful to attach some thick wires to the normally-open relay contacts to take the output current to the socket outlet, and also some thinner wires to the same point to supply the power transformer. The PCB, relay, power transformer and current transformer can now be fitted into the bottom of the case and wired up. The mains input should enter the box through a suitable sized cable gland; pass the live and neutral conductors immediately through the centre of the current transformer before connecting them to the pole contacts of the relay.

Be sure to use sufficiently thick mains flex for the wiring: for 13 A capability, this means 1.5 mm² flex (1.0 mm² for up to 10 A). Pass an extra piece of thin flex through the centre of the current transformer for use as a test conductor. One end of this wire should be connected to the live side of the power supply transformer, together with the wire from one side of FS1; the other side of the fuse should be connected to the live pole of the relay. The other side of the transformer primary should be connected to the neutral pole of the relay.

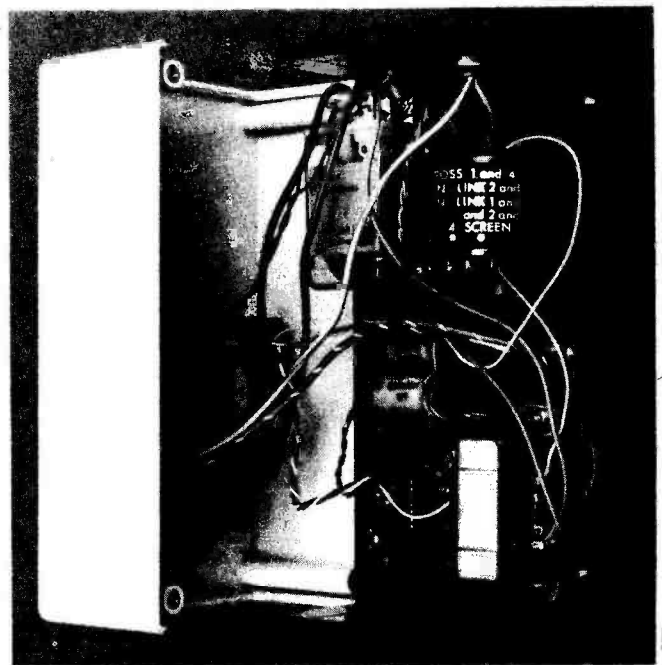
At this stage the components can be mounted into the lid of the

BUYLINES

The transformer used for T1 is not an ILP standard component, so you have to be specific when ordering. Ask for the OT 226, 12 V + 12 V secondary, 240 V primary, taped finish (not potted). We suggest you ring ILP for the exact price; their address and phone number can be found in their ads elsewhere in this issue. The case we used is available from West Hyde, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks. The PCB Service order form is on page 99.



At left and above are two internal views of the Earth Leakage Circuit Breaker. With two transformers and a power relay, things are a bit cramped so take care when wiring up. The toroidal current transformer is mounted on its side at the right of the case; the power supply transformer is on the left. The mains fuse, FS1 is fixed between the transformers, while the test resistor R17 is mounted directly between PB2 and the outlet socket.



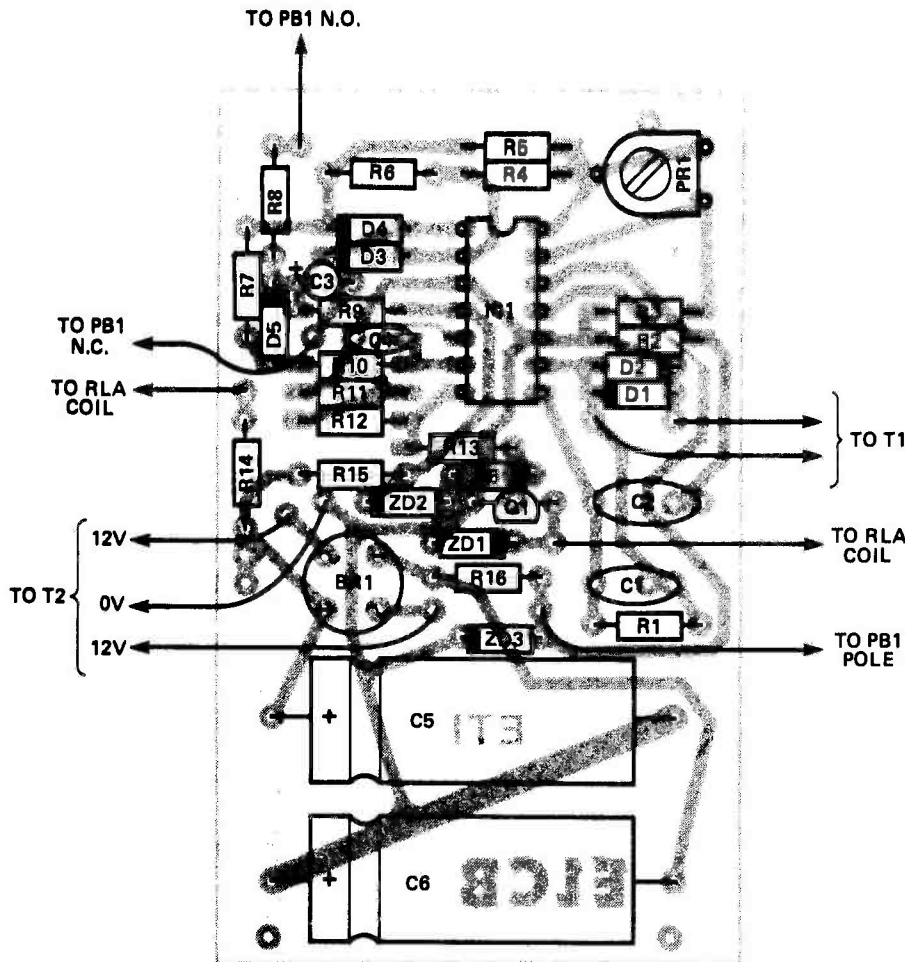


Fig. 2 Component overlay for the ELCB.

PARTS LIST

Resistors (all $\frac{1}{4}$ W, 5%, except where stated)		ZD1	36 V 1 W zener
R1	22k (see text)	ZD2, 3	10 V 400 mW zener
R2	1M0	BR1	100 V, 1 A miniature potted bridge rectifier
R3	1k0	Miscellaneous	
R4	56k	T1	toroidal mains transformer with extra windings (see text)
R5, 8, 9	10k	T2	12-0-12 6 VA transformer
R6, 11, 12	47k	PB1	one-pole changeover momentary action push-button
R7, 10	100k	PB2	one-pole push-to-make momentary-action push-button
R13	15k	FS1	250 mA 20 mm fuse and chassis-mounting fuseholder
R14	39R 1 W (or four 150R $\frac{1}{4}$ W in parallel)	RLA	two-pole relay, 12 V coil, contacts rated at 250 V, 10 or 20 amps (see text)
R15, 16	330R	LP1	amber mains neon (panel-mounting)
R17	10k 5 W wirewound	LP2	red mains neon (panel-mounting)
Potentiometer		LP3	green mains neon (panel-mounting)
PR1	47k miniature horizontal preset	PCB (see Buylines): flush-mounting mains wall outlet socket; cable gland to suit mains cable; case, West Hyde BOC 450 (188 x 110 x 70 mm), nylon bolts, wire, cable ties, hardware etc.	
Capacitors			
C1	100n miniature ceramic		
C2	1u0 miniature polycarbonate		
C3	1u0 35 V tantalum bead		
C4	10n miniature ceramic		
C5	1000u 40 V axial electrolytic		
C6	470u 40 V axial electrolytic		
Semiconductors			
IC1	TL084		
Q1	VN10KM		
D1-6	1N4148		

box. This must be done with some care to avoid fouling the components in the bottom of the box. In our device the normally-closed contacts of the relay were accessible when it was in the box and connecting the wires for the red neon was easily done. The free end of the test conductor is connected together with one of the wires from the yellow neon to the test switch (which is normally open). The 10k test resistor is fitted to the other side of the test switch. In our model this resistor is self-supporting between the switch and an insulated terminal. The other wire from the yellow neon, together with a wire from the neutral side of the power transformer, is connected to this terminal.

The wires to the reset switch can now be attached, making sure that the normally-closed terminal goes to the negative supply on the PCB, the normally-open terminal goes to the resistor and the pole goes to the capacitor.

Finally the thick output wires can be fitted into the outlet, together with the wires from the green neon. The earth conductor from the input cable is taken direct to the earth contact on the outlet and an extra wire then goes from here to the power transformer frame and to the centre tap on its secondary winding.

With a bit of luck it should now be possible to fit the box lid and base together and secure them with the bolts provided.

Setting Up

Once the device has been assembled there is very little more to be done. It should be possible to adjust PR1 so that when the TEST button is pressed the relay immediately opens. If this cannot be set up or if there is very little adjustment to spare on PR1, then to increase the sensitivity R1 may be increased in value: conversely, reduce it to reduce the sensitivity. If the sensitivity is still low when R1 is up to 47k then take the mains (and test) wires through the centre of T1 twice instead of once.

Once this has been done the device is set up to trip at about 24 mA. Note that it responds only to the out-of-balance current flowing through T1 on the mains wires and will not protect against contacts between live and neutral which result in balanced currents.

If you want to test the device we recommend that you use another 10k resistor and NOT YOURSELF . . .

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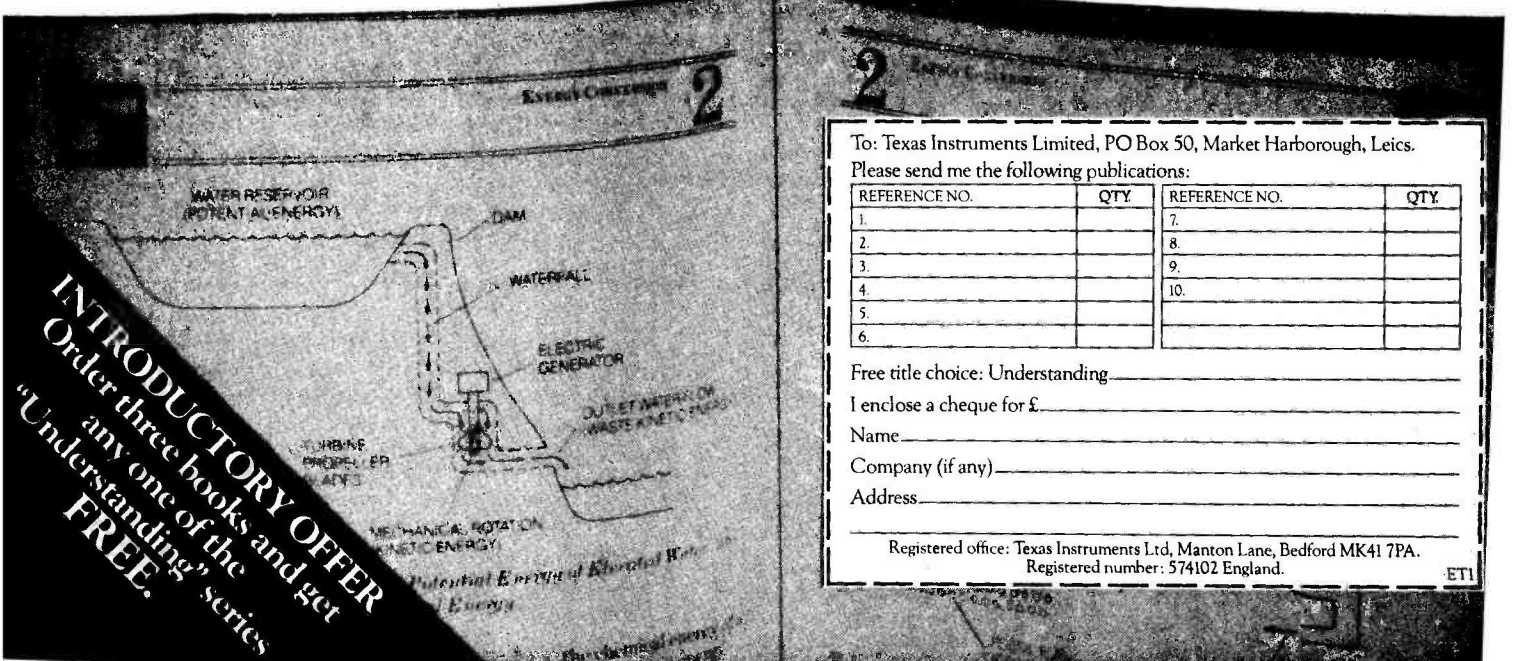
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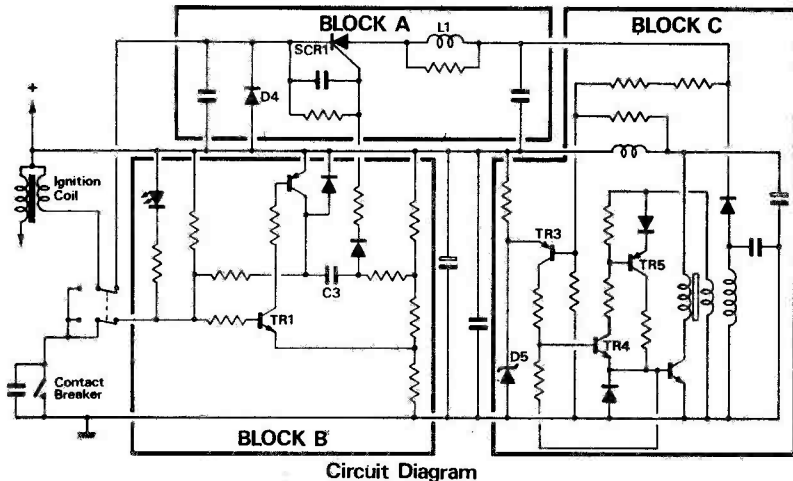
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THIS IS WHAT MAKES TOTAL ENERGY DISCHARGE SO GOOD—



Circuit Diagram

The discharge circuit in block A is the heart of the system. It looks simple but outperforms any other by far. A 2 μ F storage capacitor (twice the usual size) charged to + 370 volts, is discharged into the ignition coil primary by SCR1, providing a high energy pulse of the correct polarity. Long after the storage capacitor is discharged, the current in the ignition coil is sustained by 'flywheel' diode D4, preventing energy flowing back to the capacitor and giving 3½ times the spark energy and duration. Instead of relying on the effects of coil 'ringing', inductor L1 commutates the SCR, giving complete freedom from the usual latching problems and allowing the storage capacitor to be recharged whilst the discharge current is still flowing in the coil.

Block B is the trigger circuit and provides faultless spark timing. The emitter of TR1 is biased from the supply to provide a variable trigger threshold, allowing triggering with the supply down to about 3.5 volts but rejecting noise and signals from contact shuffle and vibration. Capacitor C3 and its associated resistors provide a variable inhibit period, after the contacts close, which filters out extreme contact bounce on 4 cylinder engines yet still allows 8 cylinder operation to over 7500 rev/min. In effect the longer the contacts stay open the longer they must remain closed before the next spark can be triggered. (Be warned:- untimed sparks can seriously damage your engines health).

Block C is the inverter, the power behind the spark. It's a 'ringing choke' type. Well designed, this type can not only be regulated and charge the capacitor from zero volts, effectively a short circuit, but is also more efficient than the traditional push-pull type. Even though it provides around 3 times the power, it still doesn't need the usual finned heat sink. Transistors TR4 and TR5 regulate the inverter output, by controlling the amount of feedback, and are in turn controlled by TR3 which compares the voltage on the storage capacitor with the reference zener D5. The output voltage is set by the zener voltage so the full output is available over the whole supply voltage range, a powerful spark is produced even with the battery down to 4 volts.

These are the more obvious features, there are many more details like the absence of 'spikes' and low di/dt and dv/dt applied to the SCR, which together with top quality components make Total Energy Discharge not only a top performer but far more reliable.

This advanced circuitry gives all the well known advantages of the best capacitive discharge systems:

Peak Performance; Improved Economy; Fires Fouled Plugs; Accurate Timing; Smooth Performance;

**PLUS
Super Power Spark; Better Starting; Optimum Spark Duration; Correct Spark Polarity; L.E.D. Static Timing Light; Low Radio Interference; Designed In Reliability.**

Information disclosed above does not imply any freedom from patent or copyright of Electronize Design.



Electronize Total Energy Discharge Ignition is suitable for use with:

- ALL** 6 and 12 volt negative earth vehicles fitted with a conventional contact breaker and coil system.
- ALL** Ballast resistor (cold start/low voltage) systems.
- ALL** Voltage triggered electronic tachometers. (Some older current impulse types (Smiths pre 1974) require an adaptor)
- ANY** Number of cylinders up to & including 8.

SPECIFICATION

(using a typical ignition coil)	TOTAL ENERGY DISCHARGE	ORDINARY CAPACITIVE DISCHARGE
Spark Power	140W	90W
Spark Energy	36mJ	10mJ
(stored energy)	135mJ	65mJ
Spark Duration	500 μ S	160 μ S
Output Voltage		
clean spark plug	38kV	26kV
fouled spark plug	26kV	17kV
Voltage Rise Time to 20kV	25 μ S	30 μ S

You can buy your Total Energy Discharge system as a ready assembled and tested unit ready to fit to your car or as a comprehensive kit of parts containing everything required, even a length of solder and a tube of heat sink compound. The kit comes complete with detailed, easy to follow instructions which enable even a beginner to assemble a kit in just a matter of hours.

The same top performance system is also available, in ready assembled or kit form, to suit cars and motorcycles fitted with twin ignition systems.

STANDARD UNIT £26.70
Assembled and Tested

STANDARD UNIT KIT £15.90

TWIN OUTPUT UNIT £36.45
Assembled and Tested

TWIN OUTPUT KIT £24.55

All systems are available direct from the manufacturer. Prices include VAT, postage and packing £1.00 extra. Access and Visa cards are welcome, just write or telephone quoting your number.



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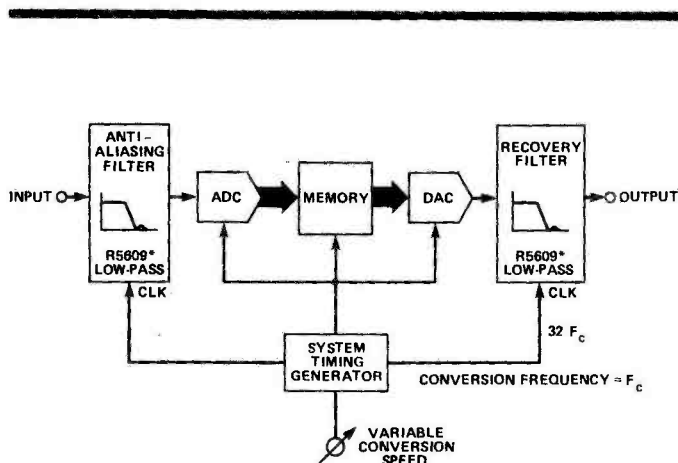
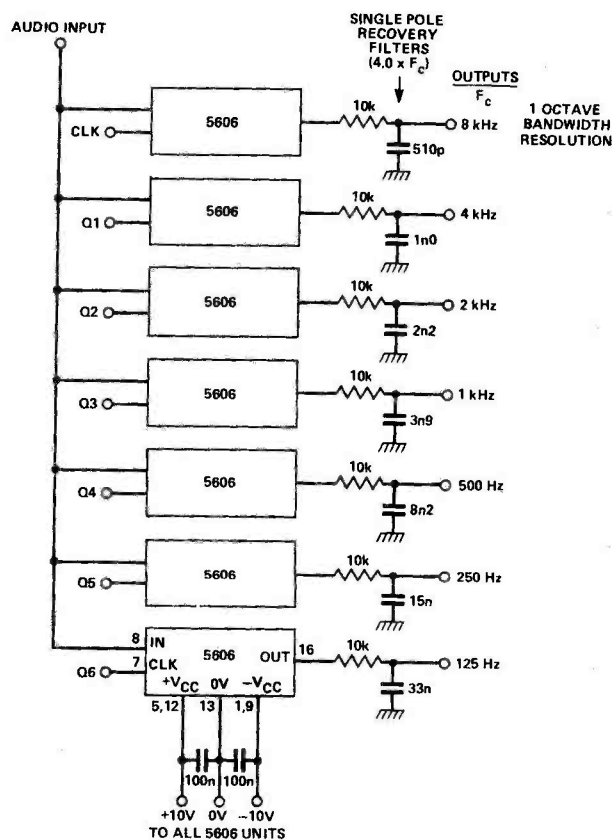


DESIGNER'S NOTEBOOK

Last month, we looked at some of the new switched capacitor ICs. This month, Tim Orr gets down to some circuits using them.

Seven-Octave Audio Analyser

The R5606 is a single octave filter. Each R5606 is clocked with a square wave generated by a seven-stage binary divider, so that successive filter break-points are spaced at exactly one octave intervals. The resulting circuit is very simple and may be used as a real-time audio analyser or as an audio equaliser with a steep filter roll-off. Half-octave or even $\frac{1}{3}$ octave resolution could be obtained by using the R5605 or the R5604 respectively. The output signal is filtered by a simple single-pole low-pass filter to remove the effects of the sampling and the residual clock breakthrough. A simple anti-aliasing filter can also be used at the input to each filter, but this may not be considered necessary. A dynamic range of about 76 dB per channel should be obtained.



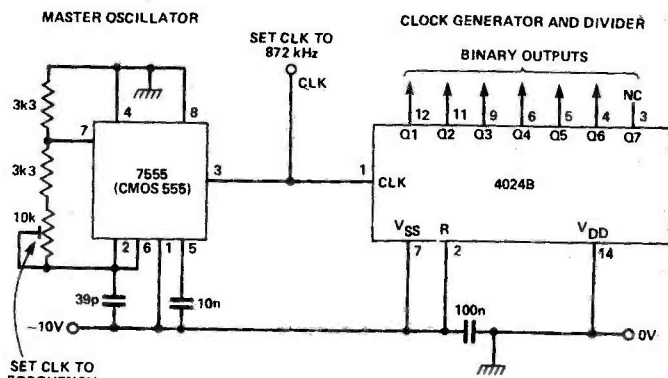
* The R5609 has a rolloff slope of 100 dB/octave.

$$\text{System bandwidth} = \frac{32 \times F_c}{100} = 0.32 F_c$$

Maximum theoretical bandwidth, as predicted by the sampling theorem = 0.5 F_c

Audio Converter With Tracking Filter

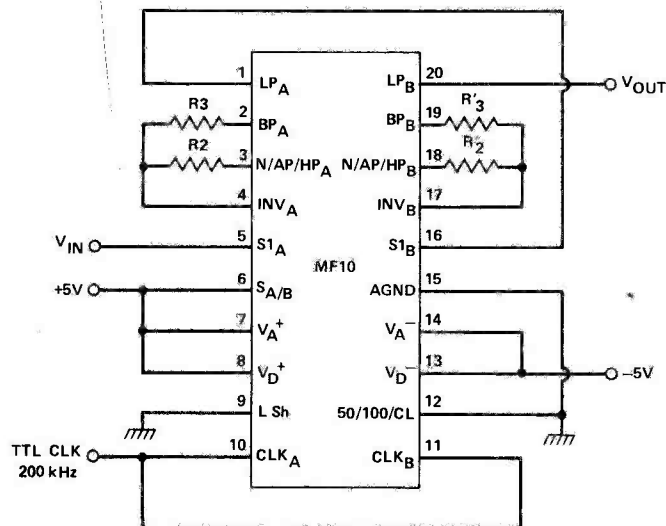
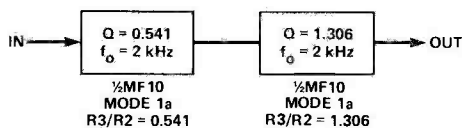
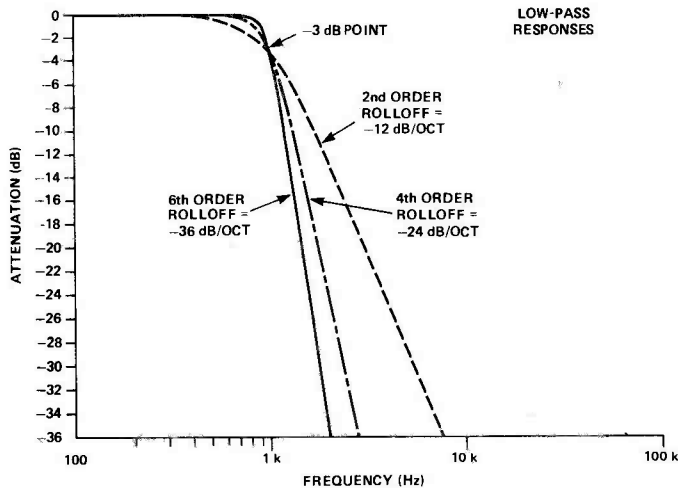
The R5609 is a steep low-pass filter which can be used as an anti-aliasing filter and recovery filter in an audio converter, such a digital delay line. If the clock for the filter is derived from the system clock and the A-to-D converter, then the low-pass filter frequency will track any changes in the conversion speed.



Low-Pass Response Using the MF10

The frequency responses of second, fourth and sixth order maximally-flat low-pass filters are shown in the graph. These can be realised by cascading second order low-pass filter sections together. The table shows the break frequencies and Q factors for both maximally flat (Butterworth) and 3 dB ripple (Chebychev) responses. The maximally flat responses are easy to realise because all stages use the same clock frequency. The 3 dB ripple response requires awkward clock frequencies. A simple design example will illustrate how to use the filter.

The figure shows a design for a fourth-order 2 kHz maximally-flat low-pass filter with an overall gain of 1 in the pass band. From the table, the first stage should have a Q of 0.54 and a frequency of 2 kHz, the second stage a Q of 1.306 and a frequency of 2 kHz. Mode 1a is the most simple realisation of the second order low-pass filter. For the first section let $R_3 = 10k$. Then $R_2 = 18.48k$ ($15k + 3k6$ would do). For the second stage let $R_2 = 10k$, then $R_3 = 13.06k$ ($9k1 + 3k9$ is near enough). Both clock pins can be tied together and driven with a single 200 kHz clock (pin 12 grounded gives a clock-to-filter frequency ratio of 100 to 1).

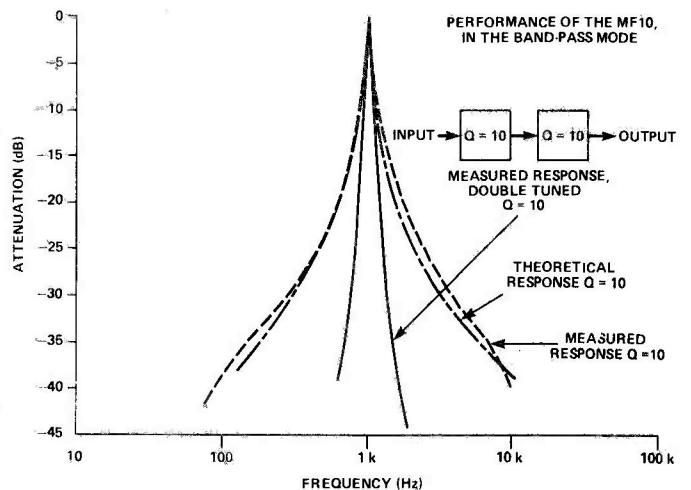
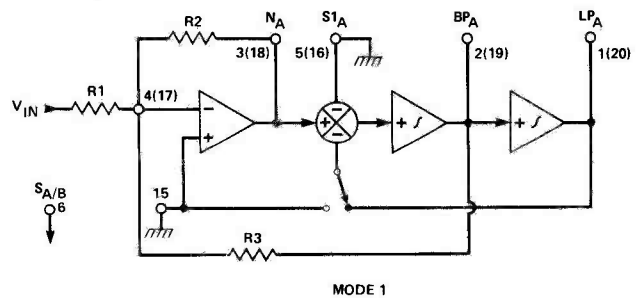


LOW-PASS FILTER RESPONSE	1st STAGE		2nd STAGE		3rd STAGE	
	f_0	Q	f_0	Q	f_0	Q
2nd ORDER BUTTERWORTH (FLAT RESPONSE)	1.0 F	0.707				
2nd ORDER CHEBYCHEV (3dB RIPPLE)	0.84 F	1.304				
4th ORDER BUTTERWORTH	1.0 F	0.54	1.0 F	1.306		
4th ORDER CHEBYCHEV	0.443 F	1.076	0.95 F	5.58		
6th ORDER BUTTERWORTH	1.0 F	0.518	1.0 F	0.707	1.0 F	1.931
6th ORDER CHEBYCHEV	0.298 F	1.044	0.722 F	3.46	0.975 F	12.78

* For the equivalent highpass response, use the same Q factor but use the reciprocal of the frequency multiplier.

Band-Pass Response Using The MF10

A simple band-pass filter can be constructed using the circuit shown as mode 1 in the first article on switched capacitor ICs, and shown again to jog your memory! For a Q of 10, $R_3 = 100k$ and $R_2 = 10k$. To give the filter unity gain at resonance, $R_1 = R_3 = 100k$. The external clock frequency determines the resonant frequency. By cascading two filters with a Q of 10, a very sharp resonance curve is produced as you can see in the graph below. If the Q factor of each filter is increased further then an even sharper response can be obtained, although this may result in a double peak if the relative resonant frequencies of the two filters deviate.



Cheap Imitations?

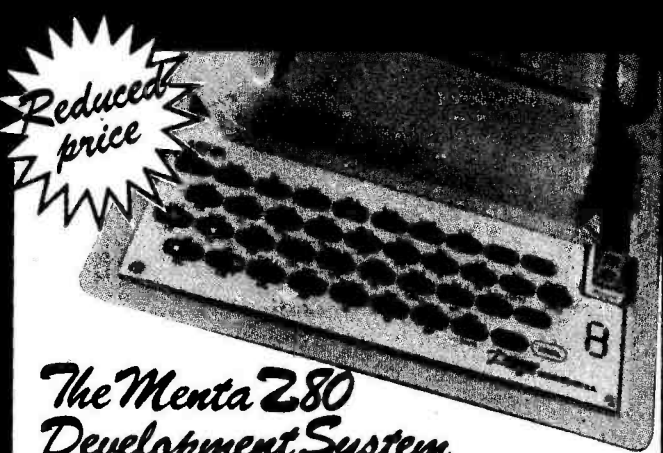


Microdoctor

is an alternative to AUTOMATIC TEST EQUIPMENT which can be very expensive. MICRODOCTOR is perfectly adequate for diagnosing faults in microprocessor boards or computers in the REPAIR SHOP or on the PRODUCTION LINE. Reports are PRINTED on the integral thermal printer. Tests supported are CHECKSUM, RAMTEST, WAIT, READ, WRITE, I/O READ, I/O WRITE, DUMP IN HEX, DUMP IN ASCII, TEST DATA LINES (for shorts between data, address and rails), SEARCH (for two specified bytes), MAP (print a memory map of ROM, RAM, I/O and EMPTY SPACE). Supports both multiplexed and non-multiplexed address/data. Standard software will also DISASSEMBLE in Z80 mnemonics - other disassemblers cost extra. Programs for board-testing can be written in MINUTES - and retained for MONTHS even if the power is switched off (CMOS RAM is backed-up with rechargeable battery). Capacity is 15 different programs of 12 tests each. Included are two PROBE CONFIGURATION CARDS (One Z80, other uncommitted), PROBE with 24 inch cable and 40-pin DIL plug - and POWER SUPPLY. Extras available are 6502 disassembler retrofit... £35, Clip-over PROBE (only needed if μ P is soldered-in)... £35.

£295
+VAT

New product new concept



The Menta Z80 Development System

uses the MOST POWERFUL LANGUAGE OF ALL - direct ASSEMBLER MNEMONICS. MENTA has VISUAL AIDS to program development which the big systems lack: a TV display of PROGRAM, REGISTERS and STACK; single-step operation (watch the cursor move from instruction to instruction, see the register-contents change, observe stack operations, etc.) BUGS can be fixed immediately without reassembling. Full speed operation is supported too - with or without BREAKPOINTS. Designed originally for the Schools' Council to teach microprocessing, MENTA is a complex CONTROLLER in its own right, like any other Z80 system, with practical, commercial applications in ROBOTICS. Features include CASSETTE INTERFACE, ASSEMBLER/EDITOR, serial DISASSEMBLER (now included as standard), 24 bits of I/O - also TV FLYLEAD, POWER SUPPLY and COMPREHENSIVE MANUAL with SOURCE-CODE LISTING.

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Olivetti Typewriter Interfaces

for ET121 and ET221 machines which permit the typewriter to be used as a DAISY WHEEL PRINTER for computers implementing the RS232, IEEE 488 (PET) or CENTRONICS PARALLEL buses: almost all computers in fact. Great for word processing and letter-writing! Same price, fitting free if requested (you pay carriage on typewriter if we fit).

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Thandar Logic Analyser Enhancements

The THANDAR TA2080 LOGIC-ANALYSER was NOT designed by DATAMAN - but we like this instrument and use it for product development. When writing software we use SOFTY for ROM-EMULATION, following the program-flow on the TA2080 screen. We modified our TA2080 to make it more useful; adding an RS232 OUTPUT TO PRINTER - also Z80 and 6502 DISASSEMBLERS. Now we can follow program operation in MNEMONICS on-screen and print TIMING or STATE DIAGRAMS and DISASSEMBLED CODE. Cost of this RETROFIT kit (12K of program ROM, socket for RS232, interface board, instruction sheet) is, if fitted by us and purchased with a TA2080

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Softy 1 with PSU

Yes, we still have a few old faithful 3 rail EPROM PROGRAMMERS around, as seen in Kensington Science Museum, if you are still using 2708's get yourself this fine old classic at a bargain price

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Ultra-Violet Eprom Erasers from

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Softy Eprom Programmer/Emulator

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SOFTY is used as a DEVELOPMENT SYSTEM for new products or just as a STAND-ALONE EPROM PROGRAMMER.

£169
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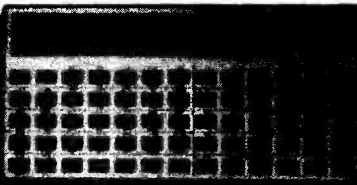
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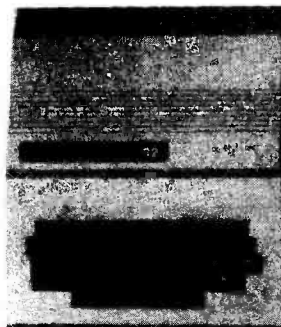
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FX-702P the casio pocket computer/calculator, basic programming, 55 scientific functions, up to 1,680 program steps.
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 MG-880 musical calculator with game and memory functions.
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 MG-777 calculator with clock, 3 games and memory functions.
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 LC-311 calculator with memory functions
PRICE.....£4.75
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PRICE.....£7.50

MICROCOMPUTERS AND PERIPHERALS

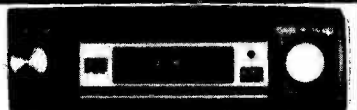


DRAGON 32

A NEW BRITISH MADE COMPUTER
 This is a powerful new microcomputer specially designed for the family and small business use. It has 32K Bytes of RAM (expandable to 64K), 16K Byte MICROSOFT COLOUR BASIC. High res. colour graphic and very good sound features. It has full size professional keyboard and comes complete with power supply and built in centronic parallel printer interface. It has a cassette interface and a slot for games cartridges. A floppy disc interface and DOS will be available shortly. Manufacturers 1 year warranty on DRAGON 32.
DRAGON 32 MICROCOMPUTER.....£189.95
SOFTWARE ON CASSETTES.....£8.95 each
GAMES CARTRIDGES TYPE 'S'.....£20.95
GAMES CARTRIDGES TYPE 'O'.....£17.50
30 CPS PARALLEL PRINTER.....£206.95
PRINTER CABLE.....£13.95

RADIO WATCH

AM535 - 1805KHZ radio watch supplied complete with good quality lightweight headphones.
PRICE.....£16.95
ALARM VERSION.....£17.95



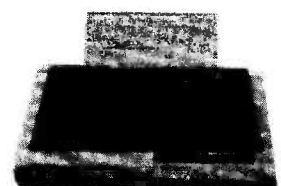
AM/FM-MPX STEREO RADIO CASSETTE

This compact, quality product is designed to provide you with exceptional listening pleasure. The features include AM/FM dial-in-door, local/distance attenuator switch for better stereo reception, FM stereo indicator. Fast forward and eject button for cassette, balance, volume and tone controls.
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Dot matrix Parallel printer suitable for use with, DRAGON 32, BBC and all other computers with centronic compatible parallel interface. Speed 30 CPS, Double width char., standard char., tractor feed, very good graphic capabilities, selectable line spacing.
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MX80T-3
 80 column, 80 CPS, dot matrix printer with high res. graphic capabilities, tractor feed, parallel interface.
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 As above but with friction and tractor feed.
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This is an individually coded 4 WATTS Radio transmitter and pocket pager receiver. The alarm system has connections for door contacts and vibration sensors. 2 vibration sensors are included. It has a range of 2 miles. Ideal for protection of vehicle or property. Power requirements for transmitter is 12V dc. Not licensable in UK.
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14 inch colour TV.....£228.95
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SANYO SMC14H-14 inch high ves. colour monitor.....£431.95
PRICE.....£431.95

RECHARGEABLE BATTERIES

CODE	TYPE	CAPACITY	PRICE
S401	AAA	200 mA	£1.30
S101	AA	500 mA	£0.90
C1200	C	1200 mA	£2.20
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CASIO AX-250

Dual time, count-down timer with memory function, 12 or 24 hour option, chronograph with lap time, optional hourly time signal, daily alarm, 3 optional melodies or ordinary bleeper calender display lithium, stainless steel bracelet.
PRICE.....£21.95

CASIO CA-851

Calculator watch with dual time/chronograph/lap time and daily alarm. It has a built in UFO invader game. The calculator functions include, +, -, x, /, and constant calculations. Stainless steel bracelet, lithium battery.
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12 melody alarm, chronograph with lap time and countdown timer. 7 melodies for daily alarm, 2 melodies for date alarm, one melody for birthday and Christmas each and optional Big Ben time signal, stainless steel bracelet, lithium battery.
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50 meter water resistant, alarm chronograph with lap time and 12 or 24 hour option, black resin case, 5 year non stop lithium battery.
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2 CHANNEL HAND HELD FM-CB RIG

27 MHZ FM (U.K. SPEC) Transceiver, channel 14 and 30, squelch control, LED indication of transmit mode. Uses 4 AA size batteries. RF output 100 mW, receiver sensitivity 1 micro volt.
PRICE.....£17.95 each
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CIRCUIT SUPPLEMENT

Knowing how intelligent all you experimenters are, we've just given you the raw data of some of the latest integrated circuit technology there is, so you can get on with it without further ado. So we'll be expecting lots of Tech Tips based on these devices. . . . What's that? Oh, alright then, just a few circuits.

TL011, TL012, TL014, TL021 (Texas Instruments) Fixed ratio current mirrors

- Wide input range, 1 nA to 1 mA
- 35 volt output capability
- high output impedance
- typically less than $\pm 1\%$ error at 25 deg C

Ratio of input current to output current varies with device code.

OUTPUT TO INPUT CURRENT RATIO	DEVICE
1:1	TL011
2:1	TL012
4:1	TL014
1:2	TL021

Types with different suffix have different temperature ranges and guaranteed current ratio tolerances over those ranges.

C suffix: 0 to 70 deg C, $\pm 10\%$ over full range

I suffix: -40 to 85 deg C, $\pm 8\%$ over full range

M suffix: -55 to 125 deg C, $\pm 7\%$ over full range

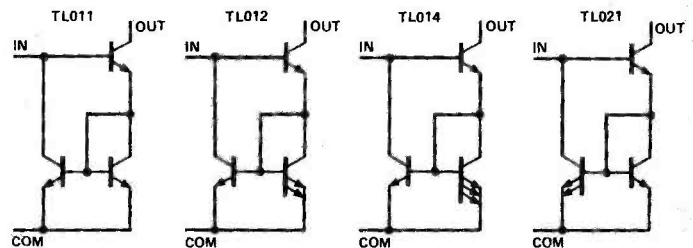
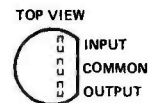


Fig. 1 Pin out and simplified internal circuitry of the TL011, TL012, TL014, TL021.

Electrical characteristics: TL011, etc	min	typ	max
Input voltage (V) (note 1) $I_{IN} = 1 \mu A$	0.4	1.0	1.5
$I_{IN} = 1 mA$	0.9	1.4	1.75
Input current (mA)			5 (note 2)
Output voltage	1.2 (note 3)		45 (note 2)
Output to input isolation (dB)	80		
Output resistance (M) $I_{IN} = 1 \mu A$	1000		
$I_{IN} = 1 mA$	1		
Maximum operating frequency (MHz)		10	
Continuous power dissipation (mW)			775 (note 2)

Key to footnotes

Note 1: figures for M suffix; I and C suffix types will have slightly higher voltages all round

Note 2: absolute maximum rating

Note 3: this is the guaranteed maximum minimum necessary to maintain current ratio.

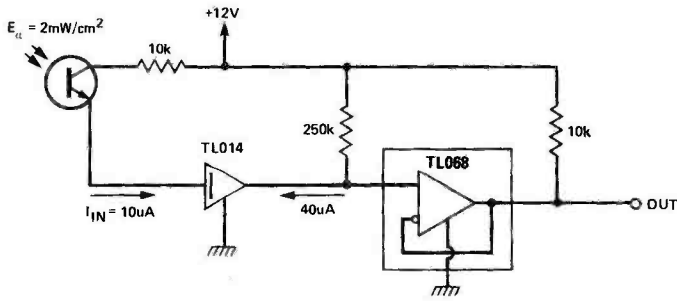


Fig. 2 A phototransistor amplifier using a TL014.

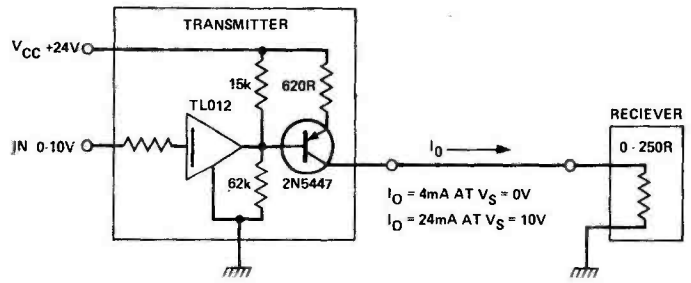
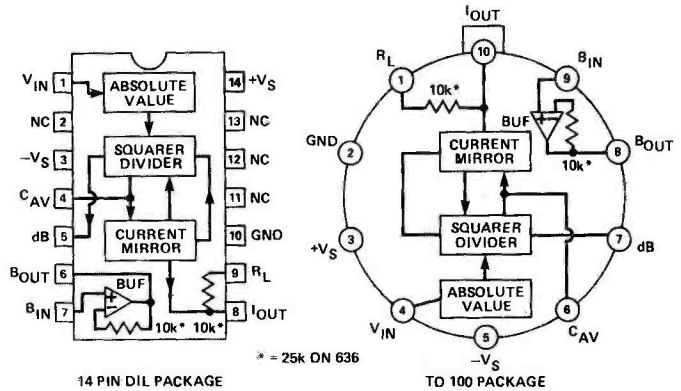


Fig. 3 A two wire current-mode transmitter using the TL012.

AD536, AD636 (Analogue Devices) RMS to DC Convertors

- true RMS to DC conversion
- dB output with 60dB range (50dB 636)
- low power consumption: 1 mA 536, 800 uA 636
- dual or single supply operation over a wide range of supply voltages
- current output available
- available in DIL or TO 100 packages.

Fig. 4 (right) Pin out of the AD536 and AD636.



Electrical characteristics		AD536 (note 1)	AD636 (note 1)
Input	peak max. for rated performance	$\pm 20V$ for $\pm 15V$ supply $\pm 5V$ for $+5V$ supply	$\pm 5V$ for $\pm 5V$ supply $\pm 5V$ for $\pm 2V_5$ supply
	max safe input	$\pm 25V$	$\pm 12V$
	input resistance	approx $17k\Omega$	approx $7k\Omega$
Accuracy	without ext. trim	$\pm 5mV \pm 0.5\%$ (7V RMS)	$\pm 5mV \pm 1\%$ (200mV RMS)
	with ext. trim	$\pm 3mV \pm 0.3\%$ (input)	$\pm 3mV \pm 0.3\%$ (input)
Frequency response (note 2)	$V_{IN} = 10mV$	6 kHz	12 kHz
	$V_{IN} = 100mV$	40 kHz	80 kHz
	$V_{IN} = 1V$	100 kHz	130 kHz ($V_{IN} = 200mV$)
Averaging time const.	multiply by value of C_{AV} in μF	25 mS per μF	25 mS per μF
Output from buffer	max output voltage (min = 0)	$+10V$ ($\pm 15V$ supply) $+2V$ ($\pm 5V$ supply)	$+1V_4$ ($\pm 3V$ supply) $1V$ ($+3, -5V$ supply)
	current	$+5mA, -130\mu A$	$+5mA, -130\mu A$
I_{OUT}	scale factor	40 μA per volt RMS (+25%)	100 μA per volt RMS (+20%)
	voltage compliance	$-V_S$ to $+V_S - 2V$	$-V_S$ to $+V_S - V$
dB output	scale factor	$-3mV$ per dB (1V RMS = 0dB)	$-3mV$ per dB (0V1 RMS = 0dB)
	error	$\pm 0.5dB$	$\pm 0.5dB$
	I_{REF} range	5 μA to 80 μA	2 μA to 8 μA
	Crest factor	error with 3:1 peak: average signal level	-0.1\%	$-0.2\%$
Power supplies	minimum voltage	$\pm 3V$ or $+5V$	$+3/-5V$ (note 3) or $+5V$
	maximum	$\pm 18V$ or $+36V$	$\pm 12V$ or $+24V$
	current (quiescent)	1 mA (max 2 mA)	800 μA (max 1 mA)

Key to footnotes

Note 1: higher specification versions available
 Note 2: this is for 1% additional error over DC error

Note 3: may be operated on $+2V/-2V_5$ but will not give specified performance.

CEM 3350 (Curtis) dual VCF

- Dual state variable filters with independent exponential frequency and Q control
- Wide frequency range: 15 octaves typical
- Choice of two simultaneous outputs: low-pass, band-pass, or high-pass
- Wide supply voltage range: $\pm 3V$ to $\pm 18V$

Definition of terms

V_{IF}	fixed gain input
V_{IV}	variable gain input
V_{LP}	low-pass output
V_{BP}	band-pass output
V_{CQ}	Q control voltage input
V_{CF}	pole frequency control input
V_{CC}, V_{EE}	positive and negative supplies
I_{REF}	reference current input

Application notes

The transconductors inside the IC are NPN differential pairs with current mirror active loads (similar to CA3089) so input levels must be kept low (20–80 mV) for acceptable distortion. Inputs must normally be attenuated and output level should be restored using a BIFET op-amp to avoid problems with input offset currents that might be caused by the transconductors' high output impedance.

Note that applying increasing negative V_{CQ} will increase Q, and that pole frequency decreases with increasingly positive V_{CQ} . For negative V_{CF} , $g_m F$ (and hence pole frequency) is approximately linear, but becomes exponential when V_{CQ} is positive.

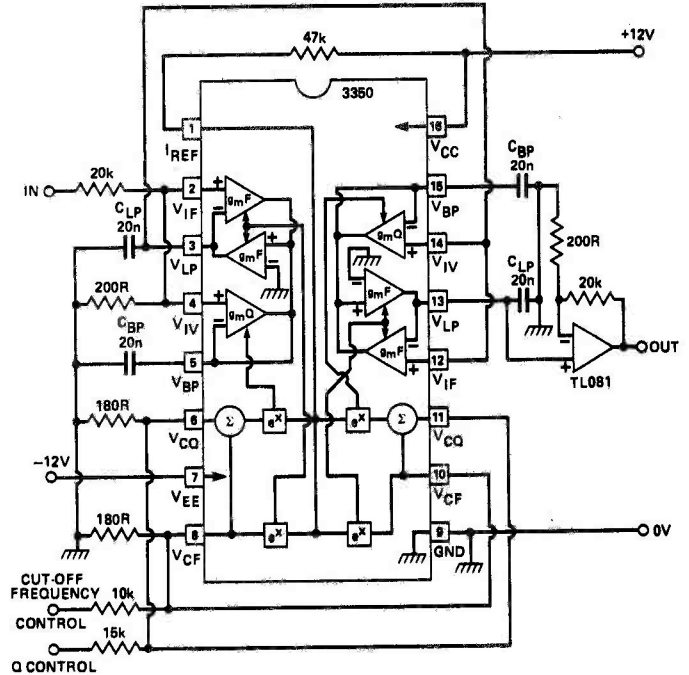


Fig. 10 CEM 3350 pin out and configuration as voltage controlled four-pole low-pass filter. Band-pass outputs could be cascaded by connecting V_{IV} and V_{IF} in the second section to V_{BP} in the first section, and taking the output to the op-amp from V_{BP} .

Electrical characteristics: CEM 3350

(Supplies $\pm 12V$, I_{REF} 400 μA)

	min	typ	max
Pole frequency control range	4000:1	12000:1	
Sensitivity of pole frequency control scale, midrange (mV/decade)	57	60	63
Exponential error of frequency and Q control scale (%) (note 1)		1.0	3.0
Transconductance of Q transconductors (mmho) (note 2)	4.5	6.9	9.3
Maximum transconductance of pole and Q transconductors (mmho)	11.0	14.2	16.0
Distortion in passband (%) (note 3)		1.0	5.0
Maximum Q without enhancement transconductance output impedance ($M\Omega$) (note 2)	50 1.0	150 4.0	
Supply voltages (V)	± 3		± 18 (note 4)
Supply currents (mA): positive negative		2.5 6.5	3.0 7.5

There is a choice of fixed gain and variable gain inputs on both filters in the IC. The difference between these inputs is shown in Fig. 14. Signals applied to the fixed gain input will have gain Q at the resonant peak and unity elsewhere in the pass-band. Signals applied to the variable gain input will have unity gain at the resonant peak, while the gain in the pass-band will be $1/Q$. Thus the fixed gain input can give overload problems, while the variable gain input will lead to changes in output volume as Q is adjusted. One way of trying to reach the best compromise is to apportion the input between the two inputs using an attenuation network (or, in more simple circuits such as Fig. 10, feeding the signal to both inputs). Another method would be to use the fixed gain input only, and to reduce the Q if a certain signal output level is exceeded.

Q is given by:

$$Q = \frac{3}{2} \sqrt{\frac{C_{LP}}{C_{BP}}} \exp(-V_{CQ}/V_T)$$

where $V_T \sim 25$ mV at room temperature.

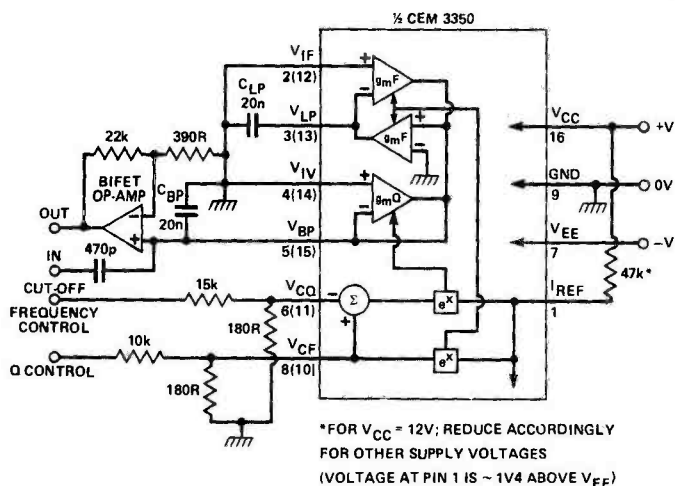
Key to footnotes

Note 1: $+60$ mV $< V_{CF} < +240$ mV

Note 2: control voltage = 0

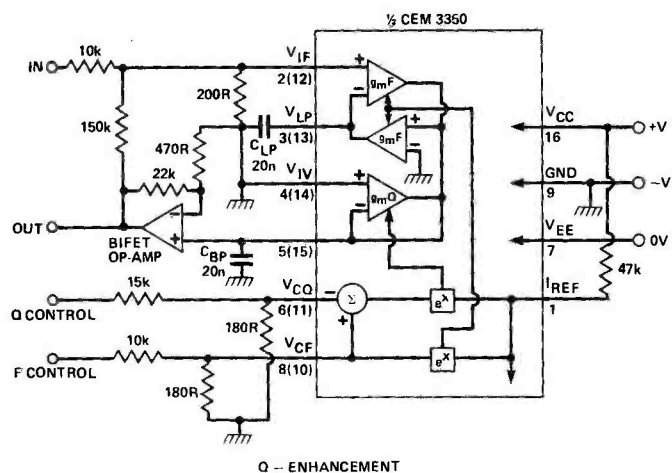
Note 3: V_{IF} or $V_{IV} = 40$ mV p-p

Note 4: maximum total differential supply for guaranteed operation is 26 V.



*FOR $V_{CC} = 12V$; REDUCE ACCORDINGLY FOR OTHER SUPPLY VOLTAGES (VOLTAGE AT PIN 1 IS $\sim 1/4$ ABOVE V_{EE})

Fig. 11 High-pass filter using CEM 3350: response will fall by 12 dB per octave below the cut-off frequency.



Q - ENHANCEMENT

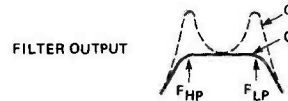
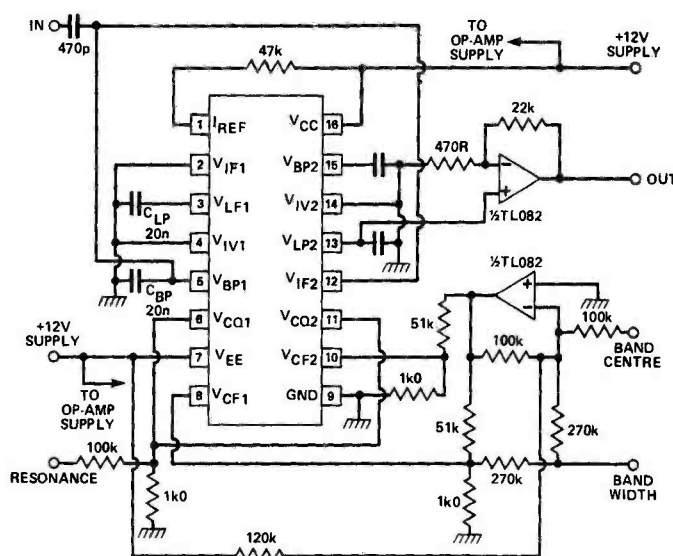


Fig. 12 (above) Low-pass and a high-pass filters can be combined to give a band-pass filter with a voltage-controlled band width. The circuit shown is an example of series interconnection; parallel interconnection is also possible.

Fig. 13 (left) The Q of the circuit may be enhanced above the normal maximum of 100-200 by applying regenerative feedback as shown: but beware too much feedback, as this will cause oscillation at the resonant frequency.

Available from Digisound Ltd.

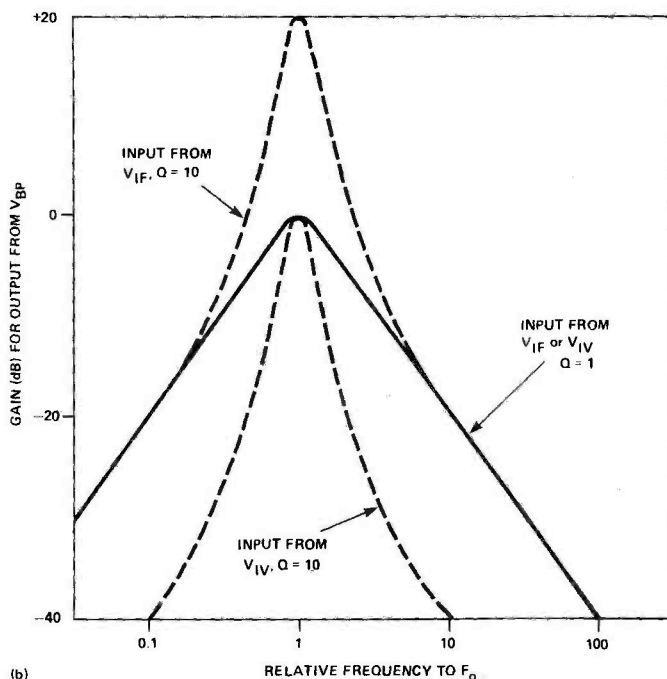
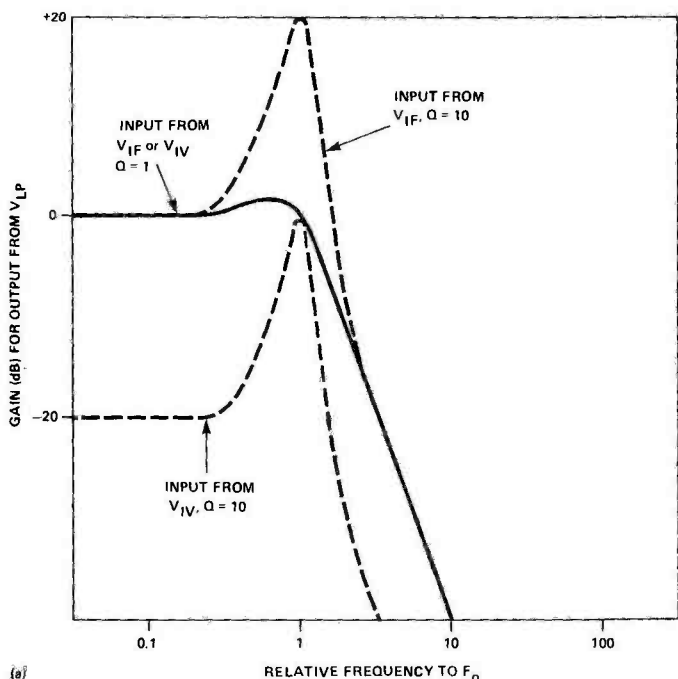


Fig. 14 Low-pass (a) and band-pass (b) responses for sections, with $Q = 1$ and $Q = 10$. In the case of curves with V_{IF} or V_{IV} input, other input has been grounded.

ZN428E-8 (feranti) Eight-bit D-to-A convertor

- D-to-A convertor, data latch and reference voltage in a single package
- single supply operation
- CMOS and TTL compatible
- 800 μ S setting time

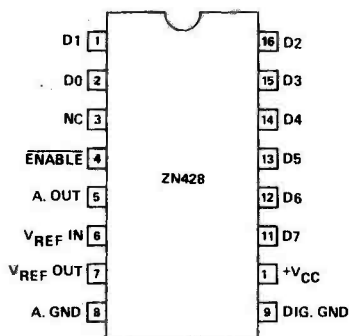


Fig. 15 ZN428 pin out.

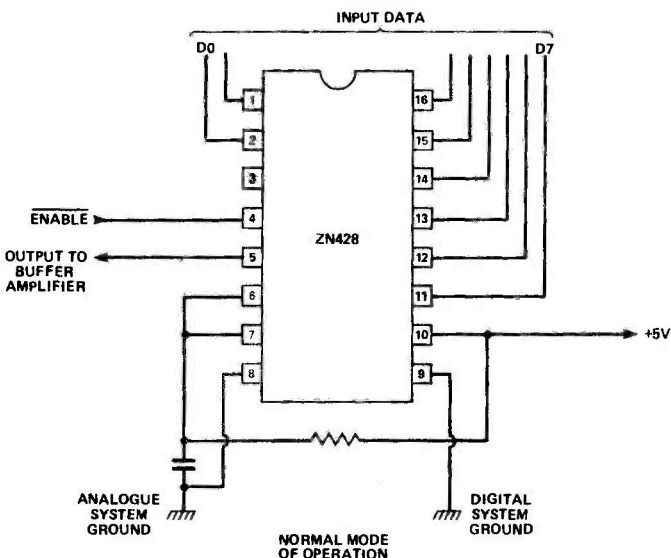
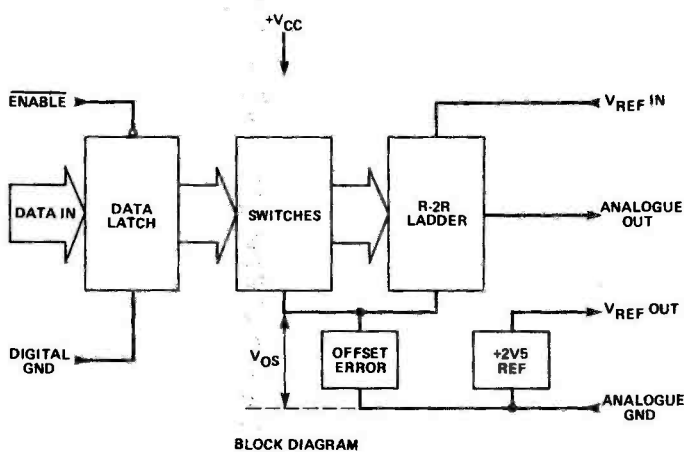


Fig. 16 (above) Normal mode of operation of the ZN428.

Fig. 17 (left) Block diagram of ZN428.

Operational notes

When ENABLE is low, the data inputs drive the D-to-A directly. When ENABLE goes high, the data is held in the latch until ENABLE next goes low.

Internal reference voltage source is a band gap diode circuit and it needs an input current to operate. Using a decoupling capacitor is recommended. There is no internal connection between the internal reference voltage source ($V_{REF OUT}$) and the reference input to the R-2R ladder ($V_{REF IN}$).

Electrical characteristics: ZN428E-8

		min	typ	max
Supplies	voltage (V)	4.5	5.0	5.5 (note 1)
	current (mA)		20	30
Internal reference	voltage output (V)	2.475	2.550	2.625
	current (mA)	4		15
D-to-A convertor	linearity error (note 2)			0.5
	offset voltage, V_{OS} (mV)		2	5
	reference voltage input (V)	0		3.0 (note 3)
	settling time to 0.5 of LSB (μ S)		0.8 (note 4)	1.25 (note 5)
	output resistance ($k\Omega$)		4	
Logic	enable pulse width (nS)	100		
	data set-up time (nS)	150		
	data hold time (nS)	10		
Ground	max. discrepancy between an. and dig. gnd (mV)			200

Key to footnotes

Note 1: absolute maximum is 7 V

Note 2: expressed as fraction of least significant bit

Note 3: absolute maximum $+V_{CC}$

Note 4: average after one LSB transition, $R_L = 10 M$, $C_L = 10 pF$

Note 5: average after all bits switching, R_L, C_L as before.

LF 347 (National Semiconductor) quad JFET op-amp

- pin-for-pin replacement of LM148
- approximately full gain and band width down to $\pm 4V5$ supply voltage
- no special anti-static handling of op-amp required
- internally trimmed offset voltage.

Absolute maximum ratings:

Supply voltage:	$\pm 22V$
Input voltage range, per input (note 1)	$\pm 19V$
Output short circuit deviation (note 2)	continuous
Power dissipation (whole IC)	900 mW

Available from Rapid Electronics, and other suppliers.

Electrical Characteristics: LF 347 (supply voltages: $\pm 15V$)	min	typ	max
DC voltage gain (V/mV)	50	100	
Slew rate (V/uS)		13	
Output voltage swing, load = 10 k (V)	12	13.5	
Gain-bandwidth product (MHz)		4	
Input resistance (ohms)		10^{12}	
Common mode rejection ratio (supply voltage $\pm 20V$) (dB) over input voltage range (V)	80 ± 11	100 +15/-12	
Supply voltage rejection ratio (note 3) (dB)	80	100	
Input offset voltage (mV)		1	5
Amplifier to amplifier coupling (frequency range 1 Hz to 20 kHz, supply voltage $\pm 20V$) (dB)		-120	
Supply current (all four op-amps — but no load)(mA)		7.2	11

Key to footnotes

Note 1: input voltages should not be allowed to go below negative supply voltage, otherwise op-amp may be destroyed.

Note 2: only one op-amp output should be shorted at anytime, otherwise IC may overheat.

Note 3: measured for both supply voltages decreasing and increasing simultaneously.

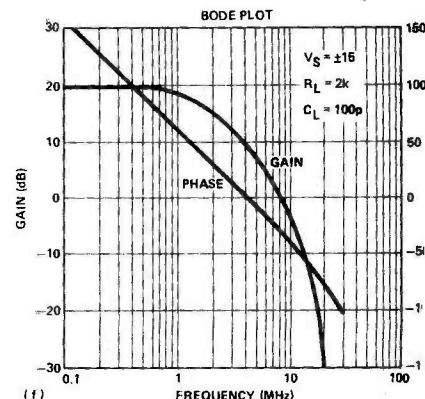
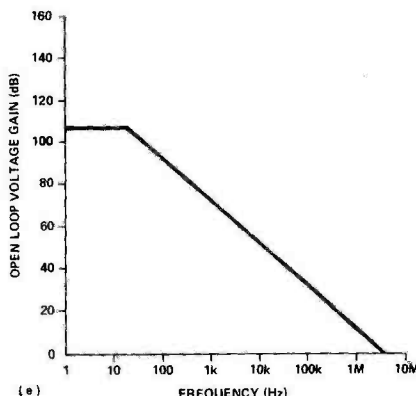
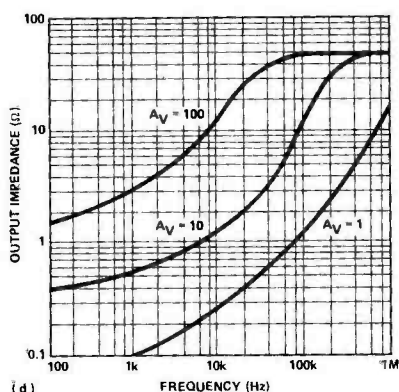
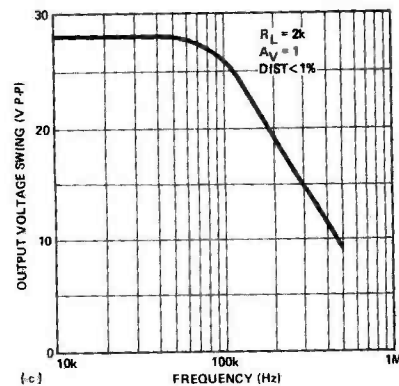
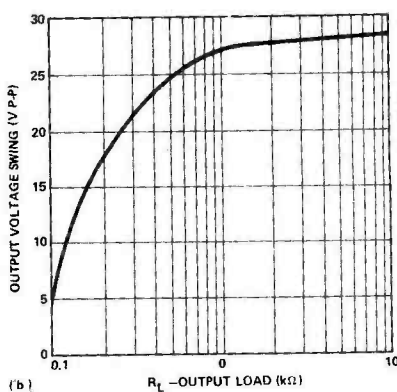
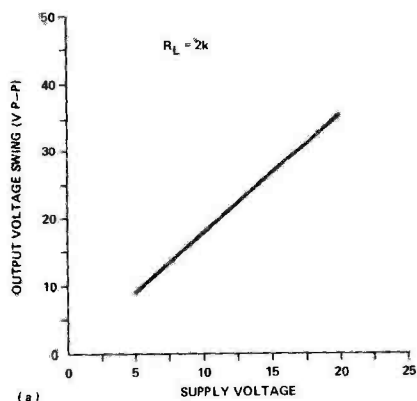


Fig. 18 Output voltage swing vs. supply (a) and output load (b), undistorted output vs. frequency (c), output impedance vs.

frequency (d), open loop frequency response (e), and bode (f) plot for LF347.

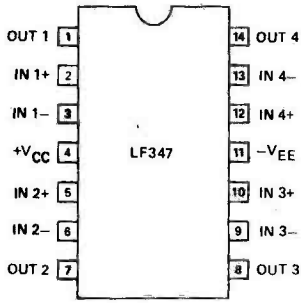


Fig. 19 Pin out of LF347.

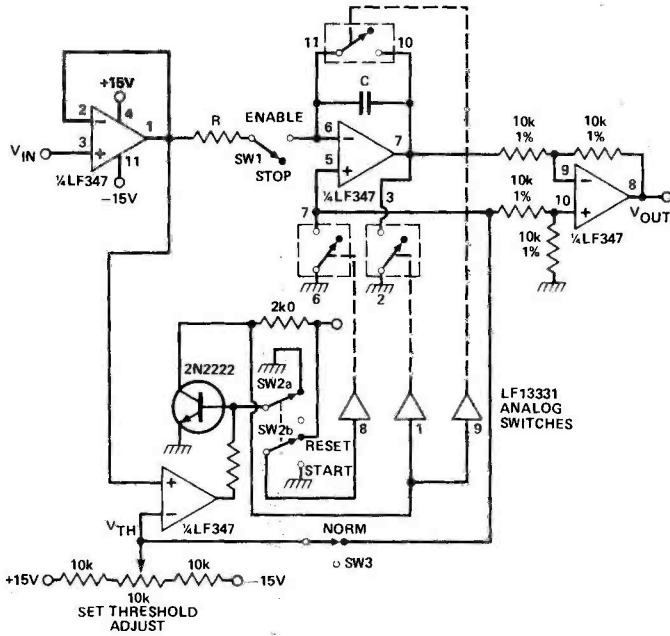
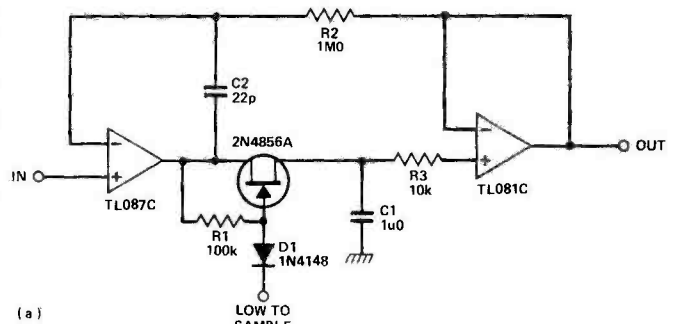
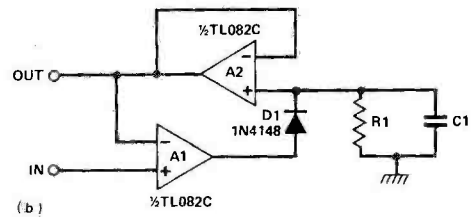


Fig. 20 Example of a long-time integrator, with reset, hold and starting threshold adjustment, using LF347s.

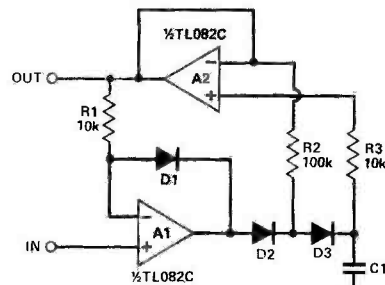
Fig. 21 We've used BIFET op-amps so much with the CEM 3350, it seems unjust that they shouldn't have a circuit or two to themselves; so here they are: a) a high accuracy sample-and-hold, b) a peak detector, and c) a low-drift peak detector.



(a)



(b)



(c) D1,2,3 ARE 1N4148 OR SIMILAR

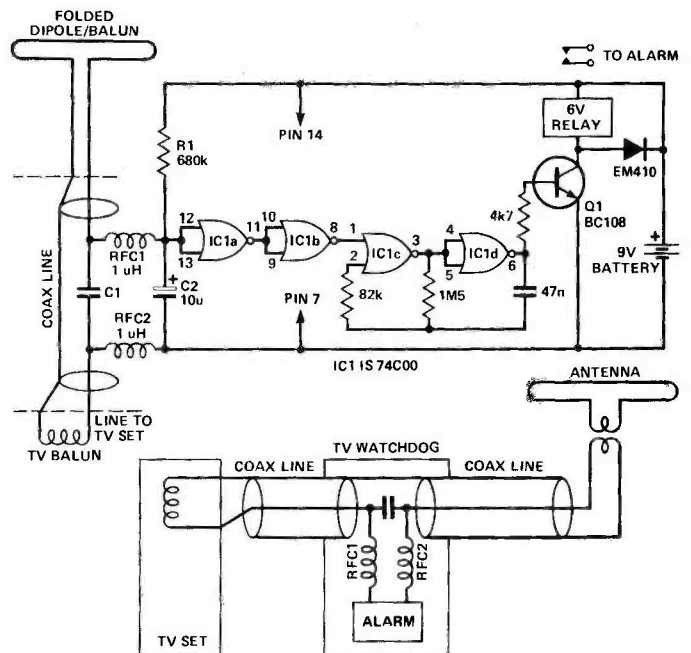
TV Alarm

Our final circuit is intended to make it harder for a thief to walk off with your TV. The basic idea is to use the aerial as the detector of the TV's non-presence. This is done by sending a small DC signal round the loop formed by the aerial pick-up loop (or the signal transformer for the aerial) and the signal transformer (or balun) in the TV. The circuit is isolated from TV signals by RF chokes RFC1 and RFC2, and C1 is inserted into the signal path to block the DC.

When the TV is disconnected, there is a 10 second delay (set by the values of R1 and C2) before the alarm goes off, so that an unwitting burglar will not know what has turned on the alarm.

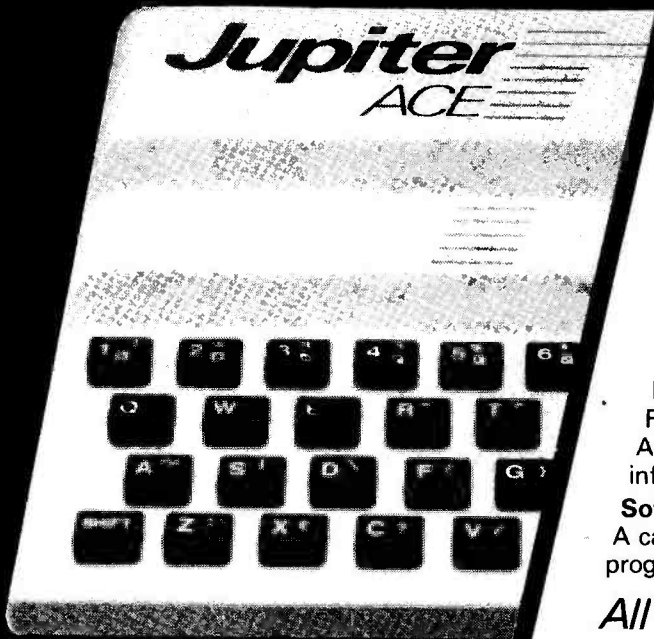
This circuit is not suitable for use with TVs that have live chases. Also, there must be DC path through the TV's aerial circuit for the alarm to work.

The idea for this circuit originated in Australia. This doesn't mean that you have to turn your TV upside-down for the circuit to work. However, so doing may help with your appreciation of 'Blankety-Blank'.



ETI would like to thank the manufacturers of the ICs featured for their help.

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The Jupiter Ace uses FORTH

The Jupiter Ace personal computer runs in FORTH, an easily understood language, typically four times as compact and ten times as fast as BASIC. Before the Ace all personal computers used BASIC and FORTH was only available to a privileged few. The Jupiter Ace also features a full-size moving-key keyboard, high-resolution graphics, sound, floating point arithmetic, a fast and reliable cassette interface and 3K of RAM.

Available soon

Plug-on parallel printer interface.

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Software

A catalogue will be sent with every machines, and includes, initially, programs for education and entertainment.

Technical Information

Hardware

Z80A running at 3.25 MHz.

8K bytes ROM

3K bytes RAM

Keyboard 40 Moving-key keyboard with auto repeat on every key and Caps Lock.

Screen Memory mapped 32 column x 24 line flicker-free display with upper and lower case ascii character set.

Graphics Chunky graphics (64 x 46 pixels) may be plotted, unplotted or over-plotted (XOR operation). Also, the entire character set (128 characters and their video inverses) may be redefined allowing intricate shapes to be drawn with a resolution equivalent to 256 x 192 pixels.

Sound Internal loudspeaker may be programmed to operate over the entire audio spectrum.

Cassette Programs and data in the compact dictionary format may be saved, verified, loaded and merged. Blocks of memory can be saved, verified, loaded and relocated. All tape files are named. Running at 1500 baud, the Ace will connect to most portable tape recorders.

Expansion Port Contains D.C. power rails and full Z80 Address, data and control signals. May be used to connect extra memory and other peripherals. IN and OUT words allow port-based peripherals to be addressed.

Data Structures Integer, Floating point and String data may be held as constants, variables or arrays with multiple dimensions and mixed data types. There are no restrictions on names.

Control Structures IF-ELSE-THEN, DO-LOOP DO-+LOOP, BEGIN-WHILE-REPEAT, BEGIN-UNTIL, all may be mixed and nested to any depth.

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Designed by Jupiter Cantab

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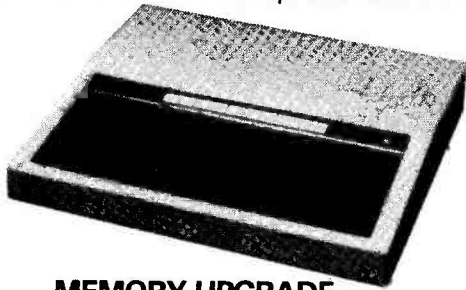
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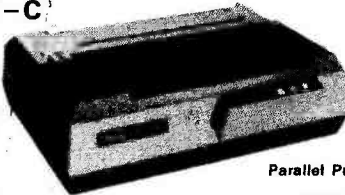
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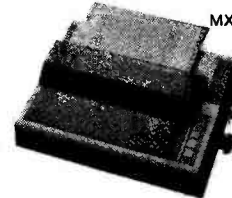
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40 pin	200p	225p	225p

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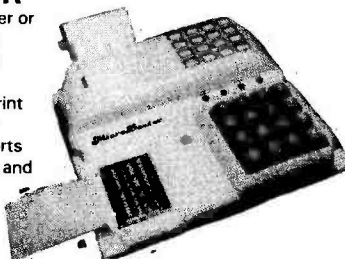
DIN STD	Plug	Sket
41617 21 way	170p	170p
41617 31 way	180p	180p
41612 2 x 32 way	250p	320p
Angled 2 x 32 way	325p	375p
41612 3 x 32 way	275p	380p
Angled 3 x 32 way	480p	—
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(for 2 x 32 way specify a + b or a + c)

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7403	11p	74199	80p	74LS247	85p	4021	40p	74ALS108	20p	74ALS166	30p	74ALS167	30p
7404	12p	74200	55p	74LS248	85p	4022	13p	74ALS109	20p	74ALS168	30p	74ALS169	30p
7405	15p	74201	45p	74LS251	36p	4023	32p	74ALS110	20p	74ALS170	30p	74ALS171	30p
7406	15p	74202	55p	74LS253	36p	4024	32p	74ALS111	20p	74ALS172	30p	74ALS173	30p
7407	15p	74203	100p	74LS255	36p	4025	13p	74ALS112	20p	74ALS174	30p	74ALS175	30p
7408	15p	74204	12p	74LS256	36p	4026	80p	74ALS113	20p	74ALS176	30p	74ALS177	30p
7409	15p	74205	12p	74LS258	36p	4027	20p	74ALS114	20p	74ALS178	30p	74ALS179	30p
7410	14p	74206	100p	74LS259	36p	4028	20p	74ALS115	20p	74ALS180	30p	74ALS181	30p
7411	14p	74207	100p	74LS260	20p	4029	40p	74ALS116	20p	74ALS182	30p	74ALS183	30p
7412	14p	74208	40p	74LS261	138p	4030	15p	74ALS117	20p	74ALS184	30p	74ALS185	30p
7413	14p	74209	40p	74LS262	20p	4031	125p	74ALS118	20p	74ALS186	30p	74ALS187	30p
7414	14p	74210	160p	74LS263	20p	4032	125p	74ALS119	20p	74ALS188	30p	74ALS189	30p
7415	14p	74211	160p	74LS264	20p	4033	125p	74ALS120	20p	74ALS190	30p	74ALS191	30p
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7417	14p	74213	160p	74LS266	20p	4035	125p	74ALS122	20p	74ALS194	30p	74ALS195	30p
7418	14p	74214	160p	74LS267	20p	4036	125p	74ALS123	20p	74ALS196	30p	74ALS197	30p
7419	14p	74215	160p	74LS268	20p	4037	110p	74ALS124	20p	74ALS198	30p	74ALS199	30p
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7426	14p	74222	160p	74LS275	20p	4044	290p	74ALS131	20p	74ALS212	30p	74ALS213	30p
7427	14p	74223	160p	74LS276	20p	4045	290p	74ALS132	20p	74ALS214	30p	74ALS215	30p
7428	14p	74224	160p	74LS277	20p	4046	290p	74ALS133	20p	74ALS216	30p	74ALS217	30p
7429	14p	74225	160p	74LS278	20p	4047	290p	74ALS134	20p	74ALS218	30p	74ALS219	30p
7430	14p	74226	160p	74LS279	20p	4048	290p	74ALS135	20p	74ALS220	30p	74ALS221	30p
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7488	14p	74284	160p	74LS337	20p	4106	290p	74ALS193	20p	74ALS336	30p	74ALS337	30p
7489	14p	74											

DESIGNING MICRO SYSTEMS PART 5

So far we've covered the brains of a computer, but it's still deaf and dumb, electronically. This month Owen Bishop takes on the role of ear, nose and throat specialist.

The CPU, its ROM and its RAM, the subjects of previous parts of this series, are a tightly-knit section of all computer systems. In most micros, they are mounted together on a single computer board. This month, we are concerned with the way in which this section of the computer circuit communicates with the rest of the circuit and with devices outside the computer proper. This aspect of computer design is known as **Input/Output**, or I/O for short.

In The Right Key

Leaving aside special-purpose computers such as those used in control applications, the most important source of input to the computer is its keyboard. This is where our finger-tips send information (instructions on what to do, and data to do it with) to the computer. As I write this sentence, my fingers are pressing keys on a computer keyboard. Each key is marked with a letter of the alphabet, a numeral or other symbol. There are also a space bar and two shift keys. How does the computer know which keys I have pressed? If I press the fifth key from the left of the second row down, I want it to put 'r' on the screen. If I also press a shift key, I want 'R'. How does it know which key means which letter?

If a keyboard is to provide input to the CPU, it must somehow place information on the data bus. The keyboard of the computer which I use for word-processing does this in a simple way. The method is one which is commonly used in micros at the lower end of the price range. Figure 1 shows the main features of the circuit. The first point to note is that there is a bank of eight buffers between the keyboard circuit and the data bus. It would be no good if data were put directly on to the bus every time I happened to touch a key. That might be just the moment when the MPU is reading from RAM. My pressing key 'r' just then could have disastrous results! It is essential that there is *something* between the keyboard and the data bus. This is the function of the buffers.

The buffers are under the control of the MPU. Each buffer has a data input, a data output and an enable input. The keyboard uses eight such buffers and they are all enabled together. When the enable input is held high (+5 V) the buffers are in the high-impedance state: in effect, the outputs are disconnected from the data bus. The buffers are held in this state when the MPU is busy reading RAM, or, for any other reason, does not want to know what is happening at the keyboard. When the enable input is made low (0 V) the outputs of the buffers take the states opposite to their data inputs (they are inverting buffers). The data present at the inputs appears inverted on the data bus lines.

Addressing The Problem

Enabling is under the control of a logical circuit, an address decoder. In Part 3 we described how an address is decoded in order that a particular memory cell in ROM or RAM can be read from or written to. The same technique is used here. Although the keyboard is not memory in the sense that it stores information, it is addressed in the same way as memory. Most addresses are allocated to RAM or ROM, but a few are allocated to the keyboard.

In my computer, the keyboard is addressed at 3800 to 38FF, though only a few of these addresses are actually used. The address-decoding logic gives a low output (to enable the buffers) whenever '0011 1000' appears on the upper eight address lines (A15 to A8). The lower eight address lines (A7 to A0) go to the keyboard matrix. As it

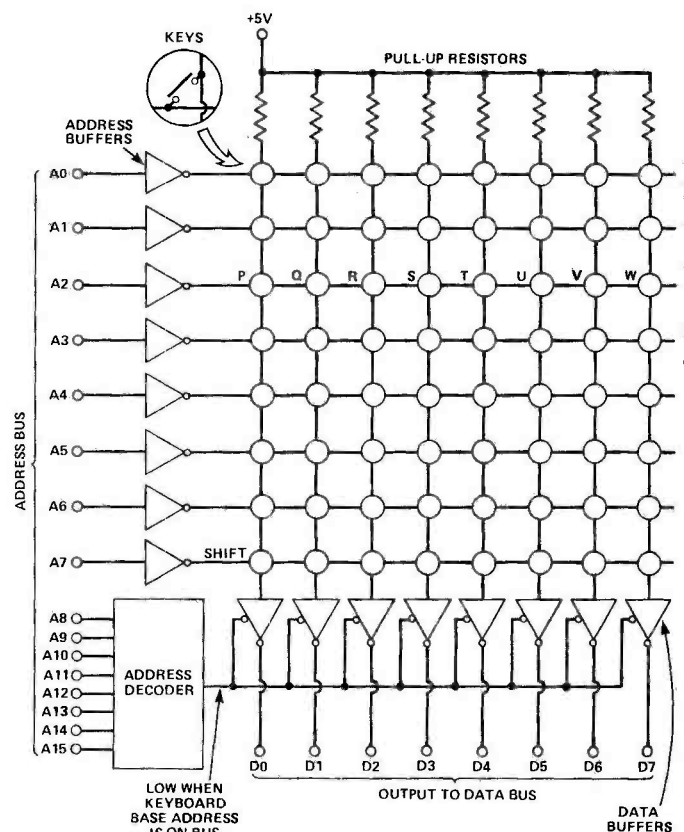


Fig. 1 A typical keyboard circuit. To simplify this, only one row of keys has been drawn.

enters the matrix, each line goes to a buffer. These are inverting buffers with open-collector outputs.

You will see from Fig. 1 that the matrix consists of eight address buffer output lines crossed by eight data buffer input lines. The keys are simple press-to-make push-buttons, joining an address output to a data input. The buffer input lines are normally held high because of the resistors connecting them to the +5 V supply line. When a key is pressed, an address buffer output becomes connected to a data buffer input. The fact that the address buffers have open-collector outputs means that if a buffer has a low output, it pulls the level down to 0 V. Otherwise the level remains at +5 V.

The Soft Solution

The rest of the input procedure depends on software: the monitor program in ROM contains a routine for reading the keyboard. The MPU addresses the keyboard by putting '0011 1000' (=38 in hex) on the high address lines (A15 to A8) and putting '1' on *only one* of the remaining address lines. For example, to address the first row of keys, the full address is '0011 1000 0000 0001' (=3801). For the next row we have '0011 1000 0000 0010' (=3802), then '0011 1000 0000 0100' (=3804) and so on through 3808, 3810, 3820 and 3840 to 3880 (all hex numbers, remember). The MPU puts these eight addresses in rotation on the address bus. When *any* one of these addresses is on the bus, the address decoder circuit enables all the data buffers. If no key is being pressed at that moment, all data outputs are low. But if one of the keys is being pressed at the same time as its address buffer output is low, a 'high' appears on one of the data lines. Thus if I press key 'r' when the MPU is addressing 3802, line A2 is high, so its buffer output is low. Since key 'r' connects this output to the buffer for data line D2, '0000 0010' (=02 in hex) appears on the data bus. The MPU now has to go to a monitor routine to interpret this data. Using this routine, it finds out that if the data is '02' when the address is 3802, then key 'r' has been pressed. An instant later, it will be addressing 3880 and, if the data becomes '0000 0001' (=01) it can then tell that the shift key also has been pressed, and that the upper-case 'R' is intended.

The MPU continually scans the keyboard in this way when waiting for input, decoding the data according to which address is in force at that instant. This approach to input relies heavily on software, and it takes several operations to detect and decode each key-stroke. Response is relatively slow. The routine required is further complicated by the need to deal with two keys being pressed simultaneously or in very rapid succession. It is necessary to check that a pressed key has been released before attempting to decode the next key that is pressed. This feature is known as two-key rollover. Fortunately, microprocessors work so quickly that even an experienced touch-typist is not able to outpace the keyboard decoding routines.

Encoding Made Easy

Although the circuit described above is simple and cheap to build, the MPU is required to do a lot of work. If this work could be done elsewhere, it would leave the MPU with more time to spend on other and perhaps less routine jobs. The alternative approach to keyboard decoding is to employ a special decoder IC (Fig. 2). Again, the keys are connected at the intersections of a matrix, but now both sets of lines come from the encoder IC. The IC has its own clock circuit and scans the matrix rapidly to find which X line and which Y line have been connected by a pressed key. Having detected a key-press, the output

latches of the IC are set to produce a seven-bit code corresponding to the pressed key, taking into account whether or not the shift key or possibly the 'control' key has been pressed at the same time.

You can think of the keyboard encoder as having some of the features of a ROM. When a set of eight memory cells in ROM is addressed for reading by the MPU, its output latches deliver to the data bus the byte stored in that cell. Similarly, the memory cells of the keyboard encoder each contain one code byte. The X and Y lines from the keyboard correspond to address lines. When a particular address is set up by pressing a particular key or combination of keys, the corresponding memory cells place their stored byte in the output registers of the IC. The data stored in the registers remains there until the MPU addresses the encoder. Then its register puts the stored code on the data bus and the MPU reads the code. Note that the MPU only has to perform *one* addressing operation: the keyboard address in the Apple II, for example, is C000. This operation is much quicker than the laborious scanning operation described earlier. The only other thing the MPU has to do is to address the encoder reset (address C001) to reset the latches, ready for them to be set by the next key-press. Note that the encoder *holds* the code until the MPU requests it. In the previously described system, if the MPU is expecting input from the keyboard, it must continually scan the keyboard in case it should miss a key-press.

Ask Me In ASCII

Whereas the code generated by the circuit of Fig. 1 depends on how the circuit is wired, the code generated in Fig. 2 depends on the codes programmed into the memory of the IC during manufacture. In order to promote good communication between keyboards, MPUs and other I/O devices, a standard code has been drawn up for use in computer systems. This is the American Standard Code for Information Interchange, known as the ASCII code (Table 1). Most keyboard encoders produce ASCII code and most computers understand it!

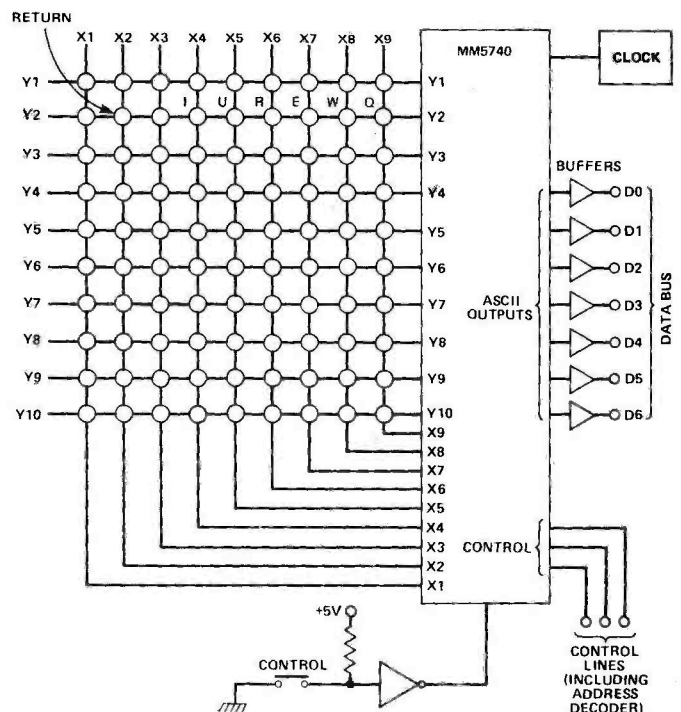


Fig. 2 A keyboard circuit using an ASCII encoder (simplified circuit; only a few keys drawn).

A quick glance at Table 1 reveals that the seven-bit codes cover more than the printable alphabetical and numerical characters and symbols. The first two columns contain what are usually termed **control codes**. These are instructions for the control of peripheral devices, especially printers. They are generated when the CONTROL key is pressed at the same time as one of the alphabetical keys. The code BS, for example, is generated by pressing CONTROL and H, and means 'backspace'. Since this is a frequently used command, many keyboards have a special 'backspace' key (←) which generates this command with a single keystroke. CR means 'carriage return'. When you press the RETURN (or ENTER) key, the keyboard sends a CR code (000 1101) to the computer. This can be used, for example, to tell the computer that the program line which has just been typed in is complete and ready to be stored in program RAM. If the MPU sends such a signal to a printer, it instructs the print-head to return to the left-hand edge of the page. The DC1 to DC4 codes are Device Control codes, available for miscellaneous functions differing from one machine to another. On the TRS-80, code DC4 instructs the line printer to print at 16.7 cpi, whereas on the Apple II it is a toggle instruction to the Silentyper printer to echo its printout to the monitor screen.

A further refinement found on some systems is a FIFO, or **first-in-first-out** device. It is wired between the encoder IC and the data line buffers. As each key is pressed, the encoder sends the corresponding ASCII code to the FIFO, which stores it. Typically, it can store up to 16 ASCII codes. The codes are sent out to the buffers in the same order as they are fed in. When the MPU is ready to read a code, a strobe signal to the FIFO results in the next available code being sent to the buffers. In this way, we have **asynchronous transfer** of data between keyboard and CPU. 'Asynchronous' means that the MPU and keyboard do not have to keep in step. If the MPU is temporarily busy and not able to accept input from the keyboard, the data queues up in the FIFO until the MPU is ready to accept it.

Plugging In Peripherals

Now that micros are becoming more commonplace, people are beginning to recognise that they are capable of far more than just playing arcade games or taking charge of the book-keeping. There is an increasing interest in being able to connect external devices to the micro — anything from a simple games control to a robot arm. The more recently made micros, even those in the lower price range, now incorporate ICs which allow a variety of peripherals to be attached. These I/O channels are often referred to as 'ports'.

There are two main types of port IC. The **parallel I/O** device (or PIO) allows data to be transferred between the computer and the peripheral several bits at a time. Commonly there are eight lines, allowing transfer of one byte at a time. The **serial I/O** device (SIO) transfers data a bit at a time, but groups bits into eights (usually) so that a byte is transmitted as a series of eight bits. We will deal with SIOs in a later issue.

Parallel Lines

Although it is only recently that PIOs have become standard on many low-cost micros, they have always been an almost essential feature of the simple computers intended principally for control applications. A well-known example of a PIO is the INS8154 (Fig. 3). Our old favourite, the Sinclair MK-14, had a socket to take an 8154, though the MPU used in this system (the 8060 or SC/MP) has a few direct I/O terminals of its own. Its three 'Flag' outputs can be programmed to have high or low outputs, giving a three-bit data output. The MPU also has

TABLE 1 : THE ASCII CODE

High nibble	0	1	2	3	4	5	6	7
0	NUL	DLE		0	@	P	.	p
1	SOH	DC1	!	1	A	Q	a	q
2	STX	DC2	"	2	B	R	b	r
3	EXT	DC3	#	3	C	S	c	s
4	EOT	DC4	\$	4	D	T	d	t
5	ENQ	NAK	%	5	E	U	e	u
6	ACK	SYN	&	6	F	V	f	v
7	BEL	ETB	'	7	G	W	g	w
8	BS	CAN	(	8	H	X	h	x
9	HT	EM	)	9	I	Y	i	y
A	LF	SUB	*		J	Z	j	z
B	VT	ESC	+		K	[	k	{
C	FF	FS	,	<	L	\	l	|
D	CR	GS	-	=	M	]	m	}
E	SO	RS	.	>	N	^	n	~
F	SI	US	/	?	O	_	o	DEL

The code is obtained by combining the high nibble (top margin) with the low nibble (left margin) to make a byte. For example the code for upper case W is '57'. The code '20' represents a space.

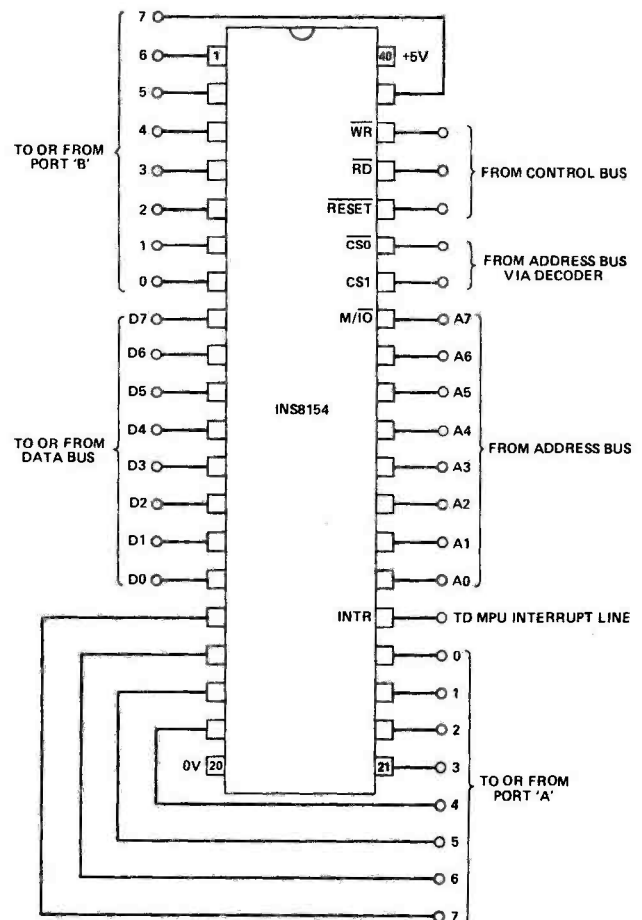


Fig. 3 Pin connections for the INS8154 I/O device.

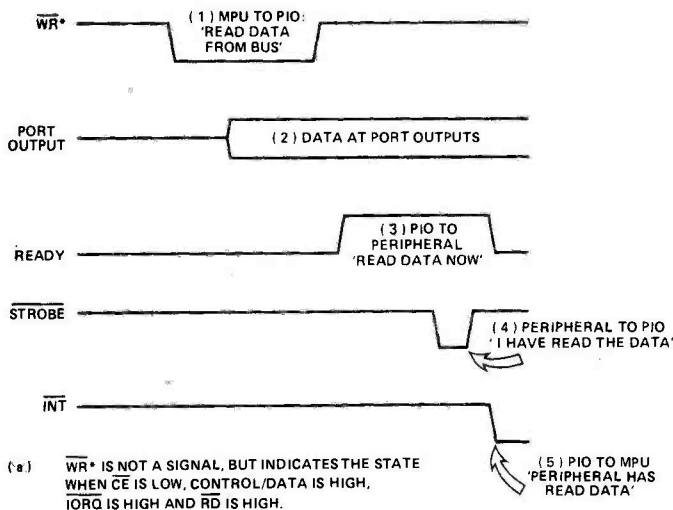
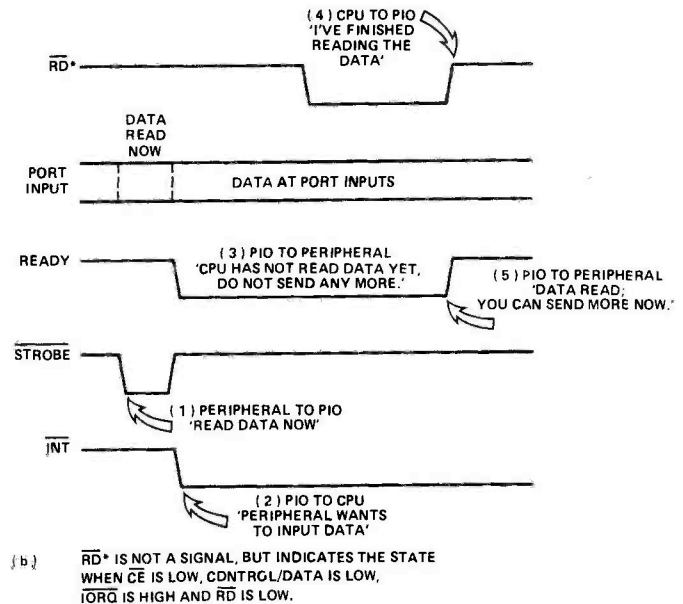


Fig. 5 Timing diagram for the transfer of data between the MPU and peripheral. Output handshaking (a) and input handshaking (b) are shown.



be read. At the same time, the READY output goes low, indicating to the peripheral that the data is being held, waiting for the MPU to read it, and that no more data should be sent in the meantime. As soon as the computer has read the data, the end of the \overline{RD} pulse resets READY, so that the peripheral knows that reading is complete and more data can be sent. Thus the sender and receiver each know which stage the other has reached. Data is transferred between them in either direction without loss.

The 8154 has a similar handshaking procedure but this is limited to port A. The \overline{INTR} line has the same function as the \overline{INT} line, but Fig. 3 shows that there are no special control lines to correspond with READY and \overline{STROBE} . Instead, two of the lines of port B are taken over for this purpose when port A is to be used in the handshake mode. The remaining six lines of port B can be used independently, in the usual way.

Dealing With Interruptions

We have seen how the interrupt is an essential part of handshaking by PIO devices. The interrupt may also be used when other peripherals want to communicate with the MPU, either through an I/O device or directly to the data bus. Often, there are several peripherals connected to a system yet all give the same interrupt signal. How is the MPU to know which one of these peripherals it is dealing with?

One method is 'device polling'. Each device has a latch circuit which gives a high output when the device is trying to input data to the MPU. The latches are enabled by an address decoder, and each is separately addressed. When interrupted, the MPU goes to its interrupt routine program, disabling the interrupt function for the time being; this prevents it being interrupted again while it is attending to the current interrupt. The interrupt routine instructs it to read each register in turn to find out which device is interrupting and to jump to a particular subroutine according to which device has interrupted. Note that this program polls the devices one at a time *in a pre-determined order*. We can program the MPU to test first the registers of devices which cannot wait long to be serviced, leaving other less urgent devices until later. In this way the software establishes a system of **priorities**.

The Z80 has a vectored interrupt mode which simplifies the process of finding out which device is interrupting: at the same time as the device interrupts, it

puts certain data on the bus. This data is read by the MPU and combined with other data already in memory to form the address where the appropriate interrupt routine begins. Each peripheral identifies itself by putting this particular set of data on the bus, causing the MPU to jump to the corresponding servicing subroutine.

Who's Shouting The Loudest?

Most I/O devices have two ports, some have three, and many computers have more than one I/O device. If the MPU has two or more peripherals and all are trying to communicate with it at the same time, the situation is like a political meeting with everyone trying to shout at once! There must be a system of priorities so that, when one of the more important peripherals is communicating, the less important ones are ignored. We have seen that software provides priority, but only after the interrupt has occurred. Hardware priority ensures that a high-priority peripheral will always get preference whenever it interrupts. The most commonly used method is known as daisy-chaining.

Daisy-chaining works like this. All the PIOs or other peripherals are connected to the \overline{INT} line by open-collector outputs. The line is normally held high by a pull-up resistor connected to +5 V, but when any one or more interrupt outputs goes low, the voltage on the line is pulled down and the MPU goes into its interrupt routine. In order to be able to generate an interrupt output, a peripheral must be receiving a high voltage level at its interrupt enable input (IEI). Normally, the interrupt enable output (IEO) of the peripheral has the same level as its interrupt

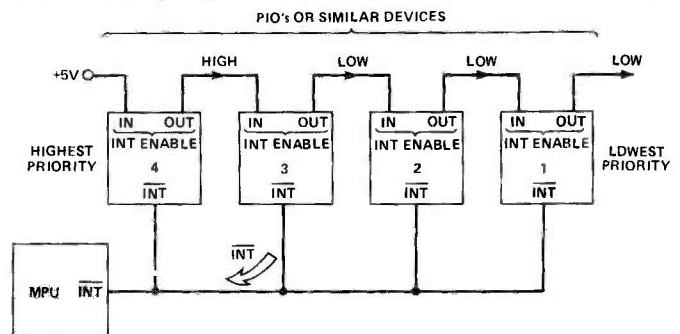


Fig. 6 Daisy-chain priority control: all PIOs are connected to the \overline{INT} line. PIO no. 3 is interrupting and passing a low signal to nos. 2 and 1 to prevent them interrupting.

input. The IEI on a peripheral receives its input from the IEO of the peripheral with the next higher priority. In Fig. 6, if none of the PIOs are interrupting, every one of them is receiving a high level at its IEI from the PIO next above it in the chain. Every one of them is able to initiate an interrupt when it wants to do so. When a peripheral is interrupting or is waiting for the MPU to respond to its interrupt request, its IEO becomes low. All peripherals below it (with lower priority) then have the low level fed down to them, and are then unable to generate interrupts.

Another method involves the use of a special priority encoder IC such as the CD4532. It is the hardware equivalent of the device-polling software mentioned above. It has eight inputs, each of which is connected to a peripheral. When any peripheral is causing an interrupt, it also puts a high level on its own encoder input. The encoder also has four outputs which can be connected to the data bus through buffers which are enabled whenever the MPU wants to read the encoder. Their outputs indicate in binary code which peripheral is interrupting. For example, if peripheral no. 6 (connected to input 6) is interrupting, the outputs put binary code 6 (0110) on the data bus. By reading the bus, the MPU can find out which device is interrupting. If more than one peripheral is interrupting at the same time, the binary code for that with the higher priority (highest number) appears at the output.

Sending A Cable

We have been so preoccupied with logic that we have largely ignored one of the main problems of the input and output of data — the wiring between the computer and the peripheral. If this is to be long, special line-driving buffers must be employed though, if the computer and

equipment are in the same room, this is rarely necessary. Computers work so fast that electrical signals can travel only a few centimetres during one cycle of operation. If wires are long, it may be impossible for the computer and its peripherals to remain perfectly in step with one another. This is one of the reasons for employing I/O ports with asynchronous interchange of data, as described above.

A more practical problem is the sheer number of conductors required. An eight-bit connection (the minimum commonly use) requires eight lines, plus a ground line and probably several control lines as well. There is a wide variety of multi-way connectors available for joining cables to computers and peripherals. Most are designed for use with ribbon cable.

Electromagnetic interference between adjacent conductors is a serious problem, especially with long runs of cable, and can lead to errors in the data being transferred. The data signals themselves are not so likely to interfere with each other, since they are all put on to the lines at the same instant, and there is a short period before they are read (again, all at the same time) during which switch-on and switch-off disturbances can settle. However, if the cable carries control signals, which are generally *not* turned on and off at the same time as data signals, these may interfere with the data carried in adjacent conductors. One solution is to ground alternate conductors, and use only those between them. A better solution is to use twisted pairs: one wire of a pair is used for the signal and the other wire is grounded. Special ribbon cable is made with twisted pairs with untwisted regions spaced along it, where it may be cut and linked to connectors using insulation-displacement. **ETI**

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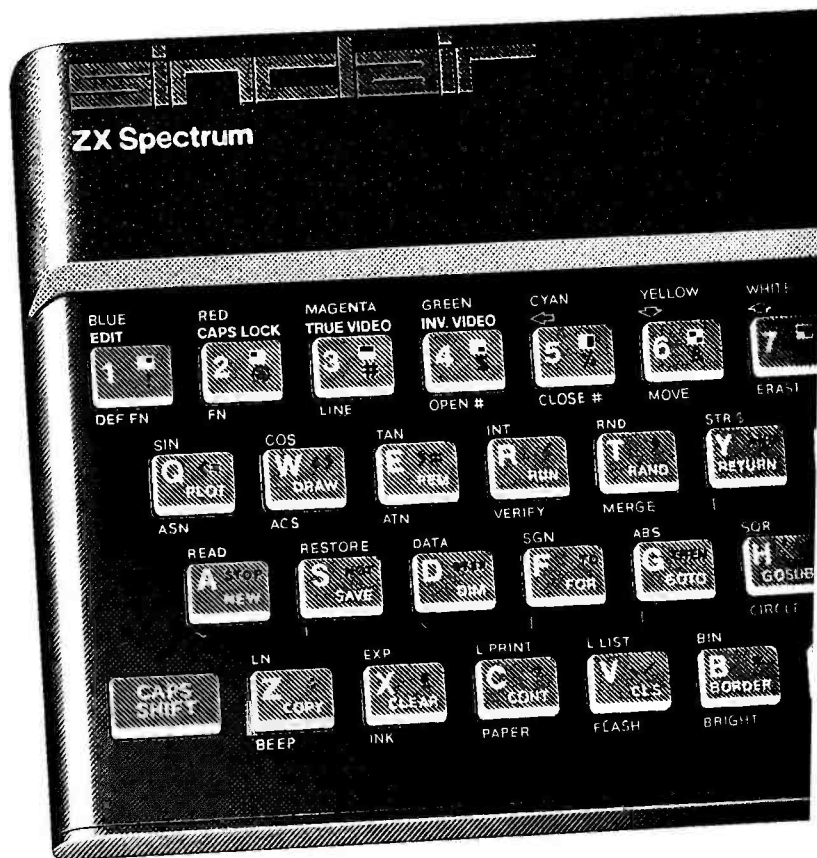
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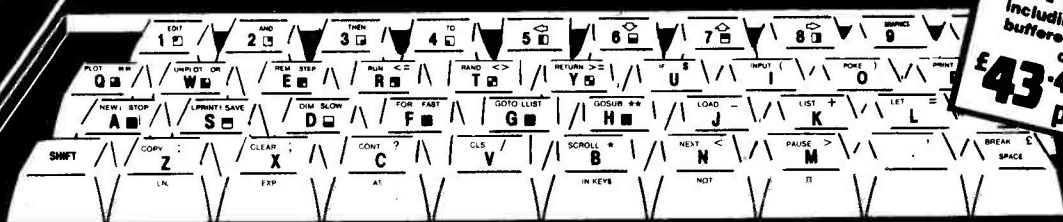


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Breakdown of memory areas...0-8K Sinclair ROM. 8-16K This area can be used to hold machine code for communication between programmes or peripherals. 16-64K A straight 48K for normal Basic use.

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Coming Soon..
RS232
Interface
Digitising
Tablet



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CORTEX PART 2

Build yourself a better brain: this month we explain the remaining Cortex circuitry and the construction of the main board.

Serial I/O on the Cortex is handled by a versatile UART, the 9902. The CPU communicates with the UART via its serial I/O bus, based on the Communication Register Unit or CRU, which requires only three wires; thus the device fits easily into an 18-pin package. The 9902 is fully programmable and the range of variations is so great that it's outside the scope of this article. In the Cortex the chip is configured to handle RS232 eight-bit codes with even parity and 1½ stop bits; the communication rate can be set from BASIC using the BAUD command and the device is activated using the UNIT statement. The parameter for UNIT is a 16-bit word, each bit corresponding to a channel that can be either on (1) or off (0).

Channel 0 is the keyboard/screen channel; channel 1 is the 9902 that is already wired into the PCB. Channels 2-15 are implemented in software and only require the addition of extra

SIZE	DDEN	TRANSFER RATE (kHz)	DIVISION RATIO (IC87)	MONOSTABLE PERIOD (µs)	COMMENTS
0	0	125	12	3.0	5¼" single density
1	0	250	6	1.5	5¼" double density
0	1	250	6	1.5	8" single density
1	1	500	3	0.75	8" double density

BUYLINES

Powertran are supplying complete kits of parts and component packs for the Cortex. A complete 64K Cortex kit will cost £295 plus VAT, carriage free. A ready-built 64K Cortex will cost £395 plus VAT, carriage free. Prices for add-ons (eg floppy discs, RS232C interface, memory expansion etc) and for component packs (eg PCB, semiconductors etc) can be found in Powertran's brochure. Powertran Cybernetics, Portway Industrial Estate, Andover, Hants SP10 2NM. Telephone 0264 64455.

HOW IT WORKS—I/O

The I/O map space is split into two regions; the bottom region is for on-board I/O devices and the top region causes an off-board access. (The CPU has an internal I/O area of 16 bits, some of which is reserved for specific hardware functions; the rest is free for the user.) The on-board I/O area of the Cortex is decoded by IC34 into eight 32-bit slots, of which only four are used. Two slots (CS A and CS C) are used for the Asynchronous Communications Controllers (ACCs), the third (CS B) for the parallel I/O for the keyboard data, flags and control lines (such as 'ROM', mentioned in the Memory section), and the fourth for the DMA controller IC8 (CS D).

9902s on the CRU bus. The Cortex powers up set to UNIT 1. Executing UNIT 2 disables the keyboard and passes control to the 9902. UNIT 3 enables both simultaneously.

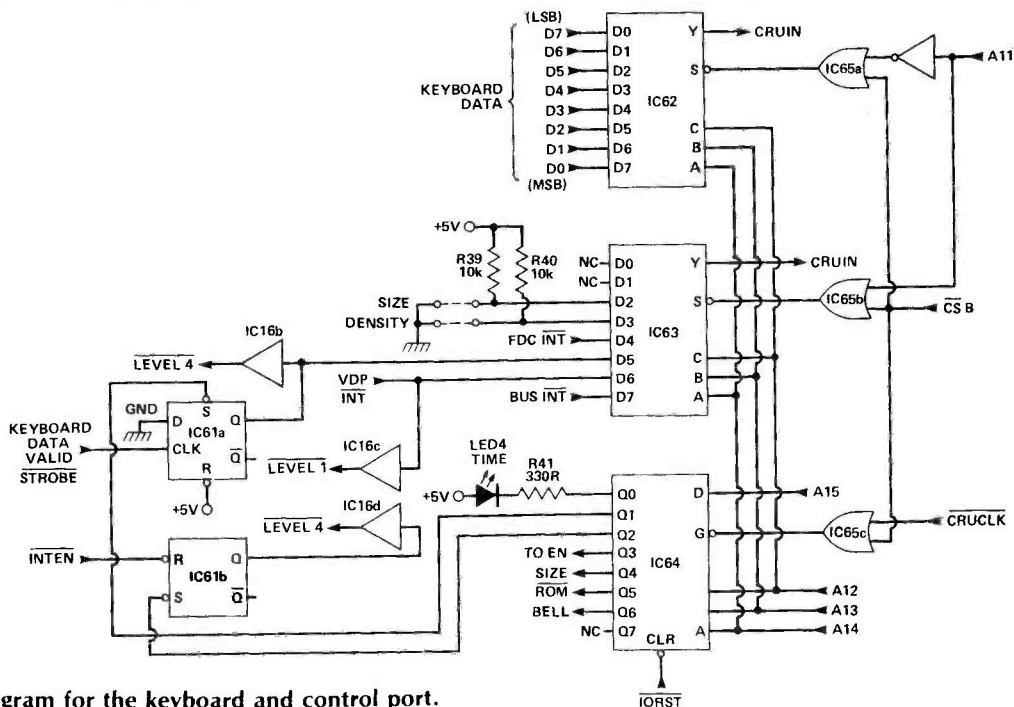


Fig. 1 Circuit diagram for the keyboard and control port.

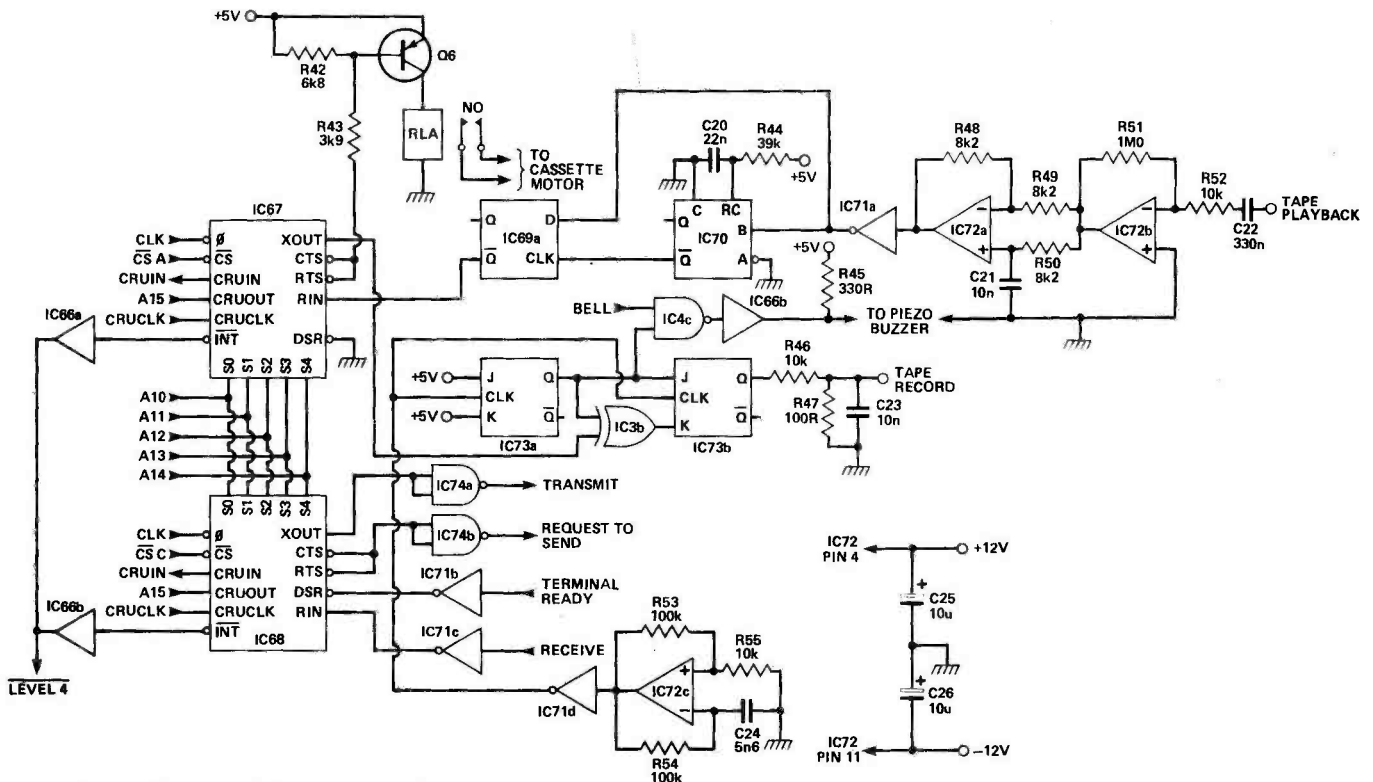


Fig. 2 Circuit diagram of the RS232 and cassette interfaces.

HOW IT WORKS — RS232 AND CASSETTE PORT

The RS232 port consists of IC68, a TMS9902 Asynchronous Communications Controller (ACC) and the TTL-to-RS232 signal level shifters (IC74a,b and IC71b,c). IC68 is a completely software-controlled device; its baud rate can be set at anything from 46 baud to over 100,000 baud. The number of bits to be transmitted or received can also be changed, as can the type, the parity and number of stop bits. The CPU drives the ACC through the serial I/O (CRU) bus. The ACC is decoded as a 32-bit block, each bit being selected by the five address lines A10-A14.

The cassette interface uses another ACC, IC67. First a 4.8kHz op-amp oscillator (IC72c) drives a level shifter (IC71d) before being divided by two in the first flip-flop (IC73a). This ensures

that the waveform has a unity mark-space ratio. The serial output from IC67 then controls the action of the second flip-flop, IC73b, via the EXOR gate IC3b. When the output is high, IC73b acts as a shift register, passing through the 2.4kHz tone; however, when the ACC output goes low then synchronously at the next clock pulse, IC73b starts to divide by two, hence generating 1.2kHz. The key point here is the synchronous switch from one tone to the other. The signal is high-pass-filtered and attenuated by R46, R47 and C23 before passing to the tape recorder.

On playback the signal is first amplified by a factor of 100 and buffered in IC72b before going through an all-pass filter, IC72c. This is necessary because of the nature of tape recording.

When square waves are recorded on tape they are accurately captured; however, on playback frequency equalisation is carried out in the tape recorder but the phase relationship is destroyed, resulting in a 'spiky' sine wave. This is corrected by the linear phase-shift-versus-frequency characteristic of the all-pass filter. Thus the original square wave shape is recovered at the output of IC72a. This is then level-shifted by IC71a and used to trigger a monostable (IC70a). At the end of the monostable period (312.5 uS) the state of the signal is sampled by the D-type flip-flop IC69a. As the half-periods of the two tones lie either side of the monostable period, each tone generates the opposite logic level at the sample point.

HOW IT WORKS — FLOPPY DISC CONTROLLER

The TMS9909 (IC76) is a highly complex micro-controller, designed to work in conjunction with the TMS9911 DMA controller to transfer data from floppy discs. The FDC can control up to four drives which can be a mixture of two sizes or types.

All signals that go to the drives are open-collector buffered by IC80,82,83 and terminated by a resistor pack on the last drive in the chain. The signals from the drives are terminated on the board by a resistor pack and then buffered by IC84.

The raw data pulses from the drive, after being buffered by IC84a, are stretched by a monostable (IC70b) by an amount dependent on the data transfer rate selected by the 'SIZE' I/O bit and the 'DDEN' (double density enable) signal (see Table 1). The output of the

monostable is used to control IC77, a digital phase-locked loop. The output of IC77 is, in the unlocked state, half the input clock frequency. When the loop is locked to a signal then the PLL inserts or deletes clock pulses in the pulse stream, thus shifting the average frequency. The programmable divider IC87 and divider IC69b are controlled by the 'SIZE' and 'DDEN' signals to select the correct clock frequency. The raw data is synchronised by IC88 to the PLL clock and then fed to the FDC. The FDC separates the interleaved clock and data bits from the pulse stream and sends data bytes via single byte DMA transfers to main memory.

Mini-floppy (5 $\frac{1}{4}$ ") drives require a motor control signal to start and stop the disc rotating. Upon starting, the disc will not go for data transfers for one

second while the disc gets up to speed. To reduce the time required to access the disc repeatedly IC79b keeps the motor running for five seconds after it is de-selected and IC79a provides the initial one second 'not ready' signal to the FDC. For standard (8") drives that don't generate a 'ready' signal there is a set of four jumpers.

The BASIC interpreter has a 'BOOT' command which causes the FDC to read the first track from disc 1 and execute it as a machine code program. This could, for example, then search for and load the UCSD interpreter. In order that the system can boot from any type of disc there are two jumpers called 'SIZE' and 'DENSITY' which are read by IC63. This enables the BASIC interpreter to set up the FDC correctly.

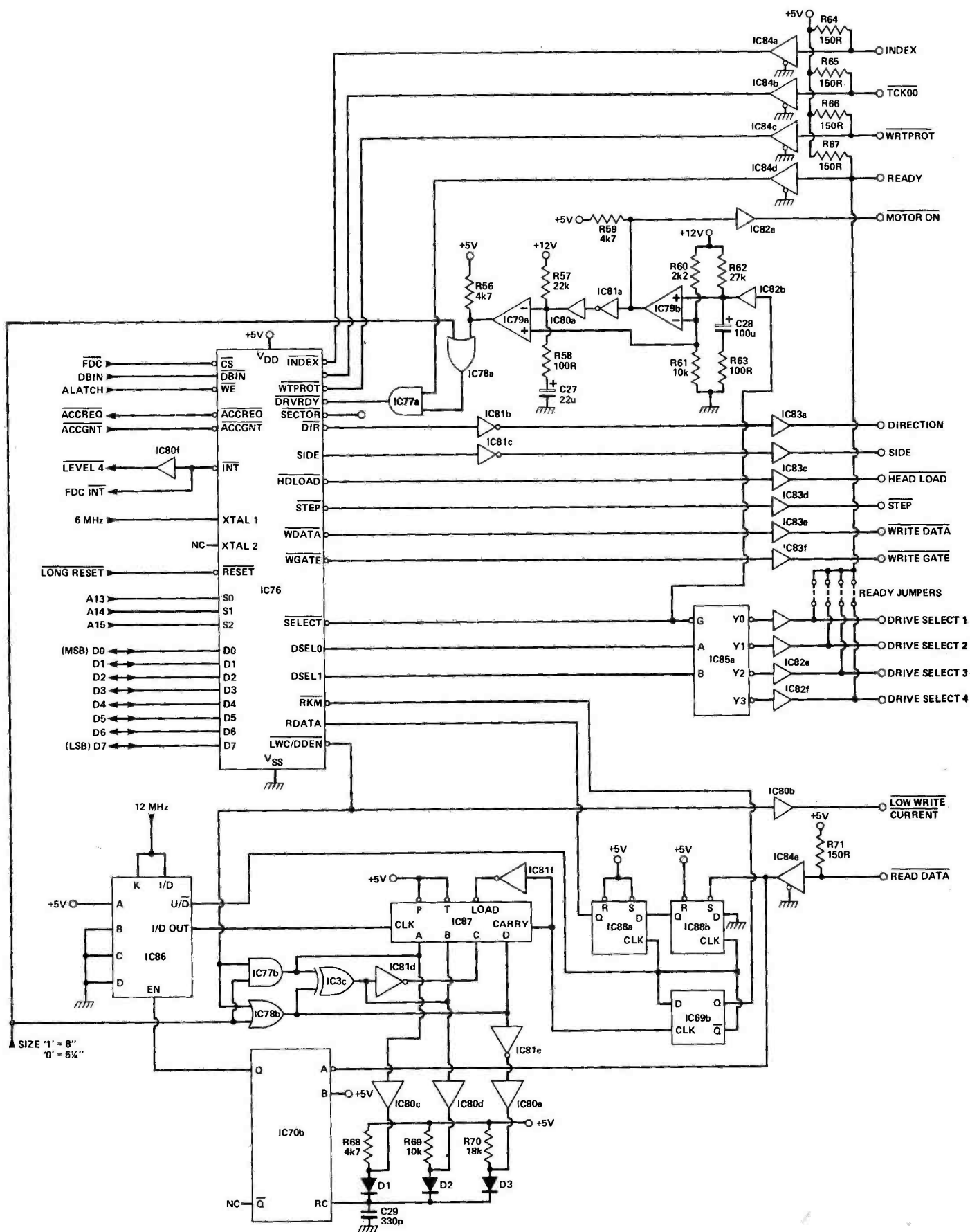


Fig. 3 Circuit diagram for the floppy disc controller section.

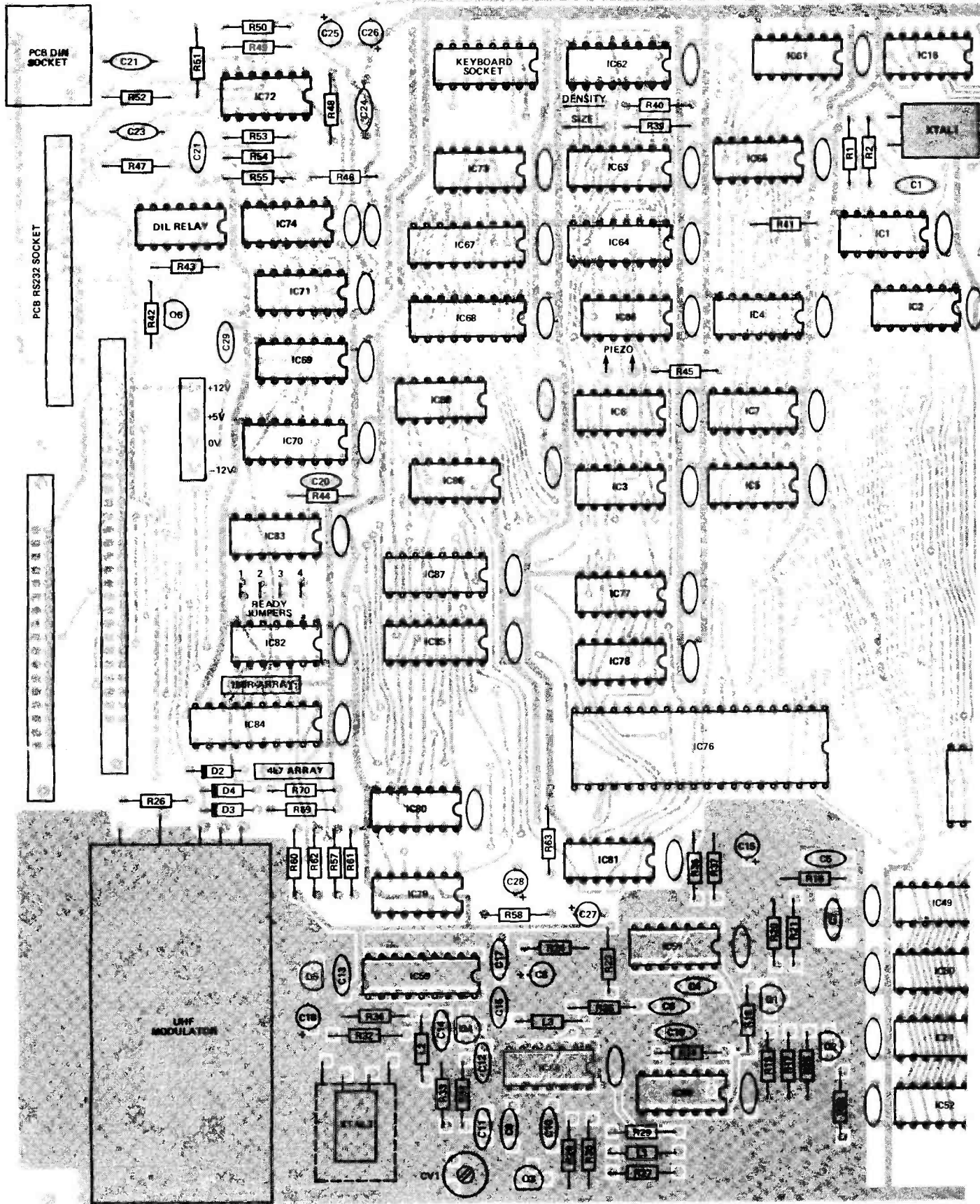
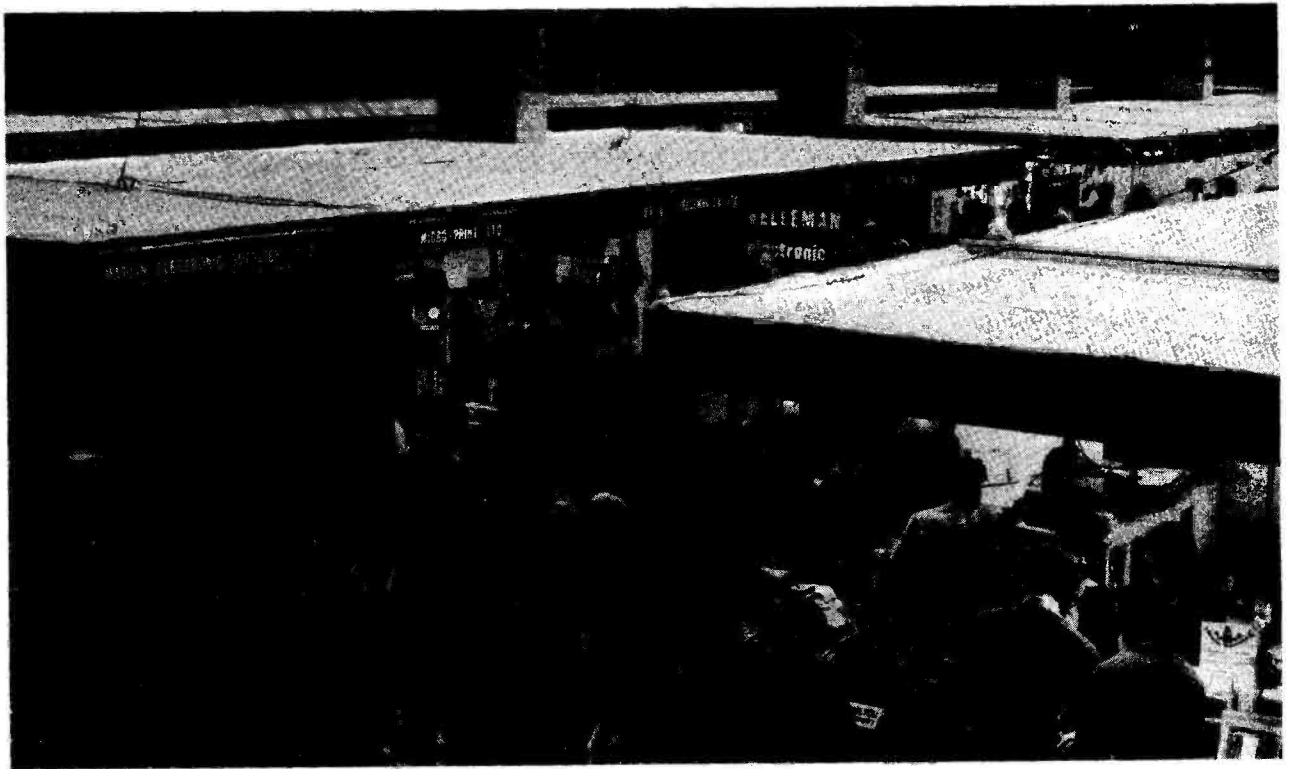


Fig. 4 Component overlay for the Cortex main board. Note that the numerous unmarked capacitors are for supply decoupling and are 47n ceramics. The grey tracks are those on the top (component) side of the board. Some changes in the IC numbering have occurred since last month due to a board redesign. To make last month's circuits agree with the above overlay, alter the

**BREAD
BOARD**

ES

—THE EXHIBITION YOU CAN'T AFFORD TO MISS—



EXHIBITION GUIDE

Introduction

BREADBOARD exhibition has now been on the scene for five years and has proved that there is a place for an exhibition for the serious electronics hobbyist. We normally use the term electronics enthusiast but one must remember that often beginners are as enthusiastic as those of us with many years experience — often more enthusiastic!

Various local exhibitions or club shows occur during the year, all of which offer something of interest to see and often to buy. Breadboard, being a centralised exhibition professionally run, can offer facilities a local club show cannot. As well as having the venue and stands that you'd expect at the premier amateur exhibition, we are fortunate in being able to attract exhibitors more used to professional exhibitions, and who are perhaps unwilling, for whatever reason, to attend the smaller shows.

Breadboard '82 not only has the stands you would expect with components, books, magazines, computers, kits etc, but also there will be a series of lectures and demonstrations for those that wish to improve their minds (or rest their feet!).

We will also be introducing a **Computer Forum** for the newcomers to computing, where some of the more popular home computers will be available for you to try out. Our staff will be on hand to help you understand those areas that are giving you a late-night nervous breakdowns!

This year we are fortunate in having two particularly interesting exhibitions/demonstrations. One is a computer moderated wargame using computers together with a scale terrain, troops, etc., that enables the visitor to assume command of the overall tactics of a modern battlefield. Should be interesting to see if Ruritania really could be next years number one super-power! Secondly we will be having a fascinating exhibition of holograms. These will be supplied by Light Fantastic and really have to be seen to be believed. For not even an arm or a leg could you buy one for your own home.

For those parts that need special restoration we will have the usual bar and restaurant open for your use beneath the exhibition hall. Don't miss Breadboard '82, you could even save yourself some money on some of the exhibition's special offers!

Peter Freebrey, Exhibition Manager

SPECIAL ATTRACTIONS

COMPUTER MODERATED WAR-GAMES

Dave Rotor sponsored by Amplicon Micro Systems, Brighton; figures supplied by Adventure Worlds, London, SW1

Wargames give you the chance to be your own general! The game that will be played at the exhibition is based on a small-scale encounter somewhere in Europe during World-War II. The players each have a small force at their command — made up of infantry, tanks and/or artillery — and have to fight out their encounter on the terrain of the board. Each game turn represents a relatively small interval of time (eg, 3 minutes) and during one move, the commander of each side can tell any or all of his forces to move or fire selected weapons. The men and machines involved in the conflict will be represented by 1:1/200 scale models specially for the humans, however the computer will have an 'image' of the battle-field stored in memory.

Fed with each players' move, the computer works out the practical consequences, governed by data on the weapons in the possession of each side, the conditions of the terrain, the men, the weather, etc. The performance of the weapons, and even the men, is deduced from known details of real-life battlefield performance.

Suppose you have a squad of ten men and you decide to move them into battle; it's known that armed men can travel at 3 miles an hour in reasonable conditions. Depending on the time that each move represents, the squad will move a proportional scaled distance (worked out by the computer) in the direction you specify. If you order them to fire their weapons (or if your opponent's tank fires at them, for instance), the effectiveness will be gauged by the distance, the known effectiveness of the weapons against the type of target they are firing on, and

all the other factors programmed. The computer will then tell you what degree of damage you have inflicted on each other.

The sort of calculation involved in the evaluation of the tables, etc, used to take human moderators some considerable time; now a fair sized home-computer can do the calculations involved in less than a second. During the exhibition, both war-gamers and computer programmers will be on hand to give detailed explanations of the programming and the theory behind the game.

HOLOGRAMS

Light Fantastic Gallery, Covent Garden, London.

Light Fantastic is the first permanent gallery of holography in Britain, and was set up after the success of the 1977 and 1978 Light Fantastic exhibitions at the Royal Academy.

Holography itself has progressed a long way since the first indistinct three-dimensional images were produced in 1947 by Gabor, a scientist working at the Rugby Electrical Company in Scotland. Gabor was subsequently awarded a Nobel Prize for his invention.

The invention of lasers in 1960 made holography much more of a practical proposition. Most of the early laser-produced holograms had to be lit by laser in an area with low ambient light level. Later in the 1960s, the technique was improved to allow holograms to be lit with a standard tungsten halogen light source. The development continued from here, now allowing low cost high-volume production in acceptable commercial quality.

Holographic Exhibitions Ltd (holding company for Light Fantastic) provide a total design to installation service for commercial holography.

Light Fantastic will be showing a selection of some of the most striking items from their permanent collection.

EXHIBITORS

Here are just a few of the many leading companies who will be exhibiting their latest lines. More and more companies are booking all the time, and electronics is a rapidly changing field, so we won't have full details of all the exhibitors until the last minute — this is just a foretaste of what is to come. A full catalogue will be available at the exhibition.

ELECTRONICS TODAY INTERNATIONAL

You've read the magazine, you've built the projects, now visit the stand and meet the people who are responsible for it all.

On display will be a large number of our projects, including the brand new 16-bit home computer, the robot arm, and many, many more, all springing into action before your very eyes! Besides this, you'll be able to put your questions to us, and we'll do our best to help. So come and see us on our stand.

HOBBY ELECTRONICS

An intelligent robot in a plastic basin is but one of the marvels on show to those of you who come to visit the Hobby Electronics stand at this year's Breadboard Exhibition.

As well as being able to see some of our best projects at close quarters — yes, they really do exist — you will get the chance to meet the people who produce HE. So, if you've been having some problem with getting your prototypes to work, or you'd just like to air your views on the mag, then pop along and we'll do our best to enlighten you. Even if you're the shy retiring type, don't be discouraged, just stroll up and play with something that takes your fancy — there's so much to choose from amongst test gear, audio, RF, gadgets, games and the like, that we'll be surprised if you *want* to look at any of the other exhibitors. Though, of course, there are plenty of others around, should you be that way inclined!

COMPUTING TODAY

Computing Today is the leading magazine for the serious home computer user looking for the professional approach. Written by micro users for micro users, inside each issue you will find feature articles, projects, general topics, software listings, news and reviews. You'll also be able to buy copies of the current magazine (as well as back issues where available) and any of our popular range of CT Software. So, if you're a committed micro user, come and meet the editorial staff and we'll show you a truly personal approach to microcomputing.

PERSONAL COMPUTING TODAY

Since its first issue in August of this year, PCT has become the magazine for the not-so-experienced computer enthusiast. We provide lots of helpful advice on choosing and using a home computer and associated peripherals, a directory of off-the-shelf software, plus lots and lots of programs from the very simple to the stunningly sophisticated. Come and visit our stand, and see how we can help you find your way through the maze of computing.

ETI, HE, CT and PCT are all magazines published by ARGUS SPECIALIST PUBLICATIONS LTD. Other magazines include **Electronics Digest**, **ZX Computing** and **Personal Software**.

ARGUS SPECIALIST PUBLICATIONS LTD, 145 Charing Cross Road, London WC2H 0EE, Tel 01-437 1002/3/4/5

BRADLEY MARSHALL LTD

Bradley Marshall is one of the leading electronic component distributors in the UK, building a reputation for the highest quality items in every area of the micro-electronics business. At Breadboard '82 they will be exhibiting a select range of items from their diverse spectrum covering over 3,000 individual product categories.

Whilst it is almost impossible to keep pace with change in the electronic market, Bradley Marshall feel confident that their new 1983 catalogue is as up-to-date as it is possible to be. As well as the complete range of Bradley Marshall components, the catalogue contains a great deal of component data to aid the hobbyist. Bradley Marshall are delighted to be able to make available advance copies of the catalogue exclusively for Breadboard '82 at a special exhibition price of 50p.

Bradley Marshall are the sole London distributors of **Crimson Electrik** Professional Audio Amplifier Modules. Crimson Electrik Modules are internationally renowned with a reputation based on quality, reliability and value for money as witnessed by the BBC, IBA and KEF to name but three. Bradley Marshall will be displaying the complete range of these extraordinary amplifiers at Breadboard '82.

Thandar and **Leader** are names that need no introduction to either the professional engineer or dedicated hobbyist as makers of some of the finest precision test equipment and accessories on the market today. Bradley Marshall will be displaying and demonstrating a selection from this high quality range.

They say a bad workman blames his tools — but not **Bahco**, the foremost quality tools from Sweden. The complete range is available from Bradley Marshall and will be on display at the exhibition.

BRADLEY MARSHALL LTD, 325 Edgware Road, London W2 1BN. Tel: 01-732 4242

Booking If your company would like to take a stall at the exhibition, ring Colin Mackenzie on 01-286 9191 soon.

**The capital's
longest running
Hobby Electronics
Show**

**BREAD
BOARD**

Keyboards — Watches — Clocks — Games — Calculators — Portable Computers — Musical Instruments

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Sell our products to your friends and family and earn a 10% commission. Details on request.

IF YOU SEE A BETTER OFFER WE WILL BEAT IT

FULL DETAILS OF INDIVIDUAL ITEMS AVAILABLE ON REQUEST

Casio have a world-wide reputation for **QUALITY, RELIABILITY and VALUE FOR MONEY**



GENERAL SPECIFICATIONS

All Casiotone keyboards (except VL-Tones) are polyphonic — up to 8 notes can be played simultaneously. They all have an integral amplifier and loudspeaker, plus output jacks for headphones and external amplification.

DIGITAL SYNTHESISER

CT-1000P

NEW



£325

A RUNAWAY SUCCESS ALREADY

10 preset voices and 1,000 switchable sounds, with a protected memory for your 10 favourites. 5-octave split keyboard; programmable arpeggio/real time sequencer; transposition. 4% x 36% x 14% inches. 22.5lbs.

49 BREATHTAKING SOUNDS

CT-202



£275

RAVE REVIEWS OF THESE SCINTILLATING VOICES

49 instrument sounds over 4-octaves, with a 4 voice memory function. 3 vibrato settings and sustain. 3% x 34% x 11% inches. 15.8lbs.

CT-101



£199

25 voices, including Piano, Organ, Harpsichord, Accordion, Xylophone, Chimes, Clarinet, Flute, Violin, Mandolin, Guitar and synths. 4-voice memory function. Vibrato and sustain. 4% x 30% x 11% inches. 16.8lbs.

BEST SELLING 4 OCTAVE EASY-PLAY

CT-403



£275

Identical to the CT-101 but in addition has easy-play auto chords and 16 rhythm accompaniments. 17.6lbs.

CASIOTONE KEYBOARDS

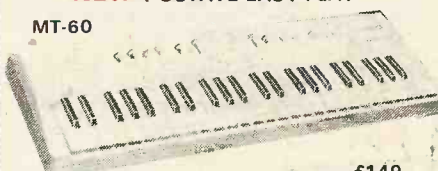
The world's fastest selling keyboards **ORDER TODAY — PLAY TOMORROW** SECURICOR 24 hour delivery at no extra charge (CT models). Small keyboards by RETURN POST. CASH & CARRY from Cambridge.

PORTABLE MINI KEYBOARDS

Battery or mains. Mains adaptor optional extra.

NEW 4 OCTAVE EASY-PLAY

MT-60



£149

25 voices with sustain and vibrato. 8 rhythm accompaniments with 'Intro/fill-in' function. Easy-play auto chords, bass and arpeggio. 2% x 25 x 7% inches. 5.5lbs.

MT-40



£99

3 octaves plus a 15-note bass keyboard with automatic function. 22 voices, with sustain/vibrato. 6 auto rhythms with dual 'fill-in'. 2% x 23 x 7 inches. Weight 4.9lbs.

MT-31



£69

The MT-31 does not have a bass keyboard, auto function or rhythm accompaniment but it is otherwise identical to the MT-40. Weight 4.4lbs.

VL-1



£35.95

Tens of thousands of this little marvel sold. 29-note mono keyboard. 100-note tune memory. 5 preset sounds plus ADSR selector. 10 auto rhythms. One-Key-Play button. Calculator. 1% x 11% x 3 inches. Weight 15.4oz.

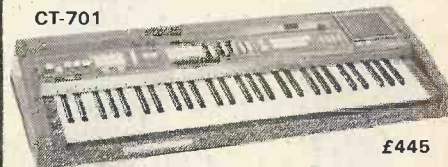
VL-10 Tiny executive version of the VL-1 with one voice. 1/2 x 7% x 2% inches. Weight 4.3oz. £26.95

BAR-CODE PROGRAMMABLE TEACHING KEYBOARDS

The 345 (max) note steps and 201 (max) chord steps can be programmed by both Casio bar-coded music scores and/or manual entry via the keyboard.

The Auto Play function, One-Key-Play function and Melody Guide (lights above the keyboard show you the next note to play), can teach you to play your programmed selection. "One of the finest teaching aids so far developed." E&MM

CT-701



£445

5 octave, split keyboard. 20 preset sounds with variable vibrato and sustain. Fingered or auto chords with bass and arpeggio. 16 rhythm accompaniments with fill-in. Two sound effects. 5 x 37% x 13% inches. Weight 27.6lbs.

CT-601 Identical to the CT-701 but without the programming and teaching functions.

NEW

MINI PROGRAMMABLE

MT-70

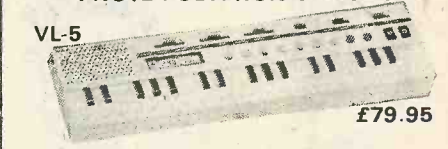


£199

A portable mini keyboard version of the CT-701. 4 octave (not split) keyboard. 10 rhythm accompaniments. Without the two sound effects, it is otherwise very similar to the CT-701. Battery or mains powered, with optional mains adaptor. 2% x 25 x 7% inches. Weight 6lbs.

4-NOTE POLYPHONIC MICRO

VL-5



£79.95

Up to 240 melody notes can be entered and stored. Auto play and One-Key-Play functions. 3 octave keyboard, with 10 preset sounds and 8 rhythm accompaniments. Battery or mains powered, with optional mains adaptor.

OPTIONAL ACCESSORIES

Bar coded/standard music.	From £2.95
CS-H domestic stand. CT models.	£30.00
CS-P Stage stand. CT models.	£35.00
CS-E 2nd K/B extension for CSP.	£12.00
VP-E volume pedal. CT models.	£25.00
SP-E sustain pedal. CT models.	£6.50
PC-2 hard case. MT-31/40	£9.95
PC-3 hard case. MT-60/70	£13.00
HC-A hard case. CT-101/403	£30.00
HC-B hard case. CT-601/701/1000P	£40.00
HC-3 hard case. CT-202	£44.00
AD-4160 mains adaptor. VL-1	£5.00
AD-1E mains adaptor. MT models/VL-5	£5.00

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WORLD'S FIRST THERMOMETER WATCH

NEW

**TS-1000
ONLY £24.95**

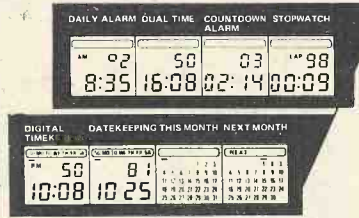
- 100m water resist
- Full display
- 12/24 hour
- Thermometer
- Thermo alarm
- Daily alarm
- Time signal
- Pro. stopwatch
- World time
- Resin case



WORLD'S MOST VERSATILE WATCHES
10 alternative displays — over 60 useful functions.

**AX-250
(left)
£24.95**

**AX-5
Resin
£19.95**



WATER RESISTANT

Rugged, go anywhere sports watches. All have a full display of time and auto calendar. Alarm and selectable half-hourly time signal. Countdown alarm timer with repeat memory function, ideal for dinghy racing. Professional 1/100 second stopwatch. Time is always on display, regardless of display mode. Amazing 5/7 year lithium battery life. 12/24 hour display.

Except for the W-35, the stainless steel case watches have a protective black bezel. (W-450, W-450C, DW-1000 and the DW-1000C).

50 metre water resistant



**W-23
£14.95**



**W-24
£12.95**

50m W/R

100m W/R



**W-35
£19.95**



**W-300
£17.95**

100m W/R



**W-450
£22.95**



**W-450C
£19.95**

200m W/R Divers



**DW-1000
£39.95**



**DW-1000C
£34.95**

We stock CITIZEN and SEIKO divers watches. Please also see J-30 under Jogging Watches.

ANALOG/DIGITAL

The best of both worlds, with both analog and 12/24 hour digital time display (dual time). Calendar, alarm, time signal, pro. stopwatch.



**AA-86
£19.95**



**AQ-101
£39.95**

AA-86 LCD analog display. Countdown alarm timer with amazing, eye-catching moving graphics! AQ-101 Classic analog, with date memory function.

GAME WATCHES

Calendar, alarm, time signal, pro. stopwatch.

NEW

**GOLF WATCH
GG-9 £17.95**

When playing real golf counts strokes at each hole. Totals strokes over 9 holes.

When playing Game par for each of 9 holes Distance from hole indicator. Select golf club. Select direction of swing. Bunkers and out of bounds Stroke counter Memorises lowest score.



RESIN



**GM-30
£19.95**



**GM-40
£19.95**

GM-30 Destroyer/submarine sea battle game. GM-40 Catch blocks from UFO and build pyramid.

GAME/CALCULATOR WATCHES

Calendar, alarm, time signal, pro. stopwatch Popular DIGITAL INVADER game



**CA-86
Resin
£19.95**



**CA-851
£29.95**

CALCULATOR WATCH

NEW

CS-821

**ULTRA SLIM
£29.95**

Only 6.6mm thick! Auto calendar mode. Daily alarm function. Hourly time signal. Professional stopwatch, 1/100 sec to 24 hours. 12/24 hour time format. Auto-light-off function.



MULTI-ALARM WATCHES

Daily alarm with pre-alarm; daily alarm with post-alarm; weekly alarm (or extra daily alarm); Hourly time signal; Calendar; pro. stopwatch.



**CA-951
£29.95**



**MM-400
£29.95**

CA-951 Calculator. 2 melody alarms. CA-95 Resin version of CA-951 £19.95. MM-400 6 melodies. Monthly alarm or extra daily alarm. Dual time. Time is always on display.

JOGGING WATCHES

Calendar, alarm, time signal, pro. stopwatch. Pacer signal for jogging and rhythmic sports.



**J-30
£12.95**



**J-50
£15.95**



**J-100
£19.95**

J-30 50 metre water resistant. Countdown alarm timer. Input data: Pacer signals. Output data: Elapsed time. 37.7 x 31.4 x 7.6mm thick.

J-50 Countdown alarm timer. Input data: Pacer signals, length of stride. Output data: Elapsed time, distance covered.

J-100 as J-50 but with calculator function instead of countdown alarm timer.

STANDARD WATCHES

Calendar, alarm, time signal, dual time, 1/10 second stopwatch.



**F-85
Resin
£7.95**



**A-656
£9.95**

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ULTRA SLIM — GOLD PLATE OPTIONAL

Calendar, alarm, time signal, dual time, stopwatch



A-660
£12.95



SA-50
£14.95

A-660 6.4mm thick. A-660G gold plated £14.95
SA-50 4.6mm thick. Countdown alarm timer.
1/100 sec. stopwatch. SA-50G gold plated £9.95.

LADIES WATCHES



L-50G
£8.95



L-780
£10.95

Basic 4-digit watches displaying hours and minutes;
calendar, seconds.
L-50G gold plated. L-780 Ultra compact.

LADIES ALARM WATCHES



LA-650
£14.95



LM-320
£19.95

LA-650 Time, calendar, alarm, hourly time signal,
countdown alarm timer.
LM-320 Time, calendar, daily alarm with 3 selectable
melodies, hourly time signal, professional stopwatch,
stainless steel case.

50 METRE WATER RESISTANT



LW-5
Resin
£8.95



LW-601
S/S
£19.95

LW-5 Basic 4 digits, displaying hours and minutes,
calendar, seconds.
LW-601 Time, calendar, alarm, hourly time signal,
countdown alarm timer.

SYMPHONIC ALARM CLOCK



MA-1
£9.95

Mozart No. 40 or Buzzer. Hourly chimes. Snooze facility
1 3/4 x 4 1/2 x 3 in.

ELECTRONIC GAMES

NEW FOR CHRISTMAS 1982

**CG-10
SOLAR SHUTTLE**
£12.95

Powered by solar
cells. Does not
require batteries.



**CG-20
MONEY & BOMB**
£12.95

Powered by solar
cells. Does not
require batteries.

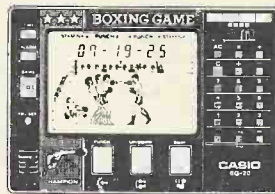
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CG-105 MOTORCYCLE RACE
An exciting and engrossing game £14.95

CG-110 SPACE BATTLE
for the enthusiast — a real challenge! £14.95

**BG-20
BOXING
GAME**

£16.95



A new version of the very successful BG-15. Now
has a full screen, with the calculator function relegated
to one side! Clock and alarm function.

**CALCULATOR GAMES
DIGITAL SPACE INVADERS**



MG-880

£10.95



MG-885

COMPENDIUM OF 3 GAMES



MG-888
£10.95



MG-777
£14.95

MG-777 has a built-in clock function.

ALARM CLOCK CALCULATORS



BG-15

BOXING GAME

£14.95

Clock, alarm,
calculator

FT-7

£14.95

Fortune teller, Matchmaker,
calendar, alarm clock.



BQ-1100 Biolator, alarm clock calculator £16.95

MELODY ALARM CLOCK CALCULATORS



UC-365 £19.95

UC-360 £19.95

3 melodies, universal calendar, date memories, 2 date
alarms, daily alarm, countdown alarm/stopwatch, time
memory. UC-365 wallet size. UC-360 card size.

SCIENTIFIC CALCULATORS

KEY: d = number of digits. b = approx. battery life.
f = scientific functions. SD = standard deviations.
R/P = Rectangular/Polar co-ordinates conversion.
(-) = number of parentheses. H = hyperbolic.



FX-7
£9.95



FX-82
£11.95



FX-100
£14.95

Dims: 19 x 76.5 x 149mm 3,000-7,500 b.
FX-7 8d, 23f, ((3))
FX-82 8d, 38f, SD, ((6))
FX-100 10d, 42f, SD, R/P, ((6))



FX-550
£15.95



FX-900
£17.95



FX-950
£19.95

FX-550 10d, 48f, SD, R/P, ((6))
FX-900 8d, 41f, SD, R/P, ((15)), b SOLAR.
FX-950 10d, 49f, SD, R/P, ((15)), H, b SOLAR.

FX-8100 £19.95

8 + 2d, 46f, SD, R/P,
((5)), H, b 1 year.

Clock, calendar,
1/100 stopwatch,
alarm, hourly chimes,
2x countdown alarms.



PROGRAMMABLES

FX-3600P
£22.95

10 + 2d, 50f, SD
R/P, ((18))
Integrals, Regression
2 program areas, 38
steps, 7 memories



FX-602P £69.95

Plus FREE Professional
Programming Pack,
worth £9.95

10 + 2d, 50f, SD, R/P
((33))
10 program areas, up to
512 steps, up to 88
memories. Alpha/
numeric display.



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PORTABLE COMPUTERS

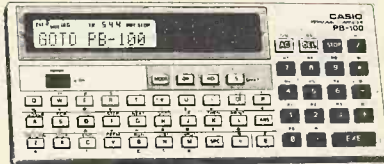
NEW

BASIC FOR BEGINNERS

PB-100 £69.95

Learn as you go

Now you can enter the new age of computers with this easy-to-understand system.



LEARN with the beginners manual "An easy-to-follow introduction to the Personal Computer". FOLLOW the step by step examples and use the programs supplied, or develop your own for business or home, including exciting games. QWERTY keyboard. Upper/lower case dot matrix display. Up to 544 program steps/94 memories, expandable to 1,568 steps/222 memories, all protected. A truly pocketable 9.8 x 165 x 71mm. Weight 116g. 360 hours battery life. OR-1 1K RAM expansion module. £11.95. FA-3 cassette interface £22.95.

SHARP PC-1500 COLOUR COMPUTER

Probably the most powerful pocket computer on earth plus FREE SOFTWARE



PC-1500 Computer PLUS £20 software voucher £169.95
 CE-150 Printer PLUS £20 software voucher £149.95
 CE-155 8K RAM expansion module PLUS £10 S/W voucher £79.95
 16K ROM extended BASIC. 3.5K RAM (expandable). QWERTY keyboard. Dot matrix display. With clock, calendar, alarm and around 30 scientific functions. CE-1504-colour printer/plotter and cassette interface. Available late 1982. RS-232C interface; 140 key custom software board; custom cassette recorder; custom briefcase.

Colour brochure and software list on request.

MICROL SPECTRUM

PROFESSIONAL SOFTWARE YOUR SINCLAIR SPECTRUM

USE AND LEARN Vol. 1. 25 BASIC PROGRAMS on cassette + 100 PAGE BOOK. Professionally written programs, routines and articles packed with practical ideas, hints and tips. Your perfect 16/48K Spectrum starter kit. £9.95

USE AND LEARN Vol. 2. 30 MACHINE CODE ROUTINES for high speed graphics, games and serious programs. On cassette with 50 PAGE BOOK. The easy way to add machine code power and speed to your BASIC programs. Available December 1982. For 16/48K Spectrums. £9.95

THE DATABASE PRACTICAL, POWERFUL, RELIABLE — the best Spectrum database — and the easiest to use. Written in machine code and BASIC. Detailed literature available on request, or for the ultimate demonstration try the DATABASE yourself with MICROL's 14 day money back guarantee. Av. October '82. 48K only. (Microdrive add-on option Jan. '83). £9.95

THE SPREADSHEET Visicalc for £10? Not quite — it lacks some of Visicalc's little-used features, runs slightly slower but has all the main Visicalc capabilities (including REPLICATE, SPLIT WINDOW, HELP) and some improvements (including easier dual screen command structures). Compare it for yourself with all other versions including of course Sinclair's own! Av. November '82. 48K only. (Microdrive add-on option Jan. '83). £9.95

MICROL 14-day money-back guarantee

PEARL

MAXWIN DRUM SETS



503 3 drums, cymbal starter kit £189
 405 "Funky" 5 drums, cymbal, Hi-Hat, Single headed concert £295
 705 Standard 5, cymbal, Hi-Hat £315
 805 Deluxe 5, 2 cymbals, Hi-Hat £350

EFFECTS PROCESSORS

FG01 Flanger £58.50
 PH.03 Phaser £45
 CH.02 Chorus £54.90
 CO.04 Compressor £42
 OD.05 Overdrive £39
 CE.22 Chorus Ensemble £102
 AD.33 Analog Delay £116
 PH.44 Phaser £87



MANUFACTURERS 12 MONTHS GUARANTEE ON ALL ITEMS

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TEMPUS

38 BURLEIGH STREET, CAMBRIDGE CB1 1DG.
 TELEPHONE (0223) 312866

© Tempus, 1982

E&OE

NEW

FX-801P

ONLY £349

THE FUTURE IS HERE TODAY

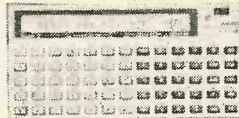


High speed computer with integral micro-cassette data control and hard copy printer monitoring.

Everything you need, in an area smaller than this page. This truly portable SYSTEM needs no peripherals on lengths of wire. Batteries last 250 hours (only display) or 5,000 lines (display and printing). Typewriter style QWERTY keyboard, plus all the advanced functions of the FX-702P.

FX-702P £79.95

With FREE Microl professional Programming Pack, worth £9.95 BASIC programming up to 1,680 program steps, up to 226 memories, all protected when switched off.



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Friday 12 November	1000-1800
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We are suppliers of electronic components and equipment to the hobby electronics/amateur radio market. We specialise in the resale of manufacturers' surplus to the retail customer. We advertise in the popular magazines and our catalogue/special offers list will be available on our stand.

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Elektor magazine provides practical and reliable circuit designs as well as an unequalled printed circuit board service (EPS) for many of the constructional projects published. In addition, there is the Elektor software service (ESS) of programs for microcomputers on disc or tape.

Elektor books will be available from our stand. Besides books containing large numbers of constructional projects, the stand will feature books for those who would like to learn more about computing, electronics, etc.

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**ELEKTOR PUBLISHERS LTD, Elektor House, 10
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Velleman electronic kits were introduced to the U.K. market nearly a year ago. They had their public debut at Breadboard '81 where they attracted immense interest. Since then they have been enthusiastically purchased throughout the U.K. where they are fast earning a reputation for their originality, high quality and excellent service.

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Velleman have a design and development laboratory in their Belgium factory where new, exciting kits are regularly produced to add to their range. They undertake major development projects for large companies throughout Europe and this highly qualified technical expertise is responsible for their successful range of kits.

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They are designed to interest not only those just beginning the addictive hobby of electronics, but also those engineers and enthusiasts who have experience in this area of technology and are able to use the Velleman kits for many of their projects and equipment.

Velleman will have a large selection of their kits available at Breadboard for inspection and sale, and an engineer will be on hand for most of the time to advise and answer questions. Their illustrated catalogue will be obtainable from the stand and is always available on request from the UK office.

VELLEMAN (U.K.) LIMITED, P.O. Box 30, St. Leonards on Sea, East Sussex, Tel 0424 753246.

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Watford Electronics was established just over nine years ago. From a very modest start, we have now grown to our present size which makes us one of the leaders in the hobbyist/OEM Electronic components supplier's market. In 1973 our range of components was no more than 500 items; today the range has increased to more than 8000 items and keeps on increasing every week to keep pace with the changing technology.

Our two aims at Watford Electronics are to supply first grade components at very competitive prices and to provide an excellent service to both mail order and shop customers. The former we have been able to achieve by bulk buying direct from the manufacturers wherever possible, thus eliminating the middleman and passing the price advantage over to our customers. The latter we have been able to achieve by sheer hard work and dedication on the part of our staff. 80% of the mail-order orders received are processed and despatched the same day. The remainder (except where items may be out of stock) are despatched the next day. Access orders received by telephone are processed and despatched the same day.

We stock a comprehensive range of components, including linear, computer, CMOS and TTL ICs, transistors and other discrete semiconductors, nearly every variety of passive component, transducers, hardware and a large variety of connectors at very reasonable prices.

On our stand at Breadboard Exhibition, we shall be displaying some of the thousands of components that we sell. (N.B. We shall **not** be selling components from our stand due to sheer volume and variety that we would have to transport every day, but we will be accepting orders for postal despatch. As a special concession, all orders over £5 accepted at the exhibition will be post free.) We shall be demonstrating our latest 'Ultimum' Micro Expansion System linked to various Micro Computers. Our Managing Director, Mr. N. Jessa will be in attendance. He will be pleased to meet and have a chat with the thousands of our customers who we have no opportunity to meet otherwise.

WATFORD ELECTRONICS, 33/35 Cardiff Rd, Watford, Herts. WD1 8ED, England, Tel Watford 40588/9

Lectures and Demonstrations

Wednesday	1100	ETI Music Demonstration
10th November	1200	Cable TV
	1300	ETI Music Demonstration
	1400	BICC-Vero: Speedwire
	1500	Gateway to Electronics
Thursday	1100	ETI Music Demonstration
11th November	1200	Cable TV
	1300	BICC-Vero: Wire-wrapping
	1400	The Digital Solution
	1500	ETI Music Demonstration
Friday	1100	ETI Music Demonstration
12th November	1200	Cable TV
	1300	The Digital Solution
	1400	BICC-Vero: Speedwire
	1500	ETI Music Demonstration
Saturday	1100	Electronic Music Techniques
13th November	1200	The Digital Solution
	1300	BICC-Vero: Wire-wrapping
	1400	Holography
	1500	Electronic Music Techniques
	1600	Cable TV
Sunday	1100	ETI Music Demonstration
14th November	1200	BICC-Vero: Speedwire
	1300	Cable TV
	1400	ETI Music Demonstration

ETI Music Demonstration

Music projects that have appeared in ETI over the past few years will be put through their paces by a professional musician. This is a good opportunity to decide, with your ears, which synthesiser or fuzz-box to build.

Cable TV – G. Brant, BSc

Cable and satellite TV systems are the newcomers to the broadcasting world of the '80s. A brief description of the existing transmission network will be given, followed by a look at these new media.

BICC-Vero

BICC-Vero Electronics will be giving audio-visual demonstrations of their new insulation displacement system called Speedwire, ideal for fast positive contacts. On alternate days, there will be lectures on wire-wrapping, an alternative system for solderless connections.

Gateway to Electronics – Dave Bradshaw, MSc

This is a lecture for beginners in electronics, and will offer a mixture of very basic circuit theory and practical advice.

The Digital Solution – Owen Bishop, BSc

In these lectures I propose to cover the whole range of applications of digital electronics, including digital computing, D-A conversion, digital recording, remote control, etc. There will be a selection of working demonstration circuits to illustrate points made in the lectures.

Electronic Music Techniques – Tim Orr, BSc

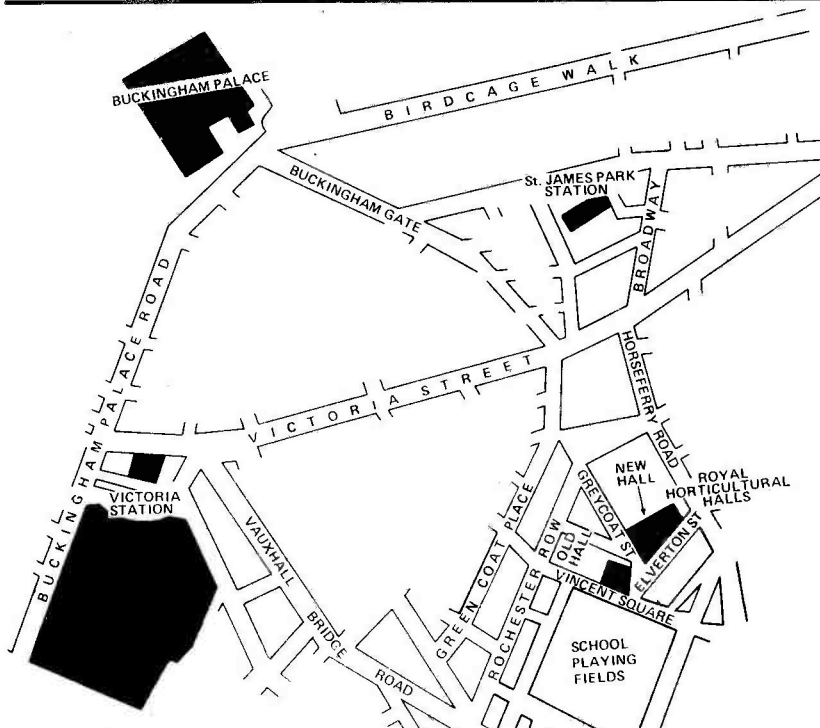
The lecture demonstration will consist of a technical explanation coupled with a musical demonstration of a polyphonic music synthesiser, a digital delay line and a vocoder: all these have been designed by the lecturer.

Holography – Andrew Pepper

This will be an introduction to the principles, methods and techniques of practical holography.

ALL LECTURES WILL TAKE PLACE IN THE LECTURE THEATRE, WHICH IS APPROACHED BY THE LIFT OR STAIRS IN THE MAIN FOYER

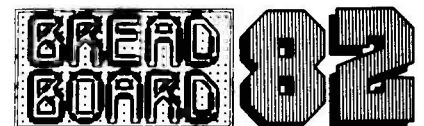
WHILE EVERY EFFORT HAS BEEN MADE TO ENSURE THE ACCURACY OF THIS PROGRAMME, PLEASE CHECK FOR DETAILS OF ANY CHANGES WHEN YOU ARRIVE

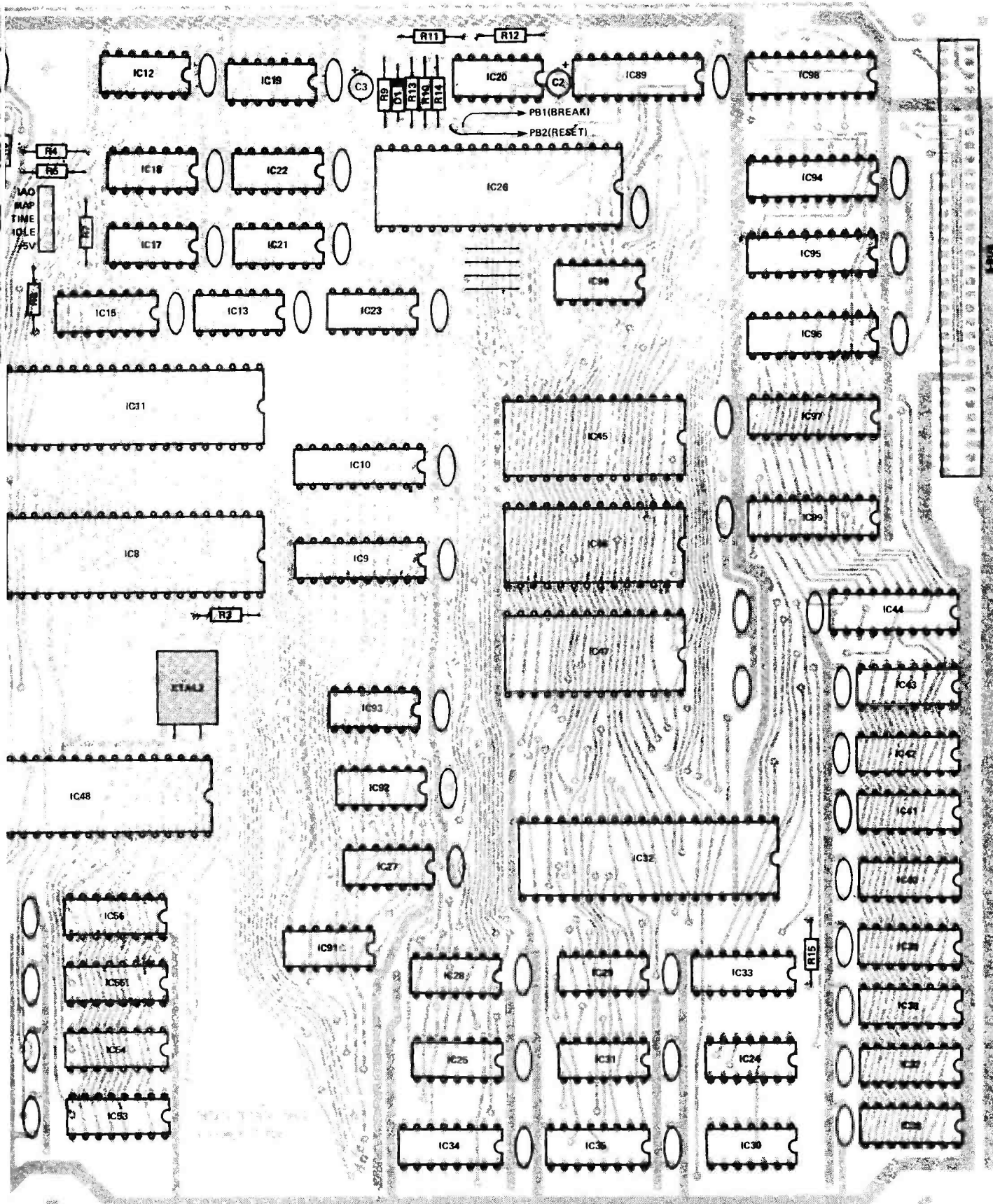


Other exhibitors will include:

BICC-Vero
 Leighton Electronics
 Micro Aids Electronics
 British Amateur Electronics Club
 Assn of London Computer Clubs
 Thames Valley Electronics
 Marco Trading
 Electronics & Computing Monthly
 SGS Electronics
 Expo Drill Company

and many more.





labelling thus: IC6a to IC1c, IC6b to IC1d, IC6e to IC1e, IC12a to IC12b, IC1c to IC12c, IC1d to IC12a, IC1e to IC12b, IC1f to IC12c, IC14a to IC4b, IC2b to IC17b. IC14 and IC75 are not used in the new numbering. R26 is not needed in the PAL circuit, but the modulator needs a 10k pull-up to +5 V, so we've called this R26. IC60b clock goes to 0 V, IC60b SET goes to SYNC.



Construction

The main board and the keyboard both have plated-through PCBs, ie there are tracks on both sides and connections between the sides are made by the copper that has been plated onto the sides of each hole. There are therefore no track-link pins; it is, however, good practice to apply solder to EVERY hole to reinforce the connections which in some cases carry power. This happens automatically when boards are 'flow soldered' by passing over a wave of solder in a solder bath during factory assembly. With plated-through boards it is particularly important not to make errors of construction as removal of soldered-in parts is more difficult than on conventional boards and

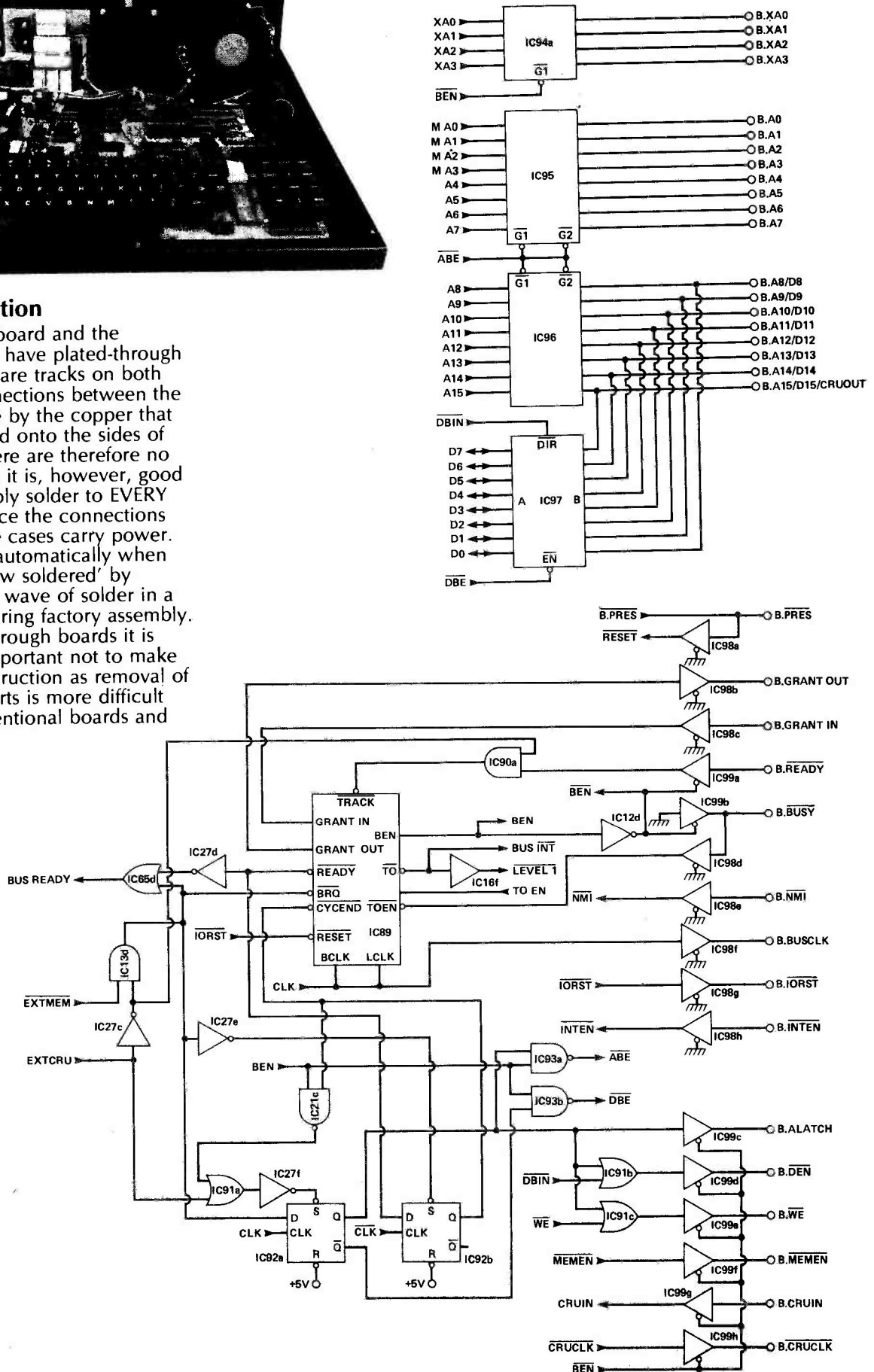


Fig. 5 Circuit diagram for the E-BUS interface.

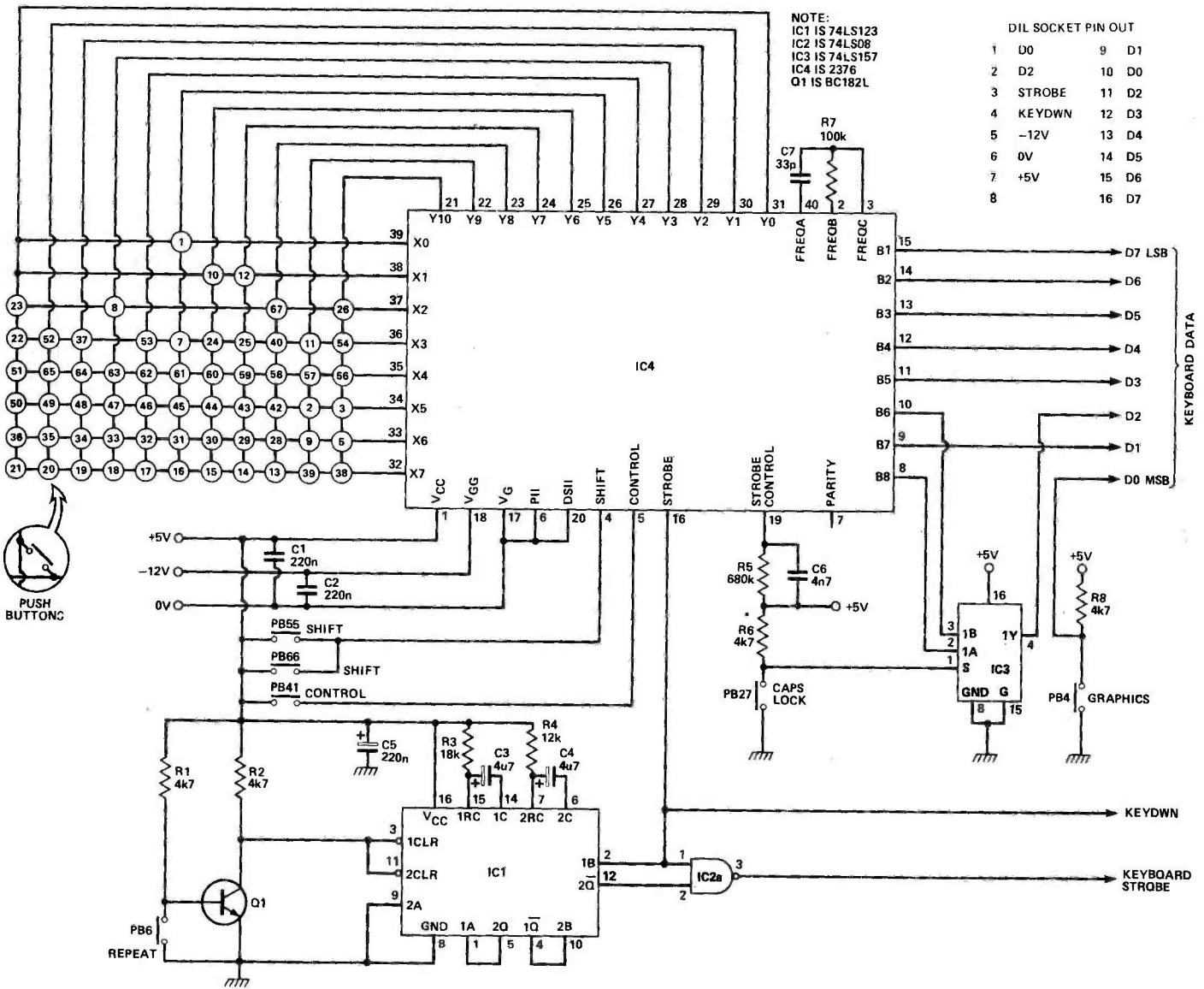


Fig. 6 Circuit diagram for the keyboard.

HOW IT WORKS — E-BUS

The E-BUS is a powerful and compact bus which allows many intelligent cards to share a common resource of memory and I/O cards. In order to share out the resources on the bus, each card has a priority according to its position. This is done by passing a signal down the bus which goes into each card as GRANTIN and comes out as GRANTOUT to form the GRANTIN of the next card. A second signal, BUSY, tells each card if the bus is in use or free. If the bus is free and a card requires the bus, it disables the lower priority cards with the GRANTOUT signal and if the GRANTIN signal and BUSY are OK it asserts BUSY and enables its data and address bus buffers.

Once the bus transfers are complete or if a higher priority card requires the bus, then the card will relinquish control. All these events are synchronised by a backplane clock, BUSCLK. Each data transfer that takes place must signal its completion using READY.

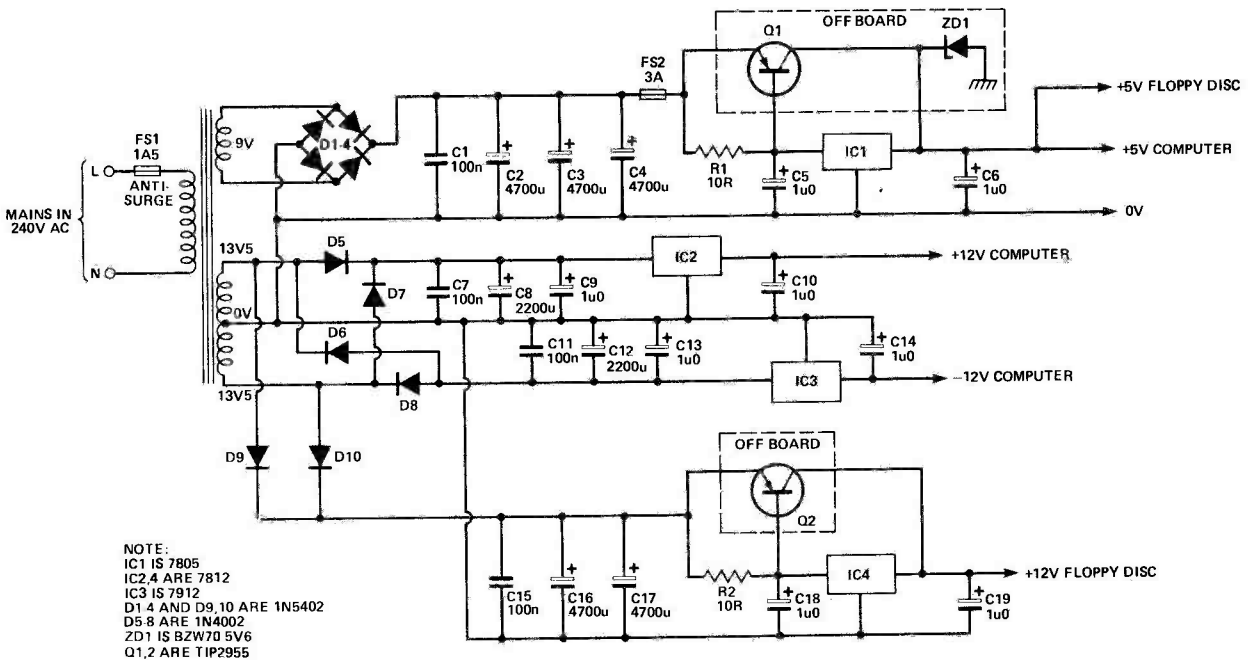
The 74LS2001 gate array (IC89) contains the bus arbitration and control logic to gain and release the bus with timeouts upon error conditions. If the card cannot gain control of the bus after 128 clock cycles, it aborts with a timeout interrupt. Also, if after 16 clock cycles the transfer has not been signalled as complete using the READY line, the controller completes and issues a timeout interrupt.

The E-BUS has provision for a multibit interrupt code signalled by the INTEN signal. This interface only provides a single interrupt level using the INTEN signal. The data, address and interrupt signal are multiplexed onto the same pins to conserve connections. The ALATCH signal is used to enable the address latches when the address is on the bus. Then either DEN or WE will be signalled, to show that either a data read or write is occurring and that data is now on the bus. The INTEN signal can be used to latch the interrupt code.

KEYBOARD

The keyboard is a separate unit providing a fully encoded output. Most of the work is carried out by the 2376 keyboard encoder (IC4). This IC contains a 50 kHz oscillator and two ring counters of eight and 11 stages, the outputs of which form an XY matrix across which the switches are connected. By this means each key is sequentially scanned. The closing of one of the switches for a sufficient length of time for switch bounce to be completed causes the scanning to stop; a 'valid' signal now appears on the strobe output. The encoder also contains a 2376-bit ROM (hence the IC name) arranged as three groups of 88 words of nine bits. The shift and control inputs select one of the three groups and the individual word is addressed by the ring counters.

IC3 is a data selector. D2 is either the output B6 or B8 depending on whether upper or lower case characters are selected by the CAPS LOCK switch. Repeated entry of a character is accomplished by multiple strobe signals from IC1, which is a dual monostable arranged as an oscillator and is enabled by a high level on the clear inputs.



NOTE:
 IC1 IS 7805
 IC2,4 ARE 7812
 IC3 IS 7912
 D1,4 AND D9,10 ARE 1N5402
 D5-8 ARE 1N4002
 ZD1 IS BZW70 5V6
 Q1,2 ARE TIP2955

Fig. 7 Circuit diagram for the power supply.

the chances of this being required are much reduced by fitting ALL parts before soldering — if the last part left for fitting is not the one required for the last space you can be pretty sure that the required part is in the wrong holes! IC sockets should be regarded as essential; these are provided with the kits and should be fitted with the index mark corresponding with the index mark on the overlay.

The final part appears next month.

HOW IT WORKS — PSU

The computer main board and keyboard together require a 5 V at 3 A supply, together with low current ± 12 V rails. One amp plastic voltage regulators on small finned heatsinks are used for the 12 V supplies; for the 5 V supply a 1 A regulator is also used but the current-carrying capacity is boosted by bypassing it with a 15 A power transistor, the base current of which passes through the regulator. R1 prevents the off-load input current of the regulator from turning on the transistor when there is no load during testing. The resistor also increases the

speed of operation of the transistor. The 1uF capacitors are for the stability of the regulator and the 100nF capacitors are used to remove fast transients originating from the mains. The zener will clamp any spikes that reach the output.

To simplify the addition of floppy discs these are powered from the same board. The drivers require about 0A7 at 5 V which is also supplied by Q1; they also require +12 V at 1A6 with higher surges at switch-on, and this is provided by a separate section using Q2 controlled by IC4.

PARTS LIST — MAIN BOARD

Resistors (all $\frac{1}{4}$ W, 5% except where stated)

R1,2	470R
R3-5,11,32	4k7
R6-8,20,21,28,37,41,45	330R
R9,12,13,15,39,40,46,52,55,61,69	10k
R10,14,47,58,63	100R
R16-19	560R
R22	120k
R23,24,31,36	1k0
R25,29,33	2k7
R27	390R
R30	1k5
R34	1k8
R35,60	2k2
R38,53,54	100k
R42	6k8
R43	3k9
R44	39k
R48-50	8k2
R51	1M0
R56,59,68	4k7 resistor array
R57	22k
R62	27k
R64-67,71	150R resistor array
R70	18k

Capacitors

C1	1n0 ceramic
C2	4u7 16 V PCB electrolytic
C3,25,26	10u 16 V PCB electrolytic

C4-6,9,10,17	100n ceramic
C7	470n ceramic
C8	33u 16 V PCB electrolytic
C11,12,16	33p ceramic
C14	47p ceramic
C15,18,27	22u 16 V PCB electrolytic
C19	100p ceramic
C20	22n ceramic
C21,23	10n ceramic
C22	330n ceramic
C24	5n6 ceramic
C28	100u 16 V PCB electrolytic
C29	330p ceramic
CV1	6-30p trimmer

Semiconductors

IC1,6,12,27,81	74LS04
IC2,17,18,61,69,88,92	74LS74
IC3	74LS86
IC4,21,31,93	74LS00
IC5,22,30	74LS02
IC7,24	74LS10
IC8	TMS9911
IC9,10,84,94-96,98,99	74LS244
IC11	TMS9995
IC13,77,90	74LS08
IC15,34,35	74LS138
IC16,66,80,82,83	74LS07
IC19	74LS164
IC20,79	LM339

IC23	74LS20
IC25,65,78,91	74LS32
IC26	74LS612
IC28,29	74LS27
IC32	TMS4500
IC33,85	74LS139
IC36-43	TMS4164
IC44,97	74LS245
IC45-47	TMS2564
IC48	TMS9929
IC49-56	TMS4116
IC57,58	4016B
IC59	LM1889
IC60	4013
IC62,63	74LS251
IC64	74LS259
IC67,68	TMS9902
IC70	74LS123
IC71	75189A
IC72	TL084
IC73	74LS73
IC74	75188
IC76	TMS9909
IC86	74LS297
IC87	74LS163
IC89	74LS2001
Q1,3,4	2N3904
Q2,5	2N3906
Q6	BC212
D1-4	1N4148
LED1-4	LEDs to choice

Miscellaneous

PCB (see Buylines); case (see Buylines); IC sockets; I/O connectors to suit; UHF modulator (UM1233 or UM1286).

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full technical manual **£20.00** alone **£9.00** with drive, refund of difference on purchase of drive.
SHUGART s/h 800-2 8" Drive's 110v 50Hz motor **£160** + £9.50 carr.
Removed from working equipment but untested. SA120 Alignment disk's **£9.95**

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DT10 Monitor a complete **MOTOROLA 9"** video monitor housed in an attractive metal case DIM approx 10" deep 16" wide and 11" high. The monitor has a 75 ohm composite video input with a bandwidth of 18 mhz. A separate internal PSU delivers 5v dc for external use and 12v DC for video monitor. The case has sufficient room inside for mounting other units such as 5" disk drives etc. Internal pots give full control over all monitor functions. Supplied in a tested, as new or little used condition. 240v AC operation **£55.00** Carriage and Insurance **£10.50**.
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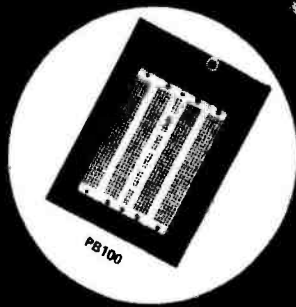
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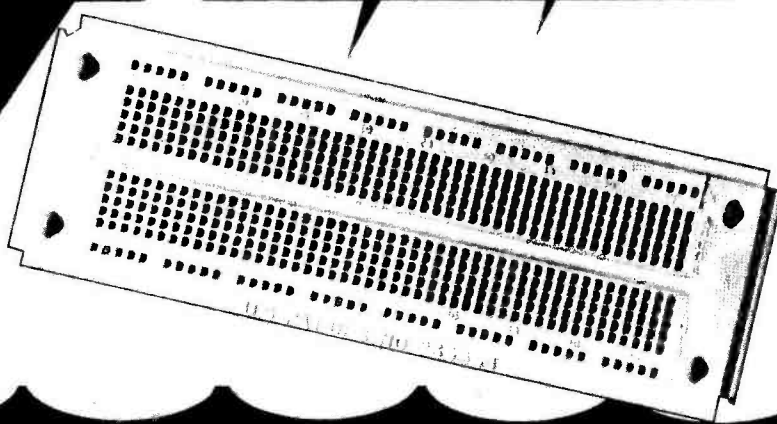
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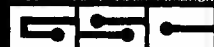
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SPECTRACOLUMN

With this project we throw some light on the problem of how to jazz up your disco or party. This cost-effective, crammed-with-everything light column can be used singly or in groups to dazzle the dancefloor. Design by Rory Holmes.

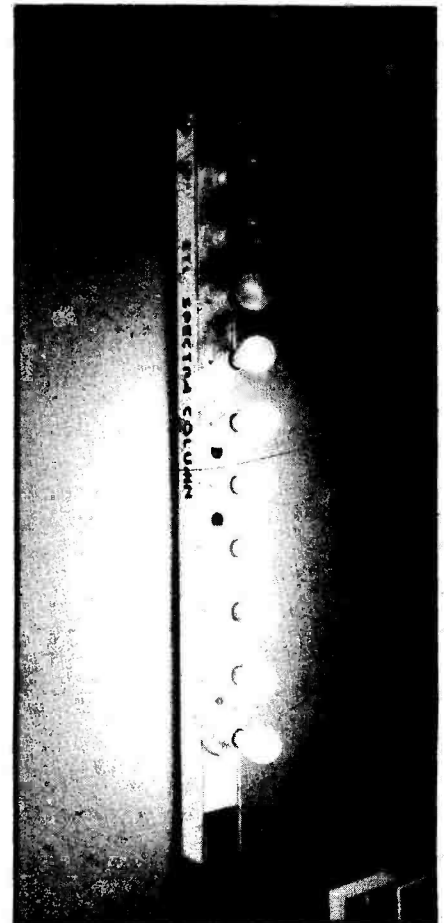
The ETI Spectracolumn is an up-market sound-to-light system; by this we mean its lighting effect is a cut above the average 'three bulb' systems, although its cost is not. Ten mains bulbs, arranged in a column, respond to the intensity of music (or any sound signal) within a pre-selected frequency range. It works like a giant bargraph voltmeter; the more energy in the chosen frequency band the more bulbs will illuminate, forming a column of light that rises up from the floor and follows the rhythm of the music. The display system is very versatile; it can be built with any type of bulb in any configuration, and may be expanded for large parties or discos. Multiple columns can be set to adjacent frequency bands to build into a giant spectrum analyser and display system. Imagine — a kilowatt light column devoted to each octave across the whole audio spectrum!

In designing the band-pass filter system we have made use of the latest switched capacitor filter IC, the MF10. This device contains two second order filters whose cut-off frequencies are directly controlled by a square-wave clock input. Clock frequency control removes the constraint of having to use high tolerance filter network components

and the associated difficulty of altering the filter frequency. The clock, and thus the filter frequency, can be set from a logic divider chain to provide any frequency in octave increments. We have configured the MF10 as a low-pass filter in cascade with a high-pass filter to allow complete control of the filter band. The upper and lower frequency limits may be set independently under logic control using rotary switches. There is no setting up or filter tuning required and the entire range of octaves is implemented with very few components.

On The Circuit

With the price of modern triacs and some economical design work from ETI, what seems to be a complex system in fact turns out to have only about £18-worth of parts (less the PCB and lightbulbs). Since the triacs don't need heatsinking, we adopted the 'let's get it all on one board' philosophy, and did exactly that. Even the small crystal mike that picks up the audio signal is mounted on the PCB to provide complete isolation between the sound equipment and the mains. Mounting a single board directly with all the bulbs in the column housing also removes the inconvenient cables that often make



Ten white light-bulbs, hanging on a wall . . .

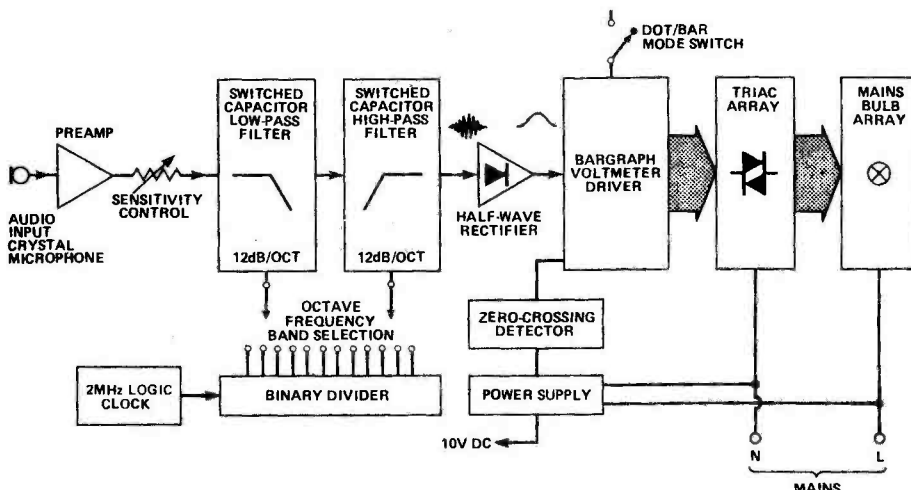


Fig. 1 Block diagram of the Spectracolumn.

FEATURES

- Drives 10 100W bulbs in bargraph or dot display
- Zero-crossing switching gives RFI elimination
- Logarithmically proportional display to correspond with music volume
- Independent high-pass and low-pass filters, 12 dB per octave
- Digitally-controlled switched capacitor filters eliminate setting up
- Pass band switchable in octave increments over 10 octaves anywhere in the audio spectrum
- Internal crystal mike gives complete isolation from sound equipment
- All parts on one PCB powered directly from the mains.

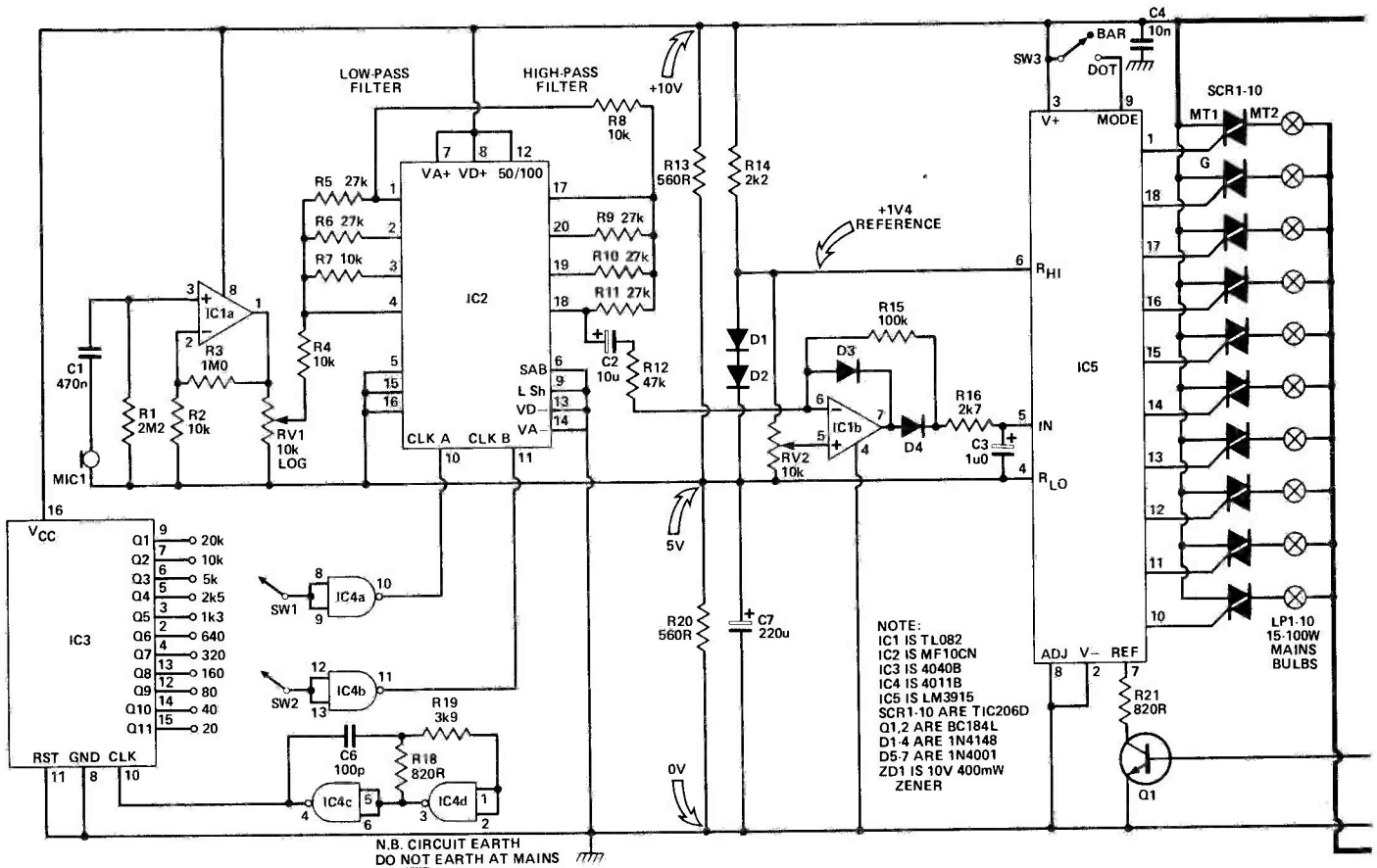


Fig. 2 Circuit diagram for the complete Spectracolumn.

TABLE 1

FREQUENCY (Hz)			
DIVIDER OUTPUTS	DIVIDED CLOCK	RESULTING FILTER F _C	STANDARD CENTRE
Q ₁ (+2)	1M	20k	
Q ₂ (+4)	500k	10k	16k
Q ₃ (+8)	250k	5k	8k
Q ₄ (+16)	125k	2k5	4k
Q ₅ (+32)	62k5	1k25	2k
Q ₆ (+64)	31k2	625	1k
Q ₇ (+128)	15k6	312	500
Q ₈ (+256)	7k8	156	250
Q ₉ (+512)	3k9	78	128
Q ₁₀ (+1024)	1k9	39	64
Q ₁₁ (+2048)	980	20	32

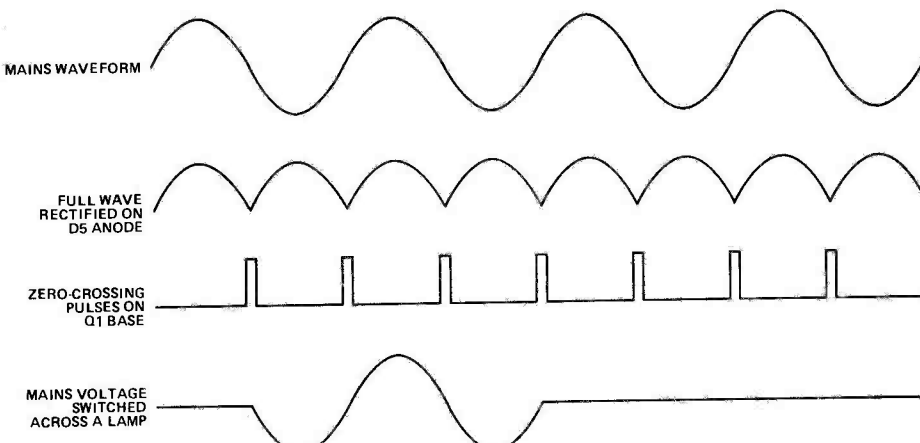


Fig. 3 Triac zero-crossing switching waveforms.

the dancefloor a dangerous place to negotiate. Finally, the design features zero-crossing triac control, so your sound equipment won't be plagued with RFI.

Using the system couldn't be easier; just plug it into the mains and switch on! No other connections are needed, because the internal mike picks up the music signal. The sensitivity control is turned up as required for the sound level, and a 'background' control is available which moves the illumination 'baseline' up or down the column, so increasing or decreasing the amount of light. With no sound it acts as a giant dimmer control.

The display could be hung on the wall, as we did for our photograph, or stood vertically on the floor. Large sheets of 'cinemoid' acetate (available from most good art shops) may be wrapped around the entire column to provide a coloured tube, which also tones down the display. But keep the plastic well away from the light bulbs!

The alternative is to use coloured bulbs. A three column system, using red, green, and blue for the bass, middle, and treble ranges would be an ideal starting system for most disco light shows. The filters could, for example, be

nut and bolt are used to clamp the metal tab to the PCB. The bolt protrudes above the component side and a further washer and nut can be added to create a screw terminal. When all the triacs are bolted in place their leadout wires should be soldered and cropped as normal. The lamp wires will be retained on the screw terminals using solder tags.

The PCB-mounting transformer has been used simply for convenience and should be soldered in as a normal component. Other types could also be used provided they are connected to the PCB pads as per the circuit diagram. Bolts should also be fitted, in the same manner as the triacs, to make screw terminals on the pads marked for the mains connections. The photographs of our completed PCB show these terminal connections.

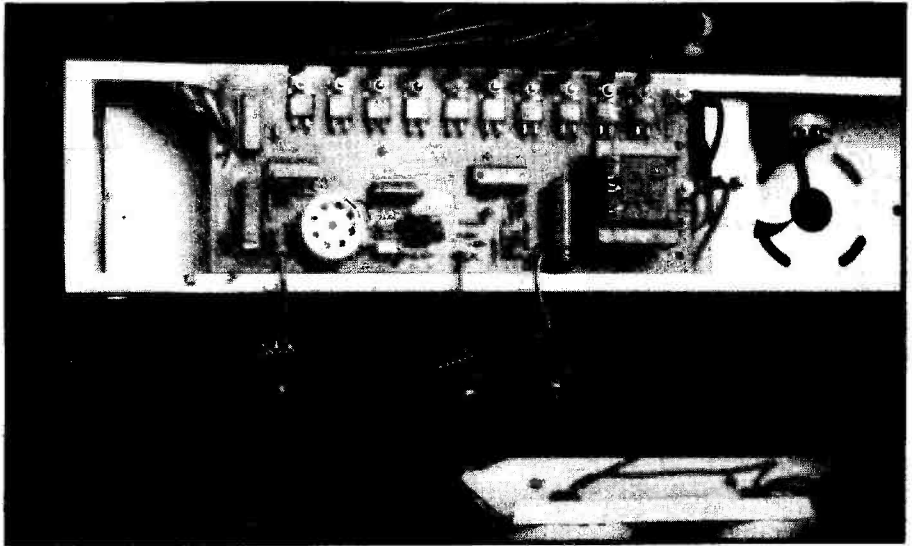
Our crystal microphone insert was 23 mm in diameter; it should be mounted last. The metal screening case of the insert is connected internally to one of its terminals. This screen terminal should be identified (use an ohmmeter) and wired to the mid-rail reference as shown on the overlay; ensure that the wire used is very thin and flexible. A piece of sponge foam about the size of the mike should be stuck to the PCB and the mike may then be glued on top of this to provide a resilient mounting, free from direct vibration pickup.

An electret condenser type of mike insert could also be used and would probably give better quality sound pickup. They usually come with their own internal FET preamplifier, which requires a 1V5 power supply. Luckily, the 1V4 reference terminal indicated on the overlay is ideal for this job, and may be wired directly to the insert.

When the board is completely assembled the two control pots and the mode switch can then be wired up as indicated. Veropins should be inserted as terminals at the appropriate points. The two rotary switches for the frequency selection should also be wired up using ribbon cable as shown in the diagram. Note that the rotary

BUYLINES

All of the electronic components, including the hard-to-find MF10, are available from Rapid Electronics, Hill Farm Industrial Estate, Boxted, Colchester, Essex CO4 5RD. The fluorescent fitting, bulbs and holders will be available from any electrical store, while the order form for the PCB Service can be found on page 99.



With the front panel removed, you can see the single PCB we employed. All the pots and switches are mounted on the sides.

switches are both set to select one out of 10 corner frequency outputs from the PCB and the rotary switches are offset by one frequency band relative to each other: ie the upper limit switch ranges from 40 Hz to 20 kHz while the lower limit ranges from 20 Hz to 10 kHz.

Testing And Setting Up

After wiring up the controls some initial tests can be made before completing the assembly. Initially, do not connect any light bulbs and do not plug in any ICs; but do remember that all parts of the circuit are effectively live. Connect the mains as shown via a double pole toggle switch and a 5 amp fuse, and then switch on. Using a voltmeter check that there is about 10 V across C5 and 5 V across C7. 10 V should also appear across pins 8 and 4 of IC1, pins 8 and 13 of IC2, pins 16 and 8 of IC3, pins 14 and 7 of IC4 and pins 3 and 2 of IC5. If all is well, unplug from the mains and insert all the ICs. One light bulb can now be wired onto the SCR5 terminal, its other lead returning to mains live. Set the upper limit switch to 5 kHz, and the lower limit to 640 Hz; this gives a fairly broad frequency band for vocal testing. The unit should be turned on again with SW3 set in bar mode. Altering the background control RV2 should cause the bulb to switch on and off at some point. As the bulb switches off continue to turn RV2 in the same direction to the end of its travel. The background illumination control is then at its zero setting. Now, depending on the sensitivity setting, a loud noise should re-illuminate the bulb. Increasing the sensitivity control should eventually allow the bulb to come on with normal speech volume. If this test works

PARTS LIST

Resistors (all 1/4W, 5%)

R1	2M2
R2, 4, 8, 22, 23	10k
R3	1M0
R5-7, 9-11	27k
R12	47k
R13, 20	560R
R14	2k2
R15	100k
R16	2k7
R17	22R
R18, 21	820R
R19	3k9
R24	6k8

Potentiometers

RV1, 2	10k logarithmic
--------	-----------------

Capacitors

C1	470n polycarbonate
C2	10u 16 V tantalum
C3	1u0 35 V tantalum
C4	10n ceramic
C5	1000u 25 V axial electrolytic
C6	100p polystyrene
C7	220u 16 V axial electrolytic

Semiconductors

IC1	TL082
IC2	MF10CN
IC3	4040B
IC4	4011B
IC5	LM3915
Q1, 2	BC184L
SCR1-10	TIC206D
D1-4	1N4148
D5-7	1N4001
ZD1	10 V 400 mW zener

Miscellaneous

SW1, 2	1-pole 12-way rotary switch
SW3	SPST toggle switch
SW4	DPST mains-rated toggle switch (250 V, 5 A)
MIC1	crystal mike insert
T1	9-0-9 3 VA mains transformer (PCB-mounting; see Buylines)
FS1	5 A fuse and fuseholder
PCB (see Buylines); 10 mains bulbs, 15-100 W, and holders; fluorescent lamp fitting (no tube required).	

PROJECT: Spectracolumn

satisfactorily then all the bulbs can be wired up to their corresponding terminal posts and the entire display can be tested.

Turning the background control up should result in the successive illumination of bulbs; now turn it down to zero, when all the bulbs should be off. Increasing the sensitivity control will now allow sound to illuminate all the bulbs. Having established a good sensitivity setting, different types of music from a record deck or radio can be used to check the different frequency bands available on the rotary switches. The display can be

switched to dot mode at any time, which provides an interesting effect with constant light level.

A Case In Point

The actual hardware construction of the light bulb arrangement is very much a matter of personal choice. We used large white plastic bulb holders, and mounted the entire column and PCB in a fluorescent light case that was to hand. The case was earthed and provided a nice self-contained unit. Batten-mounting bulb holders could equally well be screwed down to a long strip of wood and

the electronics mounted in a separate diecast box. The photographs illustrate the construction method we used.

A number of important points should be noted with the final assembly. Owing to the circuitry used, the positive rail is directly connected to the mains neutral; therefore all parts of the circuit should be treated as being effectively **live** since somebody could easily swap the mains and neutral leads by accident at the mains plug end. Consequently we suggest:

- The PCB should be mounted in a metal case on insulating pillars or blocks.
- The case should be earthed to the mains but there should be no other connection between the PCB and the case. Circuit ground **must not** connect to mains earth.
- The mode switch and on-off switch should both be 250 V mains rated and have a current rating sufficient for the total power of the bulbs used.
- The pots and rotary switches should all have plastic spindles and plastic knobs. Ideally the metal pot cases should be insulated from the chassis, or they could be soldered directly to the PCB terminals such that only the plastic spindles pass through the chassis.
- For the reasons of mains isolation the microphone must stay inside the

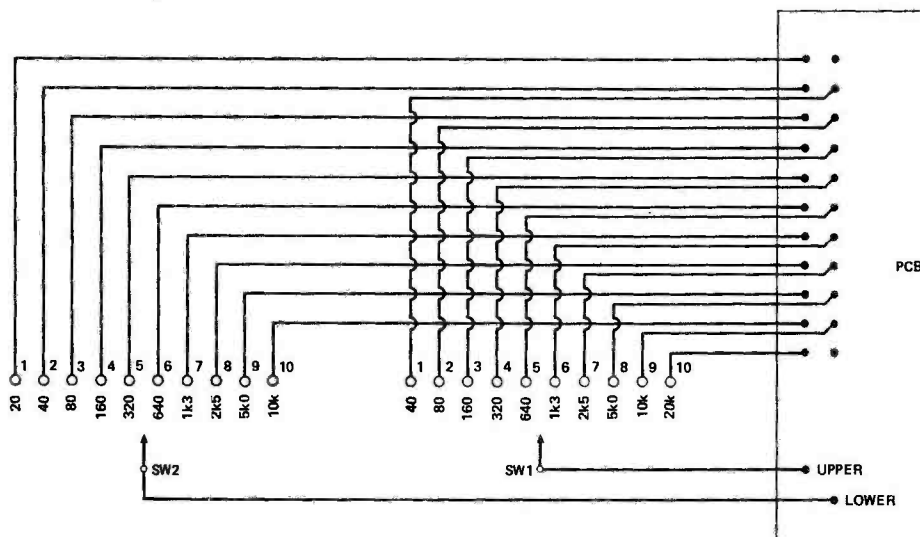


Fig. 4 This diagram shows how to wire up SW1 and SW2.

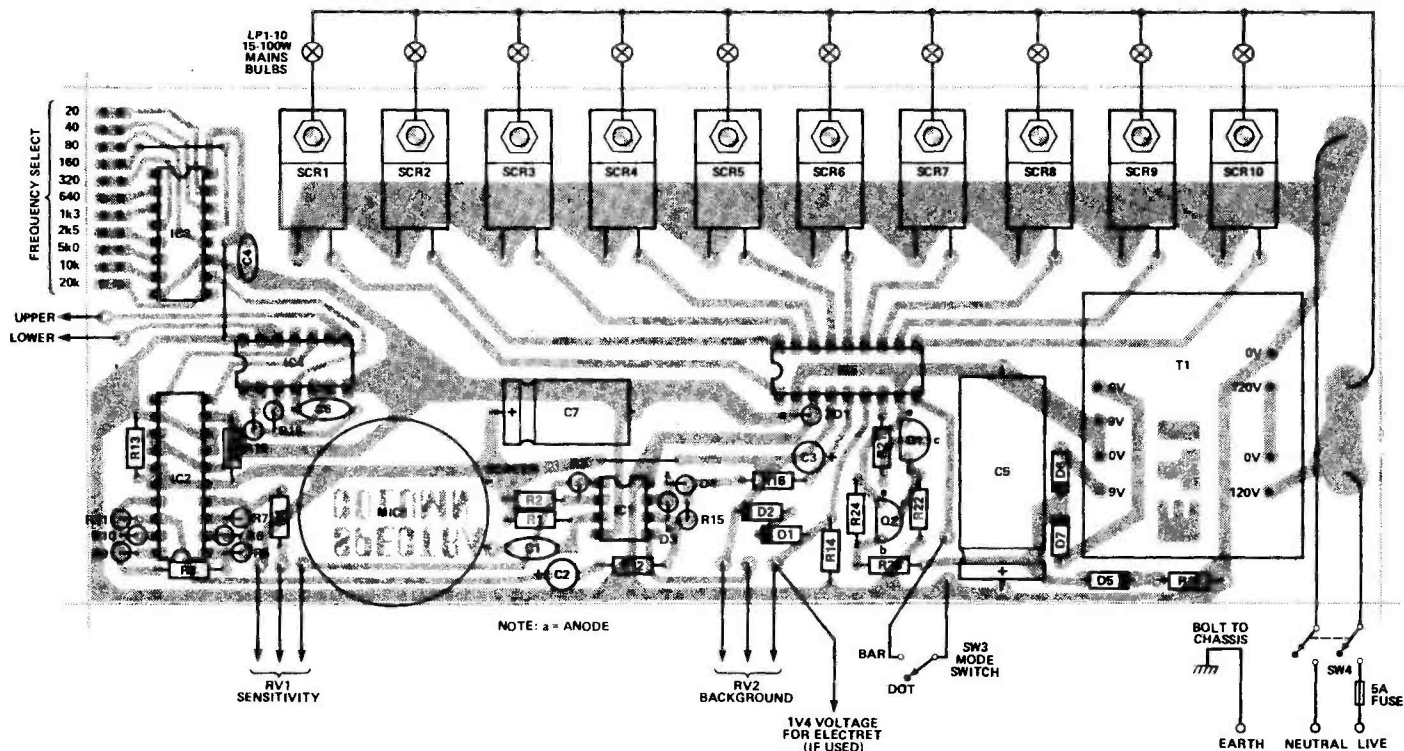


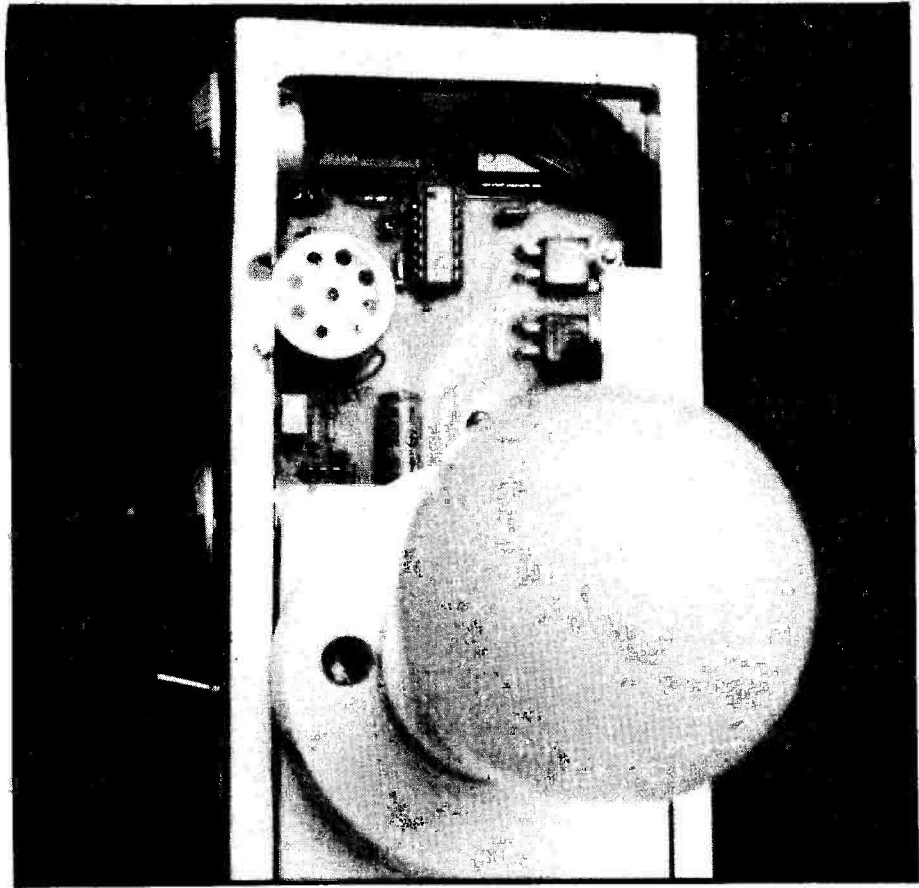
Fig. 5 Component overlay for the Spectracolumn. Use spade connectors for the triac and mains connections.

case; and on no account try to connect up the mike input to a direct audio signal from your sound equipment (this could be done **only** with an audio isolating transformer).

Notes On Modifications

For those with the urge to experiment here are some notes on modifying circuit values: R3 decreases the mike preamplifier gain; decreasing R4 and R8 increases the filter gain; increasing R6 and R10 will increase the Q of the filters; R18 alters the frequency of the master clock, currently set at 2 MHz; R21 determines the drive current to the triacs; increase C3 or R16 to increase the attack/decay display time constant; R16 could be a 22k variable pot.

This close-up of the business end of the Spectracolumn shows how we cut away part of the front panel of the fluorescent fitting to allow sounds to reach the crystal mike insert. A cover can be built using speaker cloth and a stiff card frame, as shown in the photograph on the first page of this article.



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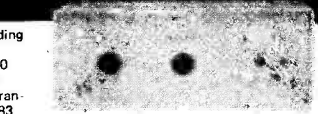
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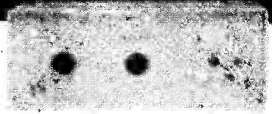
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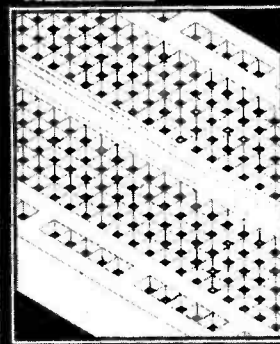


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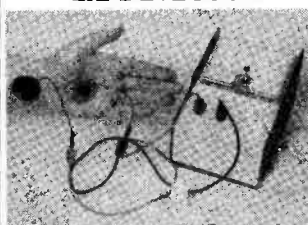
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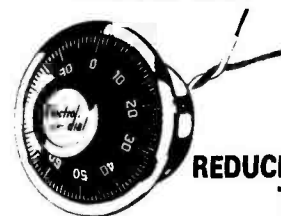
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The timebase is a circuit which generates a sawtooth waveform, one whose voltage changes linearly with time: a graph of voltage plotted against time will be as shown in Fig. 1 (though it may be either positive-going or negative-going). The best-known application is in oscilloscope timebases, but the circuit can also find use in digital-analogue converters and in timing circuits.

The most simple timing circuit is, of course, a capacitor charging through a resistor (Fig. 2). The time constant CR determines the total charging time which, though theoretically infinite, is in practice about four or five times the length of the time constant. The graph shape of voltage plotted against time is, however, exponential rather than linear because the charging current drops as the capacitor charges. All timebases of the capacitor-charging type therefore need some method of keeping the charging current constant as the voltage across the capacitor rises.

Transistor Control

In the days of valves, many elaborate circuits were devised to overcome the problem of constant current control, but it took the development of the transistor to come up with a really simple system with good perform-

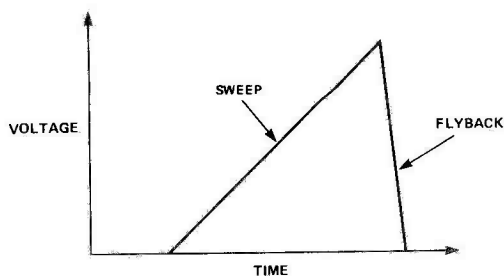


Fig. 1 The waveform of a perfect timebase — this should be a straight line.

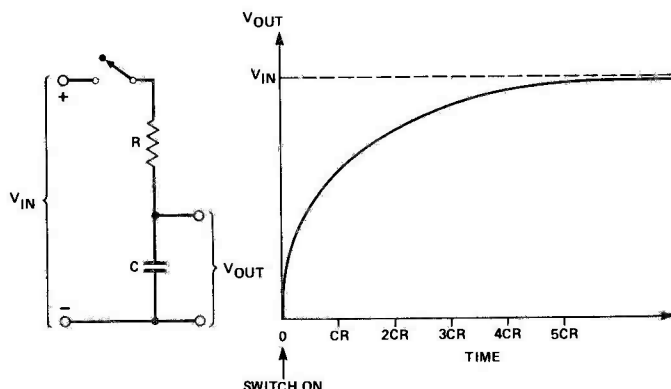


Fig. 2 Capacitor charging. When a capacitor is charged through a resistor the waveform is an exponential rather than a straight line.

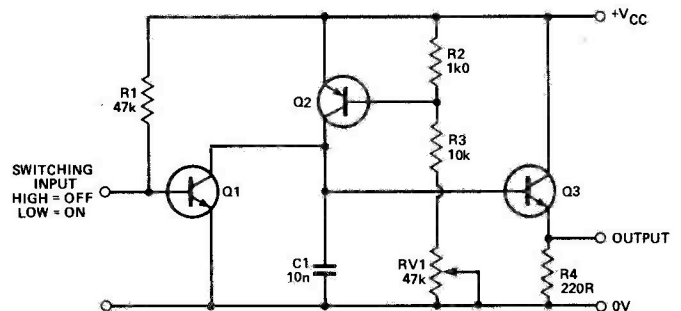


Fig. 3 Using a transistor in place of a resistor for capacitor charging. Since the current through the transistor remains constant, the sweep waveform is straight rather than exponential.

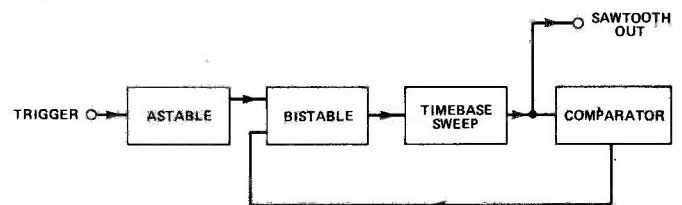


Fig. 4 Block diagram of an oscilloscope timebase.

ance. A transistor whose base-emitter junction passes a constant current will also pass a (larger) constant current between its collector and its emitter, and this current can be maintained up to the level where the collector voltage is less than half a volt different from the emitter voltage.

Figure 3 shows a simple timebase circuit using this principle. Q1 is a switching transistor which is normally conducting, keeping the voltage across the capacitor low. Q2 is a PNP transistor whose base current is set by the resistor chain R2, R3, RV1, and which can be varied by altering the value of RV1. Since the base current is constant, the collector current will also be constant. Q3 is simply an emitter-follower to avoid non-linear effects which would be caused by a resistive load connected across the charging capacitor (since a resistance takes more current as the voltage across it is increased). For best results, Q3 should be a transistor with a high h_{fe} value, and a double emitter-follower is often preferable to ensure the highest possible input resistance.

The action is as follows. When Q1 is cut off by a negative pulse at its base, capacitor C1 can be charged by current flowing through Q2. This current will not change until the collector voltage of Q2 has reached a value close to the positive supply voltage, so that the wave form is linear up to this region. If Q1 remains cut off, the waveform will then flatten off, but if Q1 is switched on again before this point is reached, then a good sawtooth shape is preserved.

Timing The Timebase

The action depends to a large extent on switching the transistor Q1 at the correct times, and all timebases consist

basically of two sections — a square wave generator which handles the switching and a sawtooth generator which provides the desired waveform. An oscilloscope timebase would use a level-detecting circuit at the output to ensure that the switching transistor Q1 was switched off before the voltage level at the output reached the non-linear region — a block diagram with waveforms is shown in Fig. 4. In this arrangement, the repetition rate of the timebase is determined by an astable which provides a trigger pulse. The trigger pulse sets the bistable, which in turn cuts off the switching transistor of the timebase generator and so starts the charging of the capacitor. When the charging has reached some preset voltage level, the level detector (comparator) circuit switches the bistable back, so discharging the capacitor ready for another sweep. For many oscilloscope purposes, the astable is set to run freely at a low speed, and is synchronised to whatever waveform is to be displayed — this is the auto timebase system found on most modern oscilloscopes. The sweep speed is then determined by the time constant of the charging capacitor.

The use of a transistor as a constant current device for a timebase is good enough for many purposes, but two other methods of creating linear sweep waveforms from the basic capacitor charging circuit have been well established for many decades in oscilloscope circuitry. One of these is the bootstrap circuit. Bootstrapping is positive feedback applied over a circuit in which the gain is less than unity, so that it does not cause oscillation.

By His Bootstraps

The principle of the bootstrap is shown in Fig. 5. A capacitor is charged through two series resistors, and a unity-gain amplifier is connected so that the voltage across the capacitor can be applied, in phase but with its DC level shifted, to the point where the resistors join. When the capacitor starts to charge, the increase of voltage across the capacitor causes a matching increase of voltage across R2, so that the voltage across R2 has not changed in this time. Since the voltage across R2 is constant, the current through R2 is also constant, which is the condition for a linear sweep.

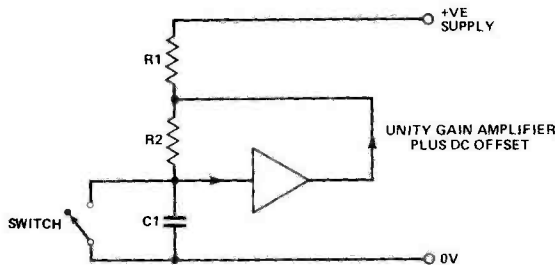


Fig. 5 The principle of the bootstrap timebase circuit.

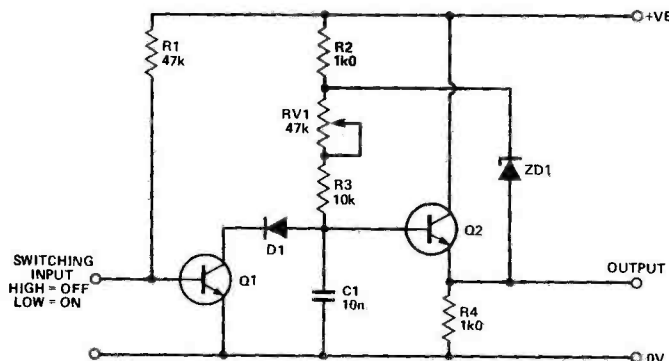


Fig. 6 A practical form of the bootstrap circuit, using an emitter-follower as the unity-gain amplifier.

The bootstrap depends on being able to keep the voltage at the junction of the resistors at a constant amount greater than the voltage across the capacitor. The whole idea seemed so absurd when it was first proposed that the (US) inventor remarked that it seemed "rather like lifting yourself by your own bootstraps". As so often happens, the name stuck.

A practical form of the timebase is shown in Fig. 6. Q1 is, as before, the switching transistor which starts and stops the sweep. The charging resistor chain consists of R2, R3 and RV1, of which R3 is a limiting resistor whose value is set so that excessive current does not flow through Q1 when the variable is set at its minimum value. D1 is used to prevent C1 from discharging below about 0V7, so ensuring that Q2 will not switch off, causing non-linearity. If Q2 is allowed to switch off, then the timebase output will have a decided 'kink' at the voltage at which Q2 switches on.

Q2 is an emitter-follower, whose emitter is connected through a zener diode ZD1 to the junction of R2 and R3. The zener diode, along with the base-emitter voltage drop of Q2 determines the voltage across R3 and RV1, so that the charging rate can be calculated. For example, suppose the voltage is 6 V, the values of RV1 and R3 add to 56k and C1 is 22nF. The charging current I is 6/56 mA, which is 0.107 mA, and the rate of change of voltage across C1 is I/C1. Using units of milliamps and nanofarads, the rate of rise of voltage will be in volts/microsecond, and the example gives 0.00486, equivalent to 4.86 volts per millisecond. If you know the sensitivity figure for the cathode ray tube for which the timebase is to be used (in terms of centimetres of deflection per volt), then you can calculate what amount of amplification will be needed to obtain full screen coverage, and what time constants will be needed for the various scan speeds.

There are limitations on the voltage gain of the emitter follower and the frequency range over which the zener diode remains effective, but with suitable choice of components, good timebase circuits can be designed around this core configuration. Commercial circuits of this type often look remarkably complicated, but once the bootstrap section is separated from the other parts of the complete timebase (the triggering and the comparator sections), the essential simplicity of the circuit can be seen.

The Miller Alternative

The other basic capacitor charging circuit is the Miller integrator. These two circuits, the bootstrap and the Miller, were curiously polarised for many years, with the bootstrap used on US equipment and the Miller on UK equipment almost exclusively. This is no longer completely true, but though you will see bootstrap timebases appearing on equipment designed in this country, you will even now seldom see a Miller timebase used on the other side of the pond.

The Miller timebase is named after (yes, got it!) Miller, who discovered the result of negative feedback across the anode-grid capacitance of triode valves. The name became attached to the timebase (which was not designed by Miller) because the Miller timebase makes deliberate use of such feedback to achieve linearity. The basic circuit is shown in Fig. 7, and the most startling thing about it is its simplicity, because the switching transistor is also the current regulator! If we imagine the transistor starting cut-off, then a square wave applied to the input will raise the base voltage until the transistor starts to conduct. When conduction starts, however, the collector voltage will drop, and the negative feedback through C1 will prevent the base voltage from rising to the level of the input voltage. Once this has happened, the base voltage can rise

FEATURE: Configurations

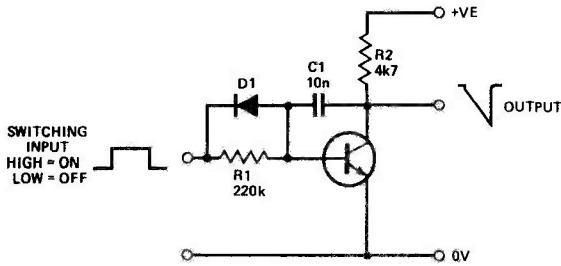


Fig. 7 The basic Miller timebase circuit.

only as fast as the capacitor C1 can be discharged, and the discharge is at a steady rate because of the negative feedback.

The time constant for the Miller integrator is given by the value of R1 and C1 rather than R2 and C1 as you might expect, and the conventional use of the circuit as shown here produces a timebase waveform which is negative-going, with a small 'step', as shown in Fig. 8, just at the point where the transistor switches on.

The circuit will operate in the opposite direction, when the 'free' end of R1 is at ground potential. In this case, the voltage at the transistor's collector rises just quickly enough to keep sufficient current flowing into its base (and also R1) to keep it on. In both cases, the simplest way to achieve the fly-back is to connect a diode, D1, in parallel with R1. For operation in the opposite direction from that first described, the direction of the diode must be reversed.

More elaborate versions of the Miller use two stages of amplification with the output in phase, and a low-impedance stage driving the capacitor. Very good results can be obtained, and with a wide-band op-amp used in place of a transistor, excellent timebase linearity is possible.

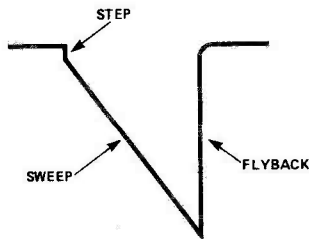


Fig. 8 The waveform from the simple Miller circuit.

Before we leave the subject, timebases can also make use of the growth of current through an inductor. The effect that is used here is the inductive equivalent of capacitor charging, and it is useful because if the inductor is also a deflection coil for a cathode-ray tube, then the timebase and deflection system can be combined. Linearity is much less easy to achieve, however, and one method is the use of a saturable reactor in series with the inductor which carries out the timebase action. The inductance of a saturable reactor will vary with the amount of voltage across it in order to keep the current constant. Using this and other components, it is possible to balance out the worst of the non-linearity of the charging process. For truly linear timebases, however, the capacitor charging circuits which we have described in this article are considerably superior to inductive timebases. No-one watching TV seems to care too much if the characters are very slightly fatter on the right hand side of the screen than on the left, but we need to know the truth from our oscilloscopes!

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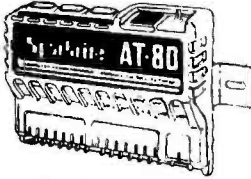
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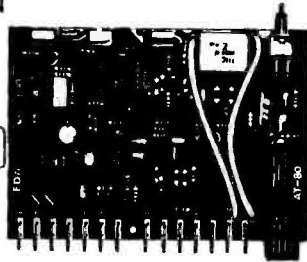
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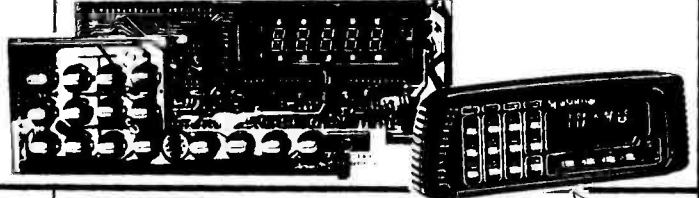
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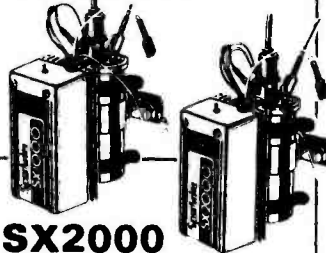
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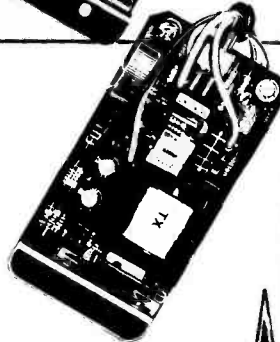
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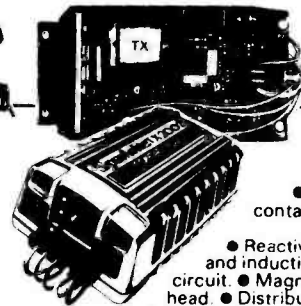
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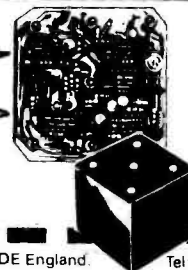


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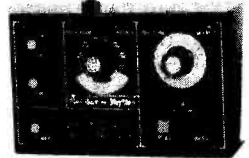
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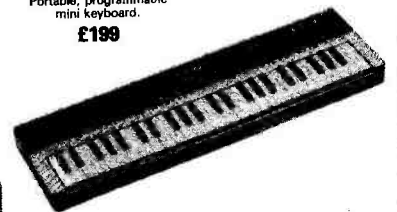
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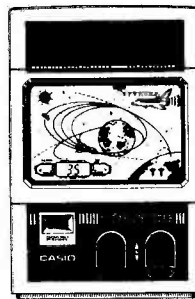


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SERVO INTERFACE

PART 2



Are you being servoed? This month we get to grips with the construction of our arm interface board, which can also be used to control up to four servos for any other application you can think of. Design by Rory Holmes.

The servo interface is built on a single-sided PCB. An additional double-sided PCB is used to make a lead-through type of edge connector plug, similar to that used on the ZX printer. The interface electronics are too bulky to be mounted directly on the Sinclair edge-connector, but our small Verobox-enclosed plug, wired to the main board via ribbon cable, puts less strain on the expansion connector.

Start construction with the main PCB, soldering in the links and resistors first (there should be eight links altogether), followed by the IC sockets and other components. Insert Veropin terminals at all the computer bus connections, since this makes wiring up to the ribbon cable easier. Veropins, or a five-way Molex connector socket should also be used at the servo output terminals as illustrated on the PCB overlay diagram of Fig. 1.

Adjust Your Address

The three DIL switches can be replaced by appropriate wire links if the address combination that you wish to use is going to be a permanent fixture. The address selection details given below should be studied to appreciate the possible configurations of the address decoder. Observe that the two switches corresponding to the Z80 control lines (those nearest C4) should always be set to logic low, ie

closed. Also note that IC3 is positioned the other way round to the other ICs.

We used the Pactec type HP case to house the main PCB which was mounted by four bolts at the corners. Four ordinary grommets were used as spacers over the bolts to allow room under the PCB for the ribbon cables. These ribbon cables are wired up to the two PCBs as shown in the main overlay and edge-connector wiring layout — an 11-way ribbon is used for the topside and a 14-way for the bottom side.

Pot Luck

The edge connector PCB is cut to exactly fit into the smallest Vero potting box. By a lucky coincidence the 23-way Sinclair expansion bus will exactly fit the inside of this box. The solder tags on the edge socket are spaced wider apart than the PCB thickness and must be adjusted slightly — don't forget the keyway orientation shown in the wiring layout. One row of tags should first be soldered as they are to the 'underside' PCB terminals and then the other row can be bent down to reach the topside terminals, allowing the assembly to fit in the Verobox.

Figure 3 shows how slots should be cut in the box to house the edge connector plug and socket. Two large size stick-on rubber feet should be positioned on the inside

of the lid to hold the board firmly in place as the lid is screwed down. If one of the feet is stuck above the ribbon cable entry point, it will act as a cable clamp. A very neat and solid connector system will result from this construction method.

Address Selection

If the Spectrum computer is to be used then IC7 and IC8 should not be plugged in (the address lines that would normally reach these ICs from the ZX81 do not go to the same pins on the Spectrum bus), but IC9 must be used. Under these circumstances the switches SW1 and SW2 and the associated pull-up resistors are not actually required on the board though they can be left in place (open circuit) if future ZX81 use is anticipated. Jumper JA must be fitted while JB and JC are left open. The switches on SW3 should all be set to logic low, ie closed, and then the four servo addresses will be

Servo 1 OUT 65340, X
Servo 2 OUT 65341, X
Servo 3 OUT 65342, X
Servo 4 OUT 65343, X

For use with the ZX81, IC8 and 9 must be fitted while IC7 is optional depending on the degree of address decoding required. Jumper links JB and JC should be fitted but not link JA. The memory map given in part 1 showed the address line logic levels needed to decode different address ranges.

PARTS LIST

Resistors (all $\frac{1}{4}$ W, 5%)
 R1-8, 25, 26 10k
 R9-23, 27 3k3
 R24 470R

Potentiometers
 PR1 47k miniature horizontal preset
 PR2 470k miniature horizontal preset

Capacitors
 C1 470p ceramic
 C2,3,6 10n ceramic
 C4 47 μ 16V tantalum
 C5 100n ceramic

Semiconductors
 IC1,2 74LS170
 IC3 40103B
 IC4 4555B
 IC5 4093B
 IC6 4520B
 IC7-9 74LS85
 Q1 BC184L
 D1-3 1N4148

Miscellaneous
 SW1-3 4-way single-pole DIL switches (wire links can be used)

PCBs (see Buylines); 0.1" 23-way double-sided edge connector (see Buylines); 5-way Molex connector socket; Veropins; case for interface — Pactec type HP, size 146 x 91 x 23 mm (see Buylines); case for plug — general purpose Vero potting box; 14-way ribbon cable.

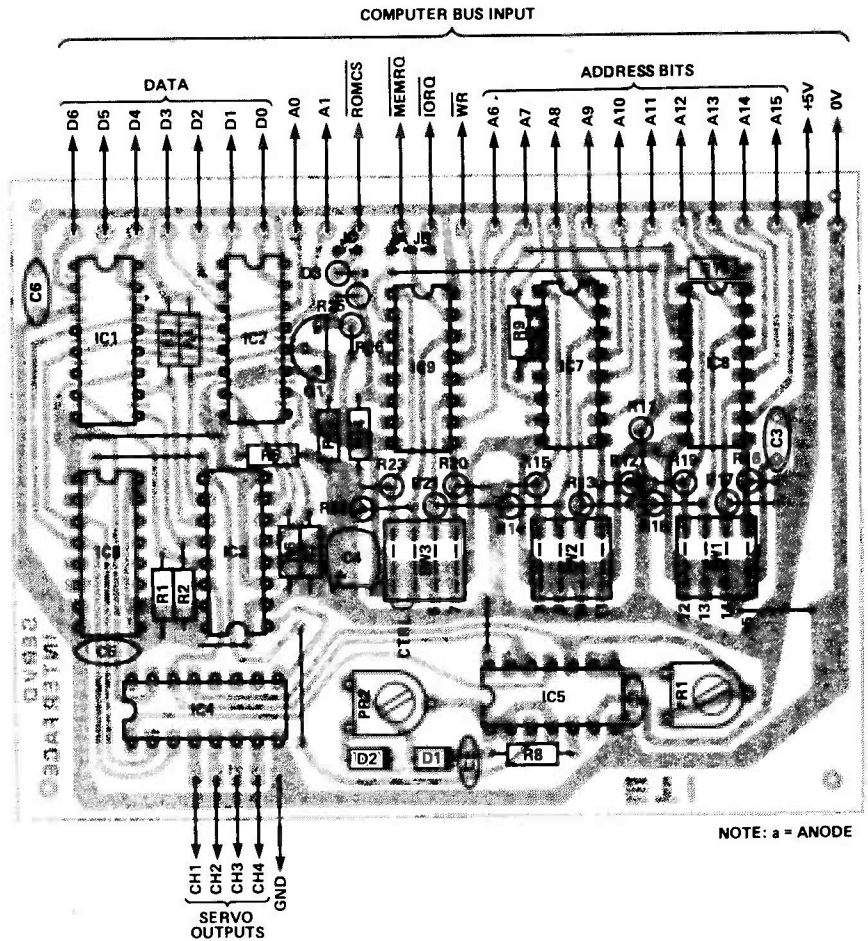
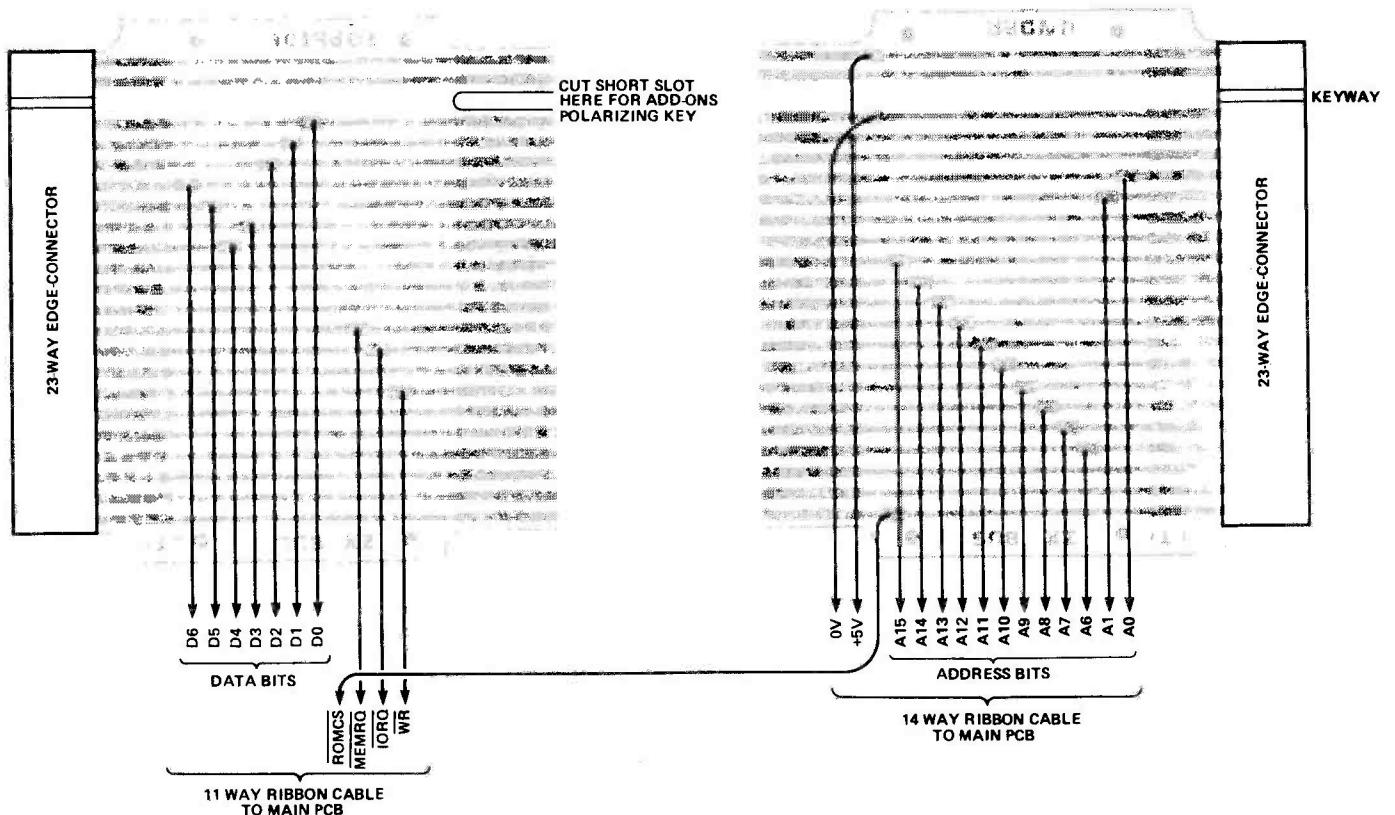


Fig. 1 (Right) Overlay for the servo arm interface board.

Fig. 2 (Below) Overlay for the edge connector PCB; this will allow the use of other peripherals, such as the ZX Printer in our lead photograph. Ribbon cable with 14 ways and 11 ways is used, although one of the wires from the 11-way piece is soldered to the other side of the PCB as shown.



BUYLINES

The 23-way edge-connector socket specified in the Parts List is available from Watford Electronics. Electroware stock the Pactec case used for housing the interface board; you can find them at Dutton Lane, Eastleigh, SO5 4SL (telephone 0703 610944). The two PCBs, one for the servo arm interface and the other for the connecting plug, can be purchased using the PCB Service order form on page 99.

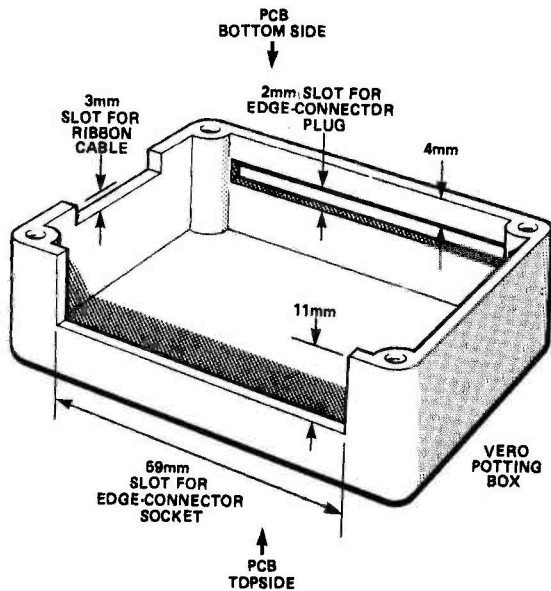
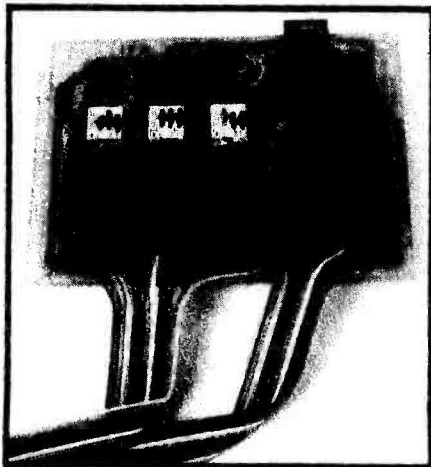


Fig. 3 Construction of the edge connector box.



A completed interface board; the ribbon cable clogs under the PCB.

These logic levels are set on the switches to decode the required addresses for the servo locations.

As an example, the switches on the PCB could be set to the following logic levels (address bits 2, 3, 4, and 5 are uncommitted so the decoder will respond to a range of addresses):

switch	6	7	8	9	10	11	12	13	14	15		
logic level	1	1	1	1	1	1	1	1	0	0		

Thus servo 1 will respond to an address in binary of

0011 1111 1111 1100

or 3 F F C
in hexadecimal. In decimal this gives servo addresses of:

- Servo 1 POKE 16380, X
- Servo 2 POKE 16381, X
- Servo 3 POKE 16382, X
- Servo 4 POKE 16383, X

The servo 4 location is the highest byte of the second 8K block.

Testing

Once all the cables are wired up the interface can be tested by plugging in to the Sinclair expansion port, either on a Spectrum or a ZX81. Ensure that the jumper links and IC/address switch combinations are set up for the type you are using, and start with no ICs plugged in. If the computer resets correctly and still seems to work, then the first hurdle is over. Check that the 5V power rail appears at all the IC sockets and then disconnect the interface to plug in all the ICs. With both presets at mid-travel turn PR1 45° anti-clockwise and PR2 45° clockwise; this will give a suitable pulse width to start with.

Plug in the interface again, reset the computer, and write zeros (using either the POKE or OUT command) to your chosen servo locations. On checking the servo outputs with a scope the 20 to 25 mS repetition (frame) rate should be observed, and the positive-going

pulses should be at their smallest width of about 1 mS. PR2 may be used to adjust the 'minimum' pulse width. To decrease the pulse width, turn PR2 clockwise. All the servo output channels should be producing identical pulse sizes but with the appropriate phase lag according to the time slot where they occur.

Now, choosing a specific servo channel, observe the pulse output on a scope as the number 127 is written to this channel. The pulse width should shift to be about 2 mS, and this 'maximum' pulse width can be adjusted using PR1. If a servo is at hand it can be connected up as shown in the diagram of Fig. 4, whereupon it should immediately take up the position dictated by the pulse width. Different numbers can now be POKEd to the servo to test a number of pulse positions.

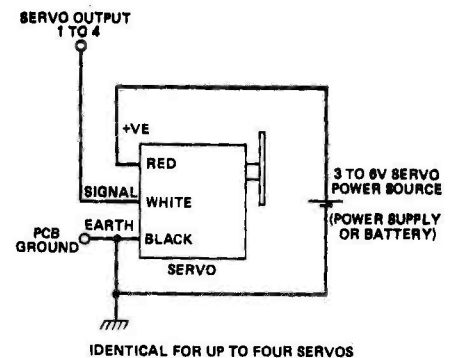
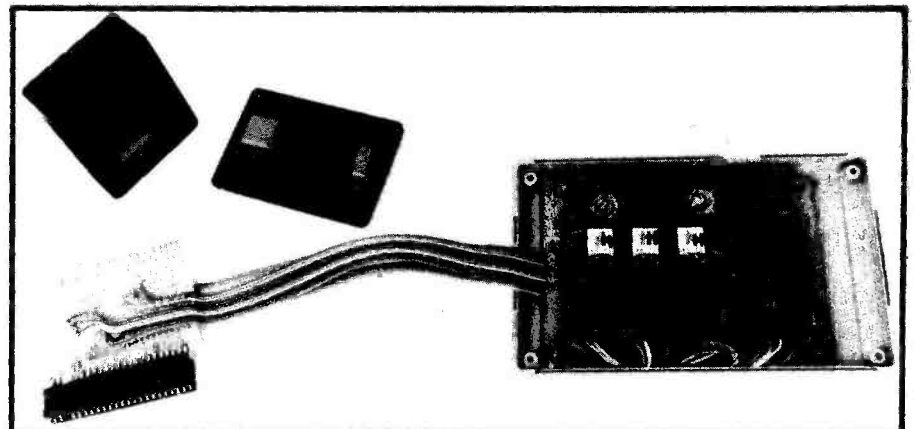
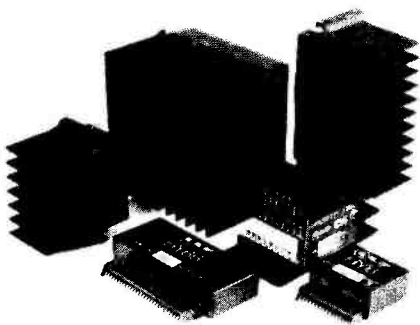


Fig. 4 Servo connections.



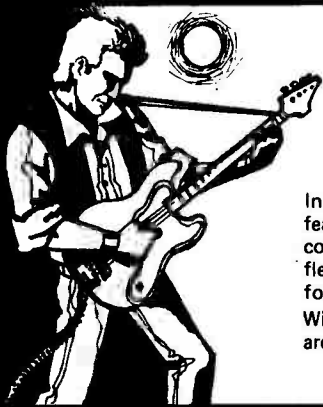
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HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
HY124	60	4	0.01%	<0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	60	8	0.01%	<0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	<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/ μ s. Rise time: 5 μ s. S/N ratio: 100db. Frequency response (-3dB) 15Hz - 50KHz. Input sensitivity: 500mV rms. Input Impedance: 100K Ω . Damping factor: 100Hz >400.

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PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY244	£17.07

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PSU 53X	2 x MOS128	£17.86
PSU 54X	1 x HY248	£17.86
PSU 55X	1 x MOS248	£19.52
PSU 71X	2 x HY244	£21.75

Model Number	For Use With	Price inc. VAT
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PSU 73X	1 x HY364	£22.54
PSU 74X	1 x HY368	£24.20
PSU 75X	2 x MOS248, 1 x MOS368	£24.20

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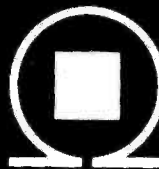
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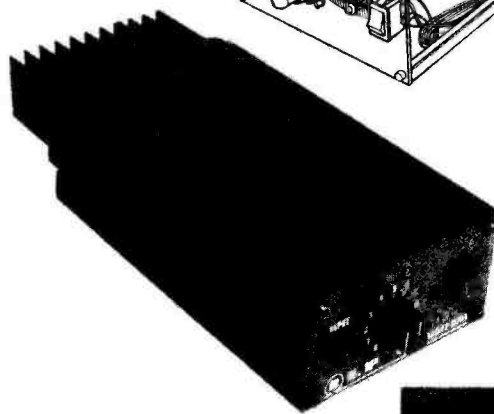
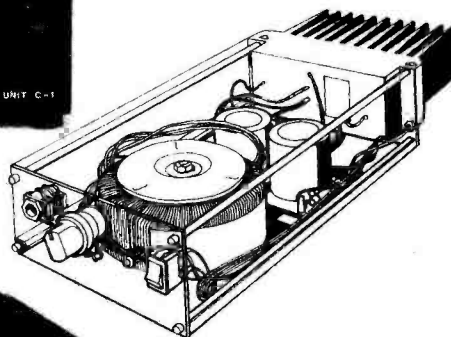
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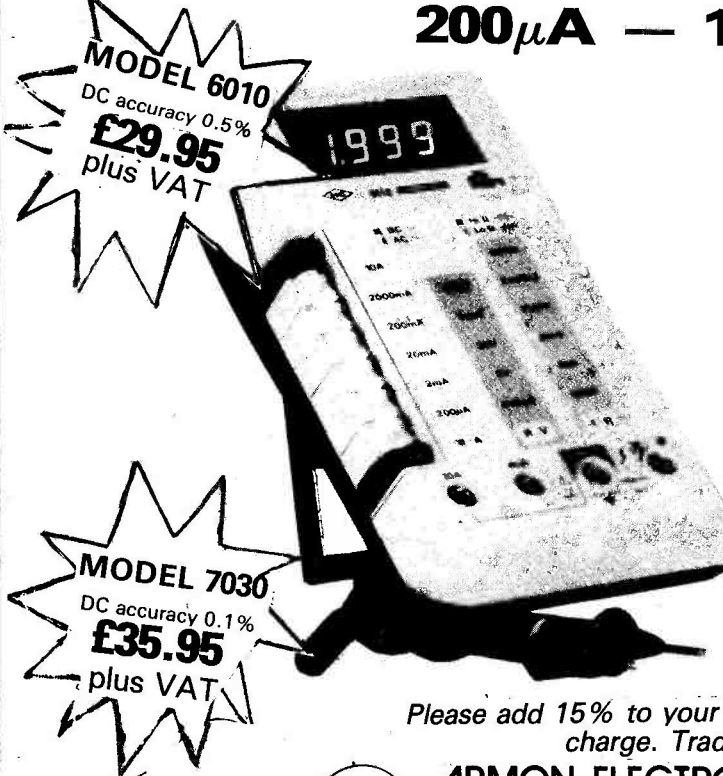
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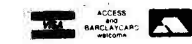
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READ/WRITE

Letters for this page should be addressed to Read/Write at our Charing Cross Road address.

Dear Sir,

I read with interest Tim Orr's series on electro-music techniques, and plan to use some of his circuits in a project. The problem is, as far as I can find out, your advertisers do not seem to stock the Curtis devices mentioned. Could you please give me some indication as to where these items may be obtained?

D. J. Stephenson,
Cheltenham

Digisound Ltd are the agents for the Curtis ICs used in Tim Orr's circuits. In particular, the CEM3310 costs £4.20, CEM3320 is £4.00, CEM3330 is £4.40, and the CEM3340 is £6.10, plus 30p postage and packing, and VAT must be added to the total order. Digisound are at 14/16 Queen Street, Blackpool, Lancs FY1 1PQ (Tel. 0253 28900).

Dear Sir,

I am presently constructing an audio amplifier which consists of the System A preamp and the Audiophile power amp split into two mono amps so that they may be sited next to the speakers.

Do you think it will be necessary to attenuate the output of the System A preamp down to 500mV to match the Audiophile preamp output or is this unnecessary as the maximum voltage swing from each preamp is almost the same?

If the DC offset of my System A preamp is sufficiently low as to make the capacitor at the output unnecessary, can I also dispense with the electrolytic capacitor at the input to the Audiophile power amp?

Finally I am using toroidal transformers in the power amps which, although they function correctly, hum quite loudly. The manufacturers (ILP) suggest that the cause is a poor mains waveform. Is there any way of reducing this effect for a modest cost?

D. A. Davies,
W. Sussex

No, it shouldn't be necessary to attenuate the output of the preamp, because the mis-match in levels is fairly small, and the right way round in any case (775mV

output into a 500mV input — the other way round would stop you from getting maximum output from the power amp). Ideally, you could leave out both the DC blocking capacitors, but in practice, we wouldn't recommend doing so because then any DC fault in the preamp would be amplified and fed through all the way to the loudspeaker's coils, which is one of the best ways we've discovered of destroying them. So for safety's sake, leave one of the caps in circuit, though keeping both is not necessary.

In our opinion, a well-designed transformer (toroidal or otherwise) should not be obtrusively noisy. However, you may have accentuated the relatively innocuous noise any mains transformer is bound to make by the way you have mounted it. We suggest experimenting with alternative techniques, for example, mounting the transformer on something soft and acoustically dead (foam rubber would be ideal but for its inflammability — so try whatever you have to hand until you find something that works).

Dear Sir,

First of all, congratulations on an interesting magazine. I am, at present, in the process of building the System A preamp and the 150W MOSFET amplifier. I would appreciate it if you could let me know of the modification involved in matching these units. I note that the preamp's output is 775mV and the amp's input is 1V.

Also, could you tell me which configuration to use to match an Elite EEI 700 MM cartridge to the preamp's input?

Yours faithfully,
W. Suzor,
South Africa.

Hmm — the opposite problem to Mr Davies. Well, you can settle for leaving things as they are and possibly not getting quite the maximum volume out of the system (it all depends on the outputs of the signal sources): or you can tinker with the preamp. Referring back to the circuit diagram in the July 81 issue, R37

may be increased to 15k: on the other hand you could reduce RV2 to a 470R pot or solder a 1k0 resistor from either side of RV2 to ground. The first modification might affect the preamp stability, the second will alter the operating characteristics of the balance control. You'll just have to suck it and see . . .

As for the cartridge matching, we recommend the use of option H in this instance. Good listening.

Dear Sir,

It was intriguing to read in the September 82 issue of Which? (with Money Which?) of the possibility of an electronic solution to the ancient problem of ascertaining when it is possible to have sex without contraception and no danger of pregnancy. Your designers will enjoy working on a project which will interpret temperature changes in the breasts and indicate if sex without conception is possible. I do hope that you can come up with such a design — it is bound to be popular.

Yours sincerely,
W. K. C. Townley,
Morecambe.

Not only does this suggestion win our Raincoat of the Month award, but if followed up would probably offend our female readership.

Dear Sirs,

With reference to ETI September, page 11; Digest News. 'Eric' is the Tangerine Users Group mascot; yes, a small IC is the mascot of that fairly large users group. Eric is more commonly known as a 24-pin 2708 EPROM.

Yours faithfully,
Master N. P. Leirs,
Swansea

PS How about a binder for my five years of back issues of ETI or a year's subscription (even better) for the above info.

Thanks for identifying Eric; as promised in the Digest item, you don't win a prize! (Sorry if we got your name wrong, but we couldn't make out your signature.)

OOPS

Two small errors crept into the Spectrum Analyst project last month. In Fig. 3, the circuit diagram of the filter-rectifier block, R37-52 should be 10k, as listed in the Parts List. In Fig. 5, the overlay for the main board, the +10V and -10V connections marked 'FROM PSU' (at the corner of the PCB nearest the caption) should be swapped over. In the Cortex article, the block diagram showed two TMS9995s; the VDP is, of course, a TMS9929.

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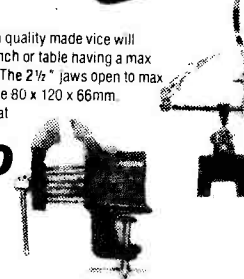


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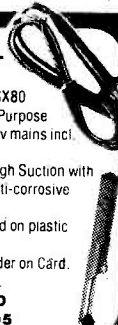
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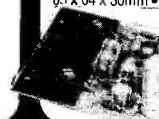
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AUDIOPHILE

Ron Harris has got lots of arms. This doesn't mean he can write articles faster than the rest of us, but it's useful for testing cartridges. Here he tells you how to give your hi-fi the (Gold)ring of confidence.

The G910IGC represents something of a rethink for Goldring. Some time ago, they launched their successful G900IGC with a compliance approaching 50cu ($\times 10^{-6}$ cm/dyne); they subsequently issued the G910 with an identical generator system and stylus, but a much reduced compliance. Ostensibly this was to bring the G900 cartridge a potentially wider audience by allowing its use in higher mass arms. (The G900IGC itself is really only viable in an SME, since any higher arm mass is liable to bring the resonance into the range where it will affect the audible reproduction.)

The resonant frequency generated by the compliance of the cantilever and the combined arm and cartridge mass can be calculated from:

$$f_r = \frac{1}{2\pi\sqrt{(M+m)C_0}}$$

where f_r = resonant frequency (Hz)

M = arm effective mass (grams)

m = cartridge mass (grams)

C_0 = Compliance (cu)

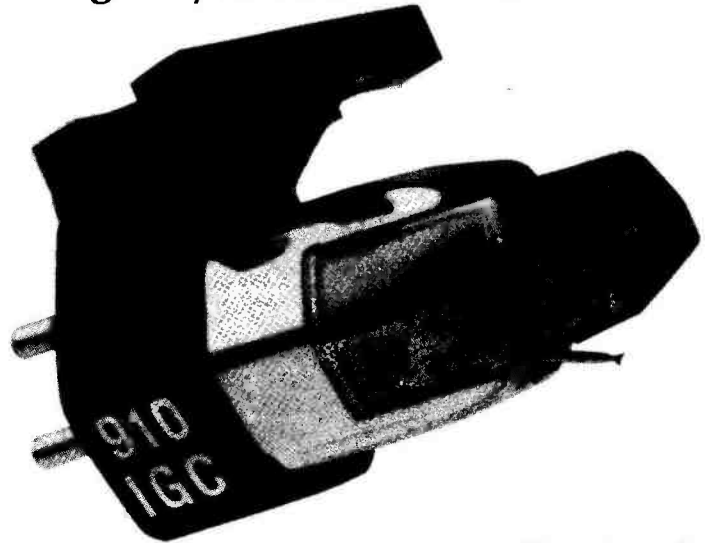
Ideally this figure should lie above the frequencies of warps on records (4-7 Hz), yet below the audio range of 15 Hz upwards: a suitable compromise has been established as being between 9-12 Hz. If you do the arithmetic, it becomes very clear that with a compliance figure up around 50cu the G900IGC is going to have a hard time with any arm having an effective mass higher than about 6-7g.

Thus the 910IGC, with its compliance of 25cu, will be more suitable for a much wider range of arms and thus allows a more secure performance in more decks. (Goldring recommend arm masses between 3g and 12g.)

No Arm Done?

It is not just the frequency of the resonance that matters, but the strength of the resonance is important too. Damping is becoming an increasingly popular option on tonearms these days, as the importance of this subsonic resonance is recognised. The effect of energy entering the resonance is to excite the arm into motion (thus affecting the cartridge's hold upon the groove) and/or to degrade the reproduction of the lower registers by pouring energy into the system at a frequency sufficiently close to the bass register to 'modulate' the signal and colour the sound severely.

In the past, ultra-high compliance figures of around 60 cu have been present in cartridge designs, notably from Empire. Shure and Goldring too were following that path, and Shure's new V15V still has a cantilever with compliance of around 35-40 cu. It does, however, incorporate its own damping system. The thinking behind this idea is that the ideal pickup system consists of a massless arm and cartridge, tracking at zero grams. Such a unit would have no inertia and no overshoot. With no mass it could not wear out records and would track every groove perfectly. Ever lower arm mass figures were



pursued earnestly, the SME Series III reaching a low of around 6g. The Ortofon Concorde and the Shure MV30HE are both attempts to reach as close as possible to the unobtainable ideal.

The closest thing, in practice, to the massless groove scanner is probably the laser-beam of the Philips Compact Disc player. It's impossible to wear out what you don't touch. Surface noise is also eliminated by this method and even scratches on the surface can be 'correlated' out by the following circuitry. Visions of silent background, massive dynamic range and practically invulnerable records are promises that lie temptingly just beyond the next technological revolution. One more miracle to await, headphones in hand and conductor's baton raised.

Speaking as a professional cynic, I've yet to hear a convincing demonstration of this 'new-wave' hi-fi. Good ol' analogue — warts and warps et al — can still beat the sleeves off anything else I've heard. Listen to a top flight analogue recording of a live performance — the Deutsche Gramophone 'Ring Cycle' for example — and I think you'll see what I mean.

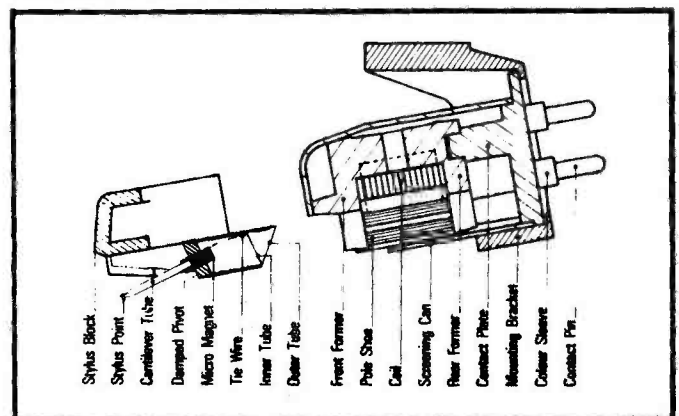


Fig. 1 Cross-sectional drawing of the Goldring G910IGC cartridge.

Lots of Life — But Not Live

A vital part of a live recording is the effect of the hall in which the recording was made. Any bounded space will affect sound generated within it. Resonances are (again) present and they reinforce certain sections of the sound spectrum, effectively adding peaks to the overall frequency response. These are directly related to the size of the hall or room and will in addition limit the bass response obtainable.

Reflections from the boundaries reach the recording mics later than the original signal and add 'reverberation' to the sound. With a different frequency spread for each reflection, depending upon the nature of the boundary doing the reflecting, a definite character will be added to the overall result.

This is because few materials reflect all audible frequencies equally, and most will absorb some quite readily. High frequencies are soaked up by brick, cloth, carpet, people — even plants! Bass frequencies are harder to absorb and travel quite effortlessly through walls into next door's living room, for example, adding little to a sense of neighbourly good-will in the process.

Thus overall, each concert hall — and living room — will have a distinct sonic character to impart to sound produced within it and it is this low-level information that digital recording is, at present anyway, lousy at replaying. Recordings of even the best orchestras and musicians are apt to sound decidedly lacking in life and character. No 'ambience' is a more up-market method of expressing the same sentiment. In plain terms they just sound dull and flat.

A Bit Short?

Perhaps as the sampling rates and number of bits used in each sample increase, this problem will be resolved. For the moment, though, we are left with the uneasy feeling that the circuitry is filtering out the life with the noise! Almost enough to justify a science fiction story or two, that — emotion classed as surface noise and filtered out at the reproduction stage! Worth a quiet shudder or two over a glass of wine, methinks.

If your tastes don't run to opera, try the new Ry Cooder LP, 'Into the Slide Area'. It was recorded live and the quality is absolutely magnificent. Frequency balance has been well maintained and the voices come across superbly. Match that one, Philips!

Back To The Plot

At least this all goes to show that there is quite a few years left in the record deck yet. It will be a considerable time until G910IGCs and Karat Diamonds become as hard to get as pine needles! It is interesting to note, though, that Quad mention in the release for their new preamp (see later in this article for more details) that the auxiliary input is now intended for 'compact disc players'

So now that we've established that the G910IGC possesses a future, let's take a closer look at it. As I said, it is identical to the G900IGC in all respects, save that lowered compliance.

This means it has the van den Hul stylus point, with its Improved Groove Contact geometry (IGC). This means a minor radius of a mere 3.5 μm and a major (contact) dimension of 85 μm lying perpendicular to the groove. Thus the stylus as a whole closely approximates to the shape of the head which cut the master disc in the first place.

Being of the same shape means that it is supposed to have less trouble following the groove — and staying in it — than other stylus profiles. Claimed benefits are improved definition of detail, better imaging through



The point of the exercise? The van den Hul in close-up. The advantages of the shape are claimed to be decreased wear, due to increased contact radius, and improved groove following abilities.

channel separation and stability, low record wear through increased contact area and lower intermodulation distortion. Not quite everything but the kitchen sink, though close. The elliptical tip may as well pack up and go home!

The *really* disquieting thing is that the IGC cartridges deliver on all the claims made for them! The surface noise really is very low, stereo image is excellent and you won't find better detail in a cartridge anywhere. Worrying that.

Stiffer Upper Lip

The older G900IGC works exceptionally well in an SME Series III, and I've encountered no problems playing the unit in this manner. Many are the tales I have heard, however, of horrendous bending cantilevers, sound breaking-up faster than the Labour Party, and unstable bass response which rocks speaker cones on their suspensions.

Most of these, I suspect, can be put down to poor matching between cartridge and arm. Still, it does a manufacturer no good to get lumbered with such tales, whether they are his fault or not. The 910IGC is thus a most sensible answer to the criticisms.

TEST RESULTS

G910IGC SERIAL NUMBER 1142

OUTPUT VOLTAGE (AT 5 cm/s):	6.6 mV (L) 6.7 mV (R)
CHANNEL SEPARATION:	1 kHz: 30 dB 10 kHz: 24 dB 20 Hz — 20 kHz \pm 1.5 dB
FREQUENCY RESPONSE:	(see graph)
STATIC COMPLIANCE:	25 cu
EQUIVALENT TIP MASS:	0.4 mg
CHANNEL BALANCE (AT 1 kHz):	within 1.5 dB
VERTICAL TRACKING ANGLE:	24°
OPTIMUM TRACKING WEIGHT:	1.7 g
OPTIMUM ELECTRICAL LOAD:	47k/200p
WEIGHT:	4.3 g
TYPICAL PRICE:	£59.00 including VAT

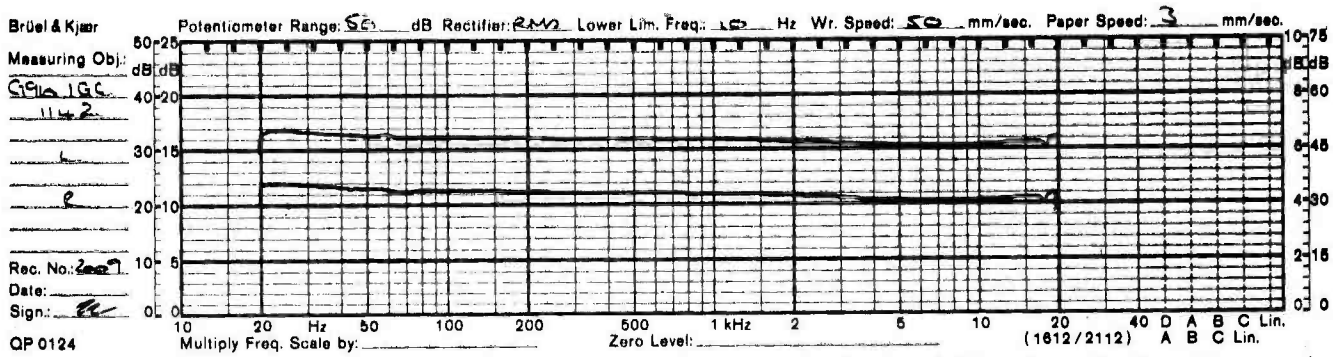


Fig. 2 (above) Frequency response plot of the G910IGC. Would that it contained a few deficiencies so that I could moan about them.

I tried the 910IGC in a wide variety of arms, from the SME itself to an Audio Technica of dubious parentage. It gave a good account of itself in all. Curiously it also appeared to offer a more refined performance than the 900IGC, even with the SME. Could it be there are more refinements lurking within the strangely shaped shell than Goldring are admitting?

The treble in particular seemed to have been cleaned-up somewhat with the 910 producing a clearer and sharper rendition of transients than its stable companion. The overall performance could simply be described as more confident and controlled, but can in no way be totally ascribed to the mere lowering of compliance.

Bench Testing

Putting both a 900 and 910 through a series of tests side-by-side failed to reveal any significant technical differences between them. The 910 measured out at 20 Hz – 20 kHz \pm 1.5dB with a slightly falling upper-end response, which may in some way account for the tolerance of surface noise.

Output was very high at around 7 mV and overload problems may well arise on lesser preamps. Using the cartridge with lower grade systems is a waste anyway, but check nonetheless. You will need around 90–100 mV

overload to be reasonably safe.

Separation was very high also, at around 30 dB at 1 kHz and 24 dB at 10 kHz. Optimum tracking was achieved at 1.7 g and no practical improvement is to be gained beyond this.

Under a microscope the finish on the diamond was very good and the alignment appeared to be spot-on. Goldring have obviously gone to a good deal of trouble with their van den Hul point and it shows in the product.

Competition Results

At around £60.00 the G910IGC is not cheap. By today's inflationary standards it is difficult to justify calling it expensive, however. Taking into account the very fine performance offered, the cartridge *can* justifiably be labelled as value for money. The sound quality is nicely open and well detailed. Bass is extended and free of 'boom', a characteristic which has, perhaps, been gained at the expense of a little 'weight'. Treble is clean and extended also, with no sign of the hardening on difficult material which can so easily beset lesser designs.

A good product, then, and one which has a great deal to offer a wide range of users. I personally preferred the G910IGC to its more specialised companion the 900. A worthy contender in the £50–£100 market.



Above: the new Quad 34 preamp — sorry, 'control unit' — lined up with the FM4. nother new Quad model is quite an event. That's more than one THIS YEAR . . . must be a rush of blood to the design department. The versatile filtering is retained from the existing 44 and the price is, well, interesting. Audiophile is trying to lay its hands on one, so more details when we hear from Huntingdon. Mind you, after that crack about design departments . . .

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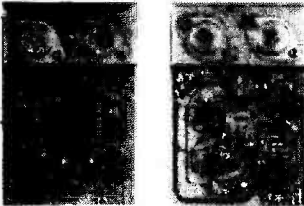
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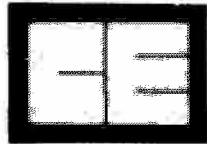
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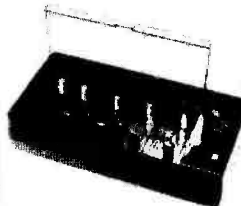
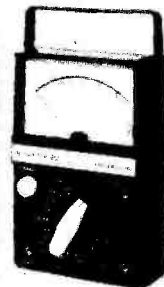


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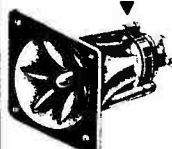
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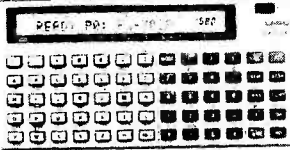
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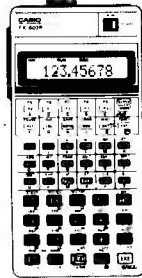
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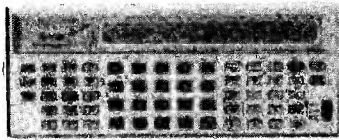


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	1x012	12+12	1.25	
	1x013	15+15	1.00	
	1x014	18+18	0.83	
	1x015	22+22	0.68	
	1x016	25+25	0.60	
1x017	30+30	0.50		
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	2x014	18+18	1.38	
	2x015	22+22	1.13	
	2x016	25+25	1.00	
2x017	30+30	0.83		
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	3x011	6+9	4.44	
	3x012	12+12	3.33	
	3x013	15+15	2.66	
	3x014	18+18	2.22	
	3x015	22+22	1.81	
	3x016	25+25	1.60	
3x017	30+30	1.33		
120 VA 90x40mm 1.2Kg Regulation 11%	4x010	6+6	10.00	£6.90 +p/p £1.67 +VAT £1.79 TOTAL £9.86
	4x011	6+9	6.66	
	4x012	12+12	5.00	
	4x013	15+15	4.00	
	4x014	18+18	3.33	
	4x015	22+22	2.72	
	4x016	25+25	2.40	
4x017	30+30	2.00		
160 VA 110x40mm 1.8Kg Regulation 8%	5x011	6+6	8.89	£7.91 +p/p £1.67 +VAT £1.44 TOTAL £11.02
	5x012	12+12	6.66	
	5x013	15+15	5.33	
	5x014	18+18	4.44	
	5x015	22+22	3.63	
	5x016	25+25	3.20	
	5x017	30+30	2.66	
5x018	35+35	2.28		
5x026	40+40	2.00		
5x028	110	1.45		
5x029	220	0.72		
5x030	240	0.66		

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	6x015	22+22	5.11	
	6x016	25+25	4.50	
	6x017	30+30	3.75	
	6x018	35+35	3.21	
6x026	40+40	2.81		
6x025	45+45	2.50		
6x033	50+50	2.25		
6x028	110	2.04		
6x029	220	1.02		
6x030	240	0.93		
300 VA 110x50mm 2.6Kg Regulation 6%	7x013	15+15	10.00	£10.17 +p/p £2.00 +VAT £1.83 TOTAL £14.00
	7x014	18+18	8.33	
	7x015	22+22	6.82	
	7x016	25+25	6.00	
	7x017	30+30	5.00	
	7x018	35+35	4.28	
	7x026	40+40	3.75	
7x025	45+45	3.33		
7x033	50+50	3.00		
7x028	110	2.72		
7x029	220	1.36		
7x030	240	1.25		
500 VA 140x60mm 4Kg Regulation 4%	8x016	25+25	10.00	£13.53 +p/p £2.35 +VAT £2.36 TOTAL £18.26
	8x017	30+30	8.33	
	8x018	35+35	7.14	
	8x026	40+40	6.25	
	8x025	45+45	5.55	
	8x033	50+50	5.00	
	8x042	55+55	4.54	
8x028	110	4.54		
8x029	220	2.27		
8x030	240	2.08		
625 VA 140x75mm 5Kg Regulation 4%	9x017	30+30	10.41	£16.13 +p/p £2.50 +VAT £2.79 TOTAL £22.42
	9x018	35+35	8.92	
	9x026	40+40	7.81	
	9x025	45+45	6.94	
	9x033	50+50	6.25	
	9x042	55+55	5.68	
	9x028	110	5.68	
9x029	220	2.84		
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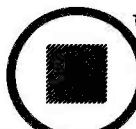
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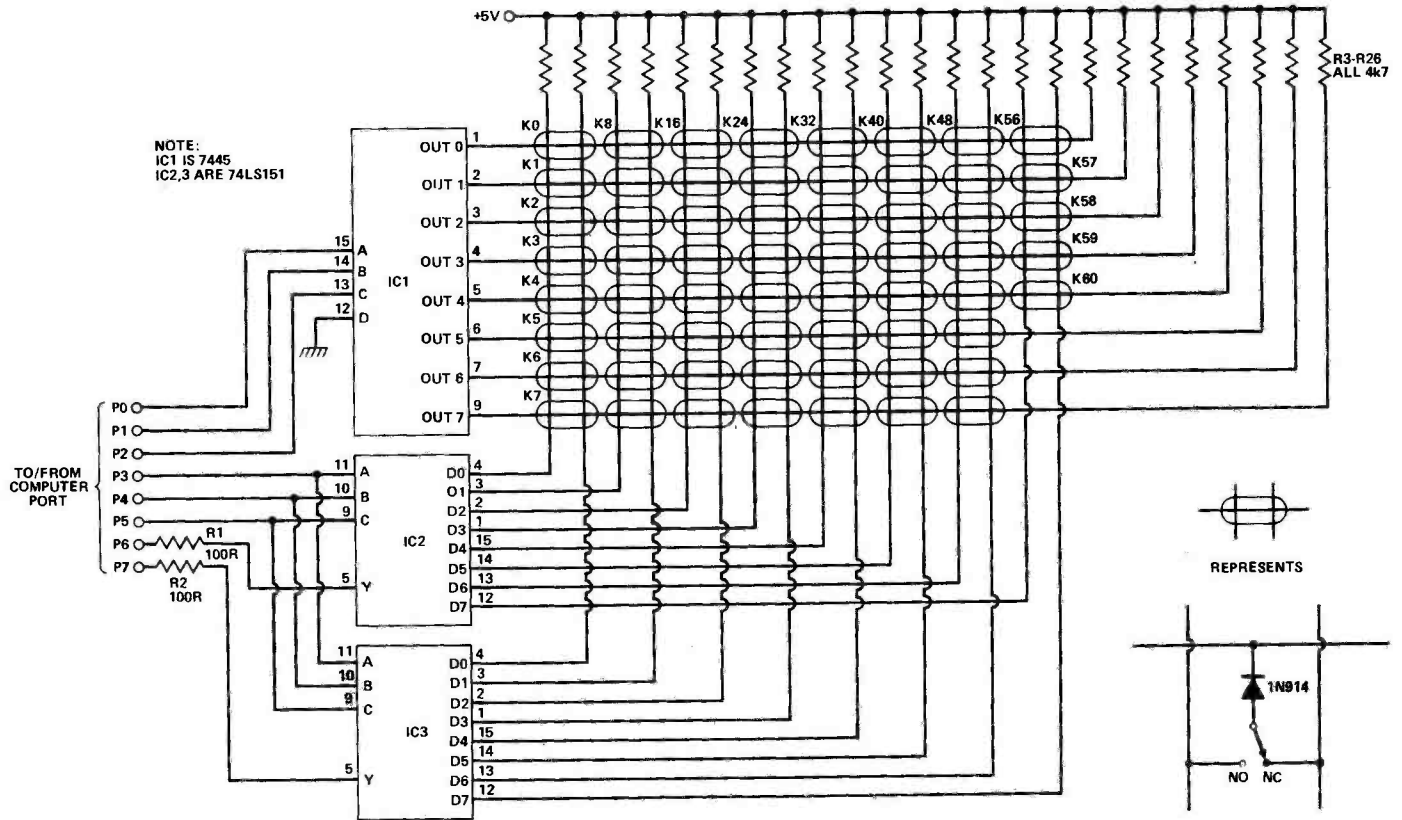
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TECH TIPS



Computer/synth Keyboard Interface

Philip Jones, Wirral

This circuit was produced to interface a 61-note music keyboard to a microcomputer for music synthesis applications. The facility for touch

sensitivity is included by using changeover contacts for the keys and two multiplexer ICs (74LS151). Complete control from the computer is possible using one input/output port.

The computer sets the port so that the lower six bits are outputs and the two top bits are inputs. A six-bit code on the output bits will select one key out of the possible 64 (although only 61 are used). The top

two port lines feed back the status of the selected key to the computer. This status can then be further processed by the software to give many different keyboard responses, for example monophonic, polyphonic, touch sensitive.

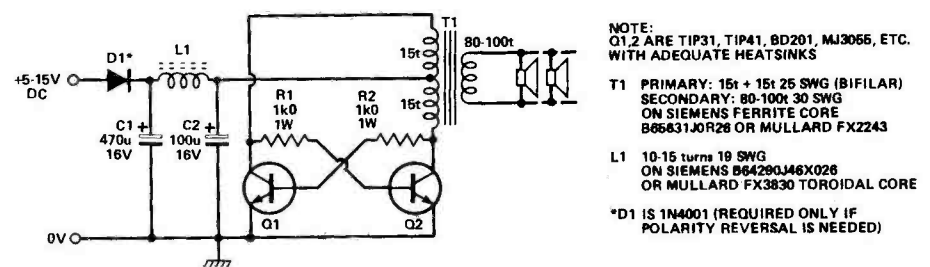
The resistors R1 and R2 protect against the danger of setting all the port lines to be outputs and thus shorting two outputs together.

High Efficiency Piezo Siren

Mrs L. Jawad, Warrington

The circuit shown is a self-starting inverter where Q1 and Q2 are connected as a multivibrator with the transformer primary forming the collector loads. The 1kΩ resistors provide the base drive.

A square-wave of nearly 1 kHz is produced. This is stepped up by the transformer secondary winding which can drive one or more piezoelectric horn tweeters. The frequency of oscillation depends mainly on the number of primary turns and the type of ferrite core used. A slight adjustment to the frequency may be made by changing the value of the base drive resistors.



A very powerful sound is produced by the horn tweeter or tweeters due to the square-wave drive signal. This circuit was primarily designed to be used instead of the horn in a car alarm system, mainly to reduce the drain on the battery since the current consumption is less than 200 mA compared to more than an amp for the horn. However, this siren can also be used in place of any

electromechanical warning devices such as bells, horns, motor-driven sirens, etc, especially those driven by a battery when it considerably reduces the current drain. Since piezo tweeters (such as the Motorola ones) are widely available and reasonably cheap, more than one tweeter can be used to distribute the sound over a larger area with the minimum of cost.

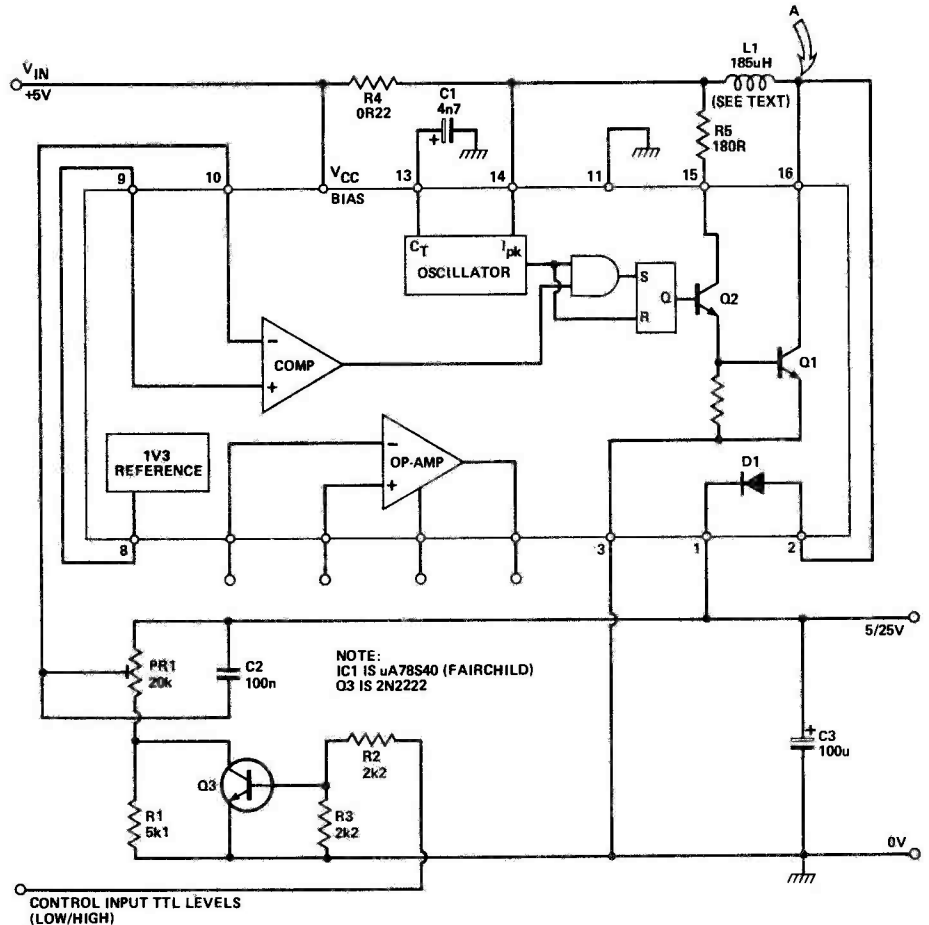
5 V to 25 V Switched Mode PSU For EPROM Blowing

C.J. Jay, Bristol

The circuit shows the application of a Fairchild 78S40 switched mode power supply chip used to generate a 25V or 5V (binary selectable) V_{pp} input to a 2716 type EPROM. The supply was designed to be quite small and compact so that it could fit onto a single card EPROM programmer. All the necessary power input requirements were satisfied by a single 5V V_{cc} input; this circuit will therefore eliminate the need for a transformer derived 25V supply and the additional supply distribution on an already overcrowded microcomputer backplane.

The 78S40 is designed into a 'step up' circuit configuration. The output is derived from pin 1 of the IC, the cathode of the internal charge pump diode D1, to a reservoir capacitor C3. When the internal transistor Q1 is turned on, current flows through inductor L1 causing energy to be stored in the magnetic flux around the windings; the charge pump diode is reversed biased when Q1 is conducting. When Q1 turns off the magnetic flux collapses, inducing a positive voltage at node A. If this node voltage exceeds the voltage on the positive plate of capacitor C3, D1 will conduct and the capacitor will charge to a more positive potential. To regulate the output voltage it is necessary to control the switching of Q1. This is achieved by tapping V_{OUT} through a potential divider of R1 and PR1 to pin 10 of the 78S40. This negative feedback controls the on/off times (mark/space), and the frequency at which Q1 switches. Q1 is driven from an internal voltage-controlled oscillator, which is in turn controlled by the negative feedback derived from V_{OUT} .

Q3 has been included in the potential divider to select the amount of feedback required to provide outputs of 25 or 5V. When Q3 is turned on the feedback is reduced,



so V_{OUT} will rise to +25V. When off, feedback is increased and the output will fall to +5V. To set the output voltage range it is necessary to adjust the multiturn cermet type trimpot, PR1. This should be done off load because high voltages can be generated if the feedback has been initially set up incorrectly. The CONTROL input may be CPU-programmed via a TTL, latch or PIA; the two resistors R2 and R3 are chosen to enable Q3 to be driven hard on or hard off by TTL high or low level inputs.

Other components used in the design are a timing capacitor C1 of 4n7, a peak current limiting resistor of 0R22 (R4) and a current limiting resistor R5, 180R. Capacitor C2 was included to aid smoothing of the switch ripple on the 25V output. L1 is 34 turns of 24 swg wire on an RS RM6 ferrite core.

Regarding the performance, the circuit provides an excellent stabilised output of 25V for loads requiring up to 75mA. The +5V supply does exhibit 500mV of switching ripple, but superimposed on a mean 5V DC level this will not violate the static input requirements of the 2716's V_{pp} input. The conversion efficiency of the entire supply was about 60%.

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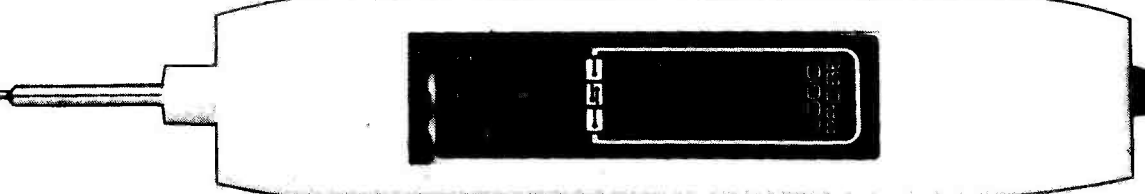
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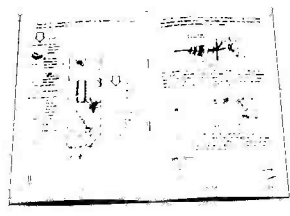
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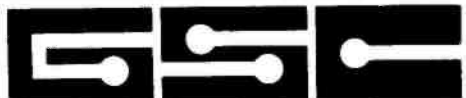
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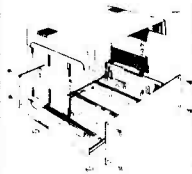


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SIGNAL LINE TESTER

If you're a PA person, here's an incredibly simple device to prevent embarrassment when all you can give them is the sound of silence. Design by Vivian Capel.

This project came about as a result of a very unfortunate incident. The author was in charge of a large public-address system that had been temporarily installed to cater for a public meeting with an audience of several thousand. There were spare microphones, spare inputs on the mixer, and to make quite sure, a spare mixer under the bench. Very little really could go disastrously wrong — but it did! Part way through the main speech everything went dead. Calm and reasoned diagnosis was employed (it wasn't really, but I couldn't admit to blind panic). Finally, after what seemed an age of silence from the speaker and murmurings from the audience, the fault was revealed as a dead short across the audio cable between mixer and amplifier rack.

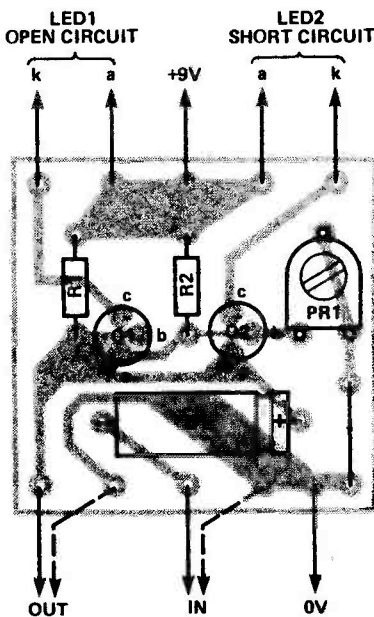
Thus the fault-warning unit here described was conceived, embarrassment being the mother of invention! The idea was to constantly monitor the condition of a signal cable; if it should go either short-circuit or open-circuit, an appropriate LED would immediately light up to indicate what had happened.

The device could be used not only for public address applications, but any situation where a vulnerable signal cable needs protection by constant monitoring. A security intercom or telephone link, for example, could be monitored to reveal a fault or tampering as soon as it occurred, and avoid the need for frequent testing.

Requirements

To utilise the device successfully, the normal signal for which the cable is used must be AC. Furthermore there must be a DC path or load resistor at the far end of the cable to pass the small open-circuit mode sensing current. The input to the amplifiers or other equipment at the far end must be AC-coupled otherwise the input stages could be affected by the DC monitoring potentials. As a rule,

these conditions are met in most slave amplifiers by the input gain control and following coupling capacitor. Should the capacitor come first, a load resistor must be added across the input socket.



NOTE:
a = ANODE
k = CATHODE

Fig. 1 Component overlay for the line checker. The line below PR1 may be replaced by a resistor — see text.

PARTS LIST

Resistors (all $\frac{1}{2}$ W, 5%)	
R1	100k
R2	10k
Potentiometer	
PR1	10k miniature horizontal preset
Capacitor	
C1	10u 25 V axial electrolytic
Semiconductors	
Q1, 2	BC108
LED1, 2	3 mm red LED
Miscellaneous	
PCB (see Buylines); case and sockets (if built separate from audio equipment).	

BUYLINES

Nothing is used in this project that you can't find in your junk box. The PCB can be bought from our PCB Service as advertised on page 99.

In considering the design, several features were deemed desirable. First, the value of the load terminating the line should not be critical. While false indications can be obtained under extreme load conditions with the circuit eventually evolved, there is a wide latitude in load values and no false alarms will be obtained within the specified limits. The nominal load for which the circuit was designed is 10k, but variations up to 20k and down to under 1k Ω can be tolerated. This will accommodate most applications, but other values could be obtained by changing the values of the three resistors from those given.

Second, the circuit must take very little current as it is active for the whole time the mixer is switched on. A current of 1 mA was stipulated as the maximum allowable in the quiescent mode. This meant that few active components could be used, and that they had to be non-conducting until a fault condition occurred.

Third, the unit should be as simple as possible; far too many electronic circuits at present are needlessly complicated. In this case simplicity was pursued not merely for its own sake but as a fundamental necessity for fault monitoring equipment. It has to have a high degree of reliability if it is to be depended upon, and every extra component is one more that could itself break down.

Construction

The original circuit was built in to the mixer and powered from the mixer batteries, but construction and housing is by no means critical and almost any convenient form can be used. Input and output sockets can be standard jacks, Cannon XLR plugs or any suitable terminations appropriate for the equipment involved.

Before applying the battery voltage make sure that the variable preset PR1 is fully advanced so that maximum resistance is in circuit. If it should be fully the other way

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Up until now PCBs were always the hardest component to obtain for a project. Of course you could make your own, but why bother anymore?

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In addition to the PCBs for this month's projects, we are making available some of the more popular designs from our recent past. See the list below for details. Please note that **NO OTHER BOARDS ARE AVAILABLE.** (If it's not listed, we don't have it!)

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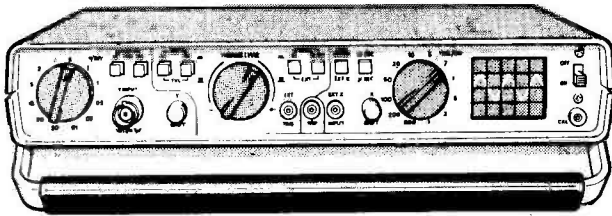
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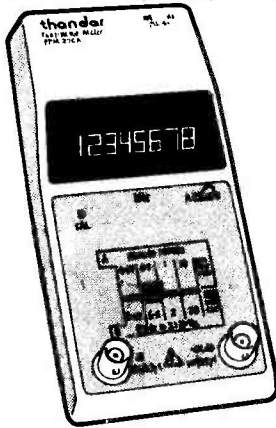
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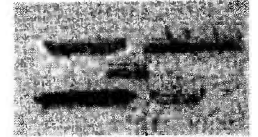
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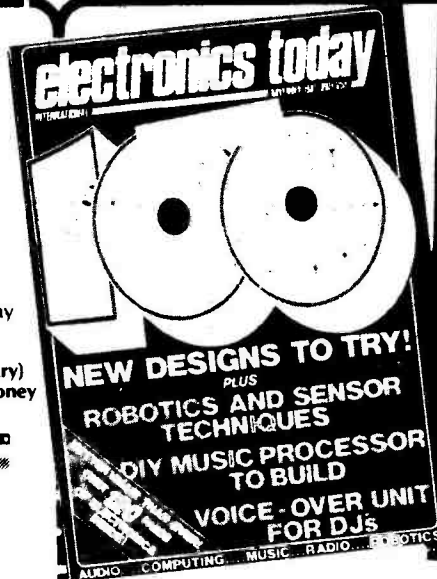
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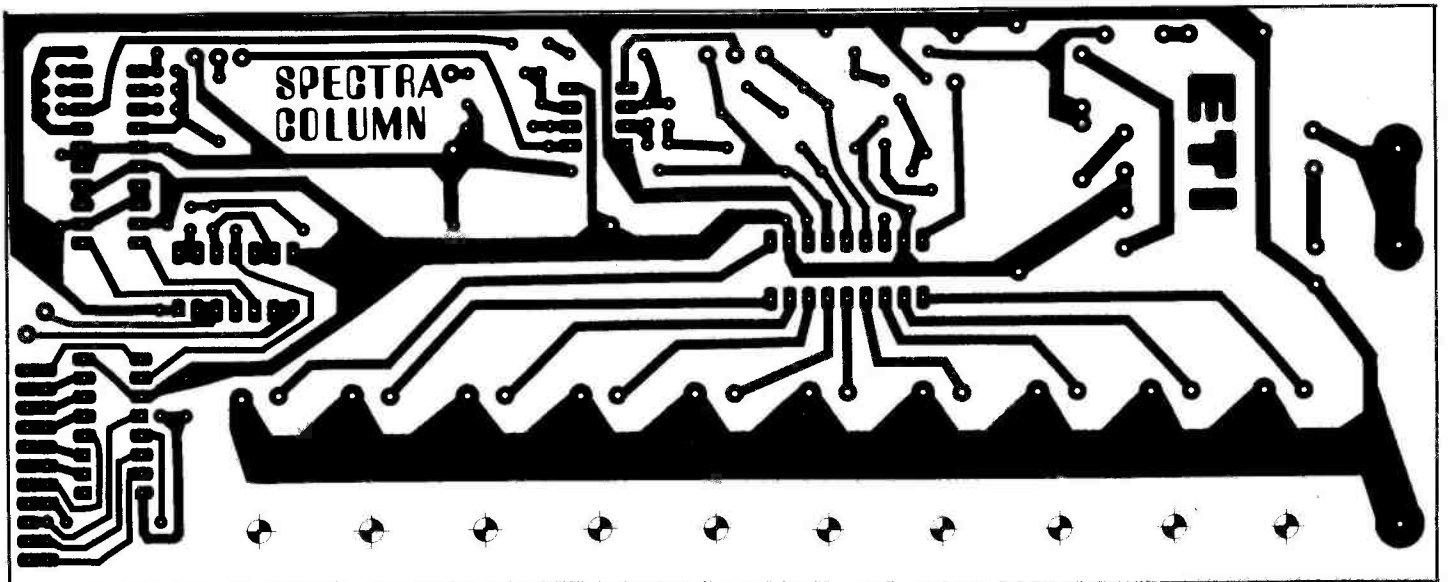
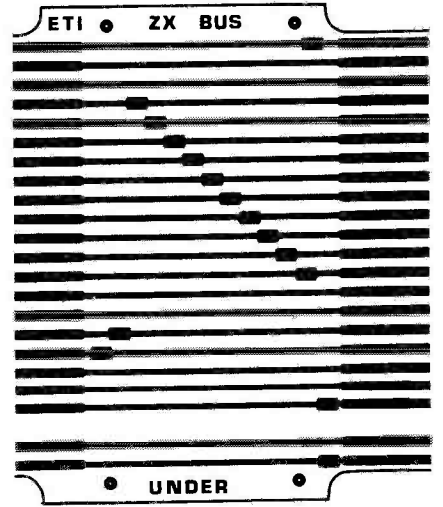
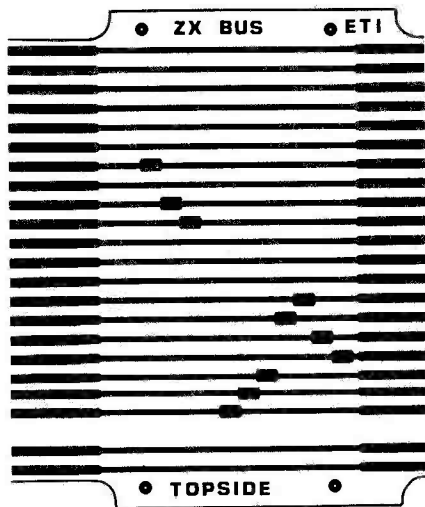
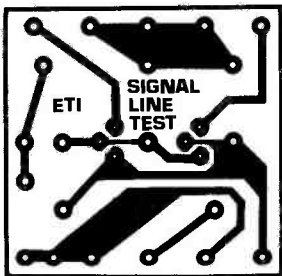
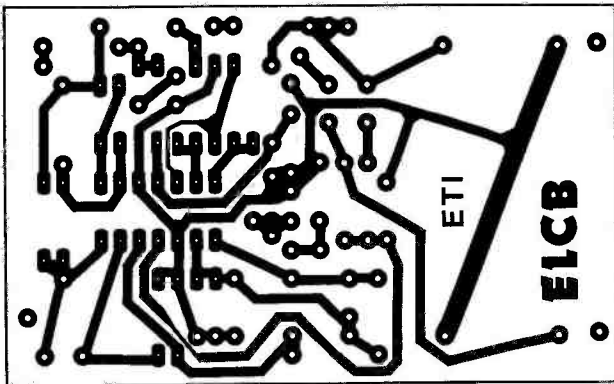
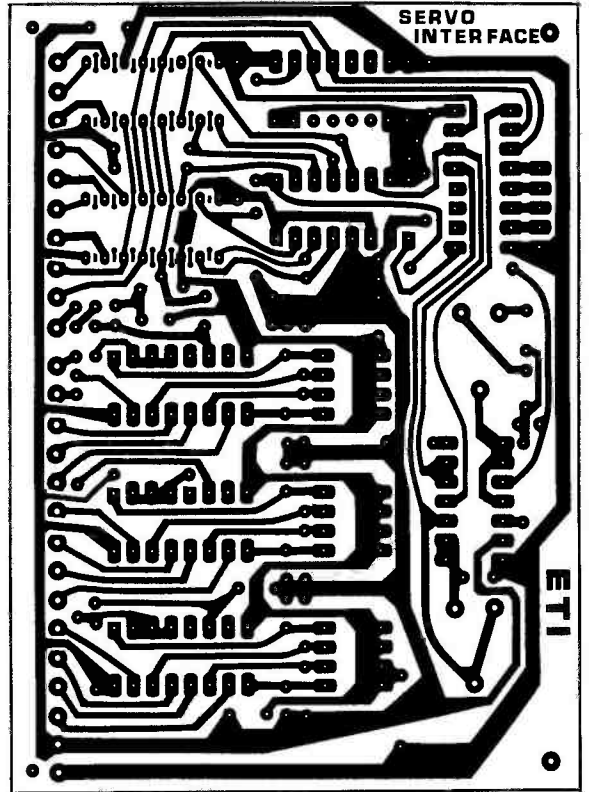
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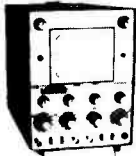
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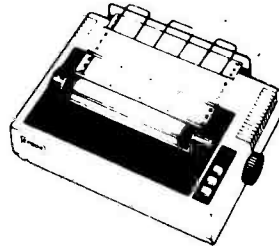
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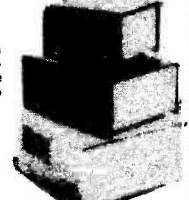
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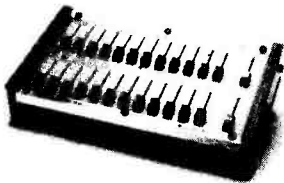
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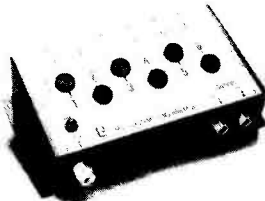
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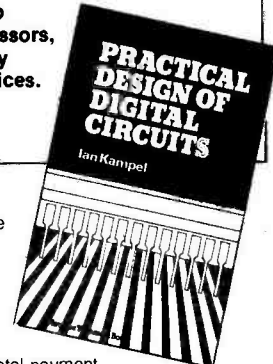
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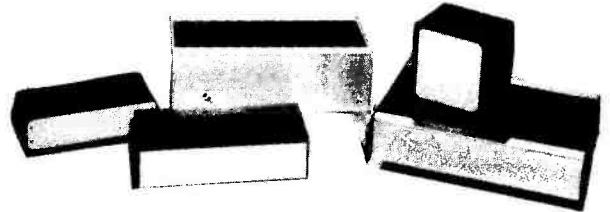
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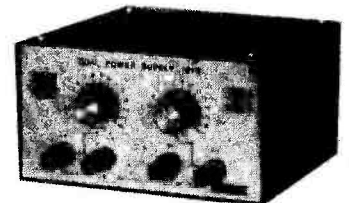


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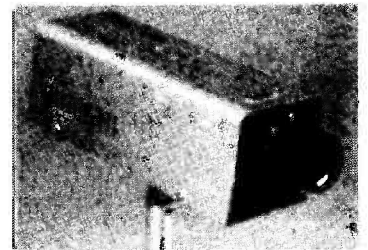
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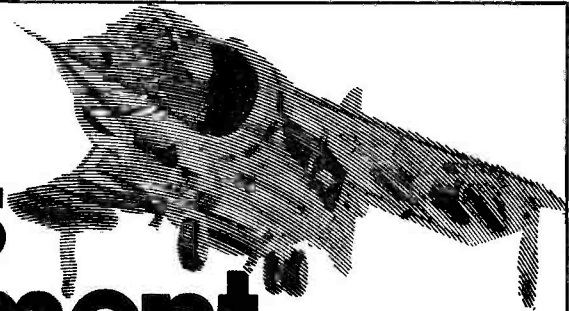
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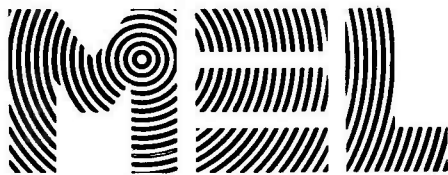
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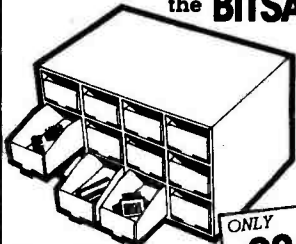
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Once again it's time to tread boldly into word-processor-land and sort out our year's offerings into alphabetical order. Everything we've done is listed (sometimes more than once under alternative names or alternative sections) with the exception of Digest (always up front), Foil Patterns (always up back) or Read/Write (why would you want to know where *that* was?)

FEATURES

A Decade of Electronics: 10 Years of ETI
Breadboarding Systems
Buying Mail Order
Casio FP-10 Printer
Circuit Supplement
Column Loudspeaker Design
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Electromusic Techniques Part 1
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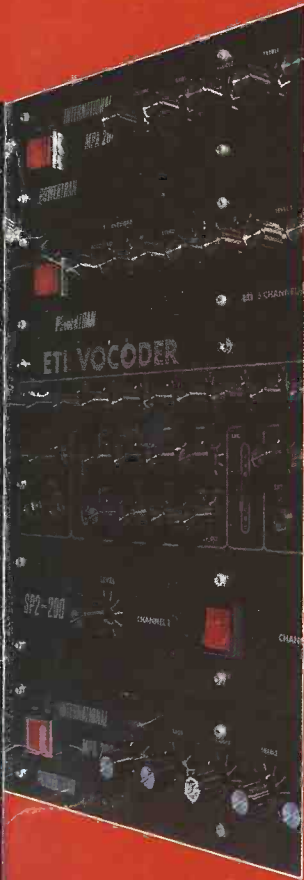
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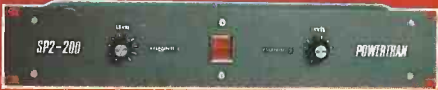
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