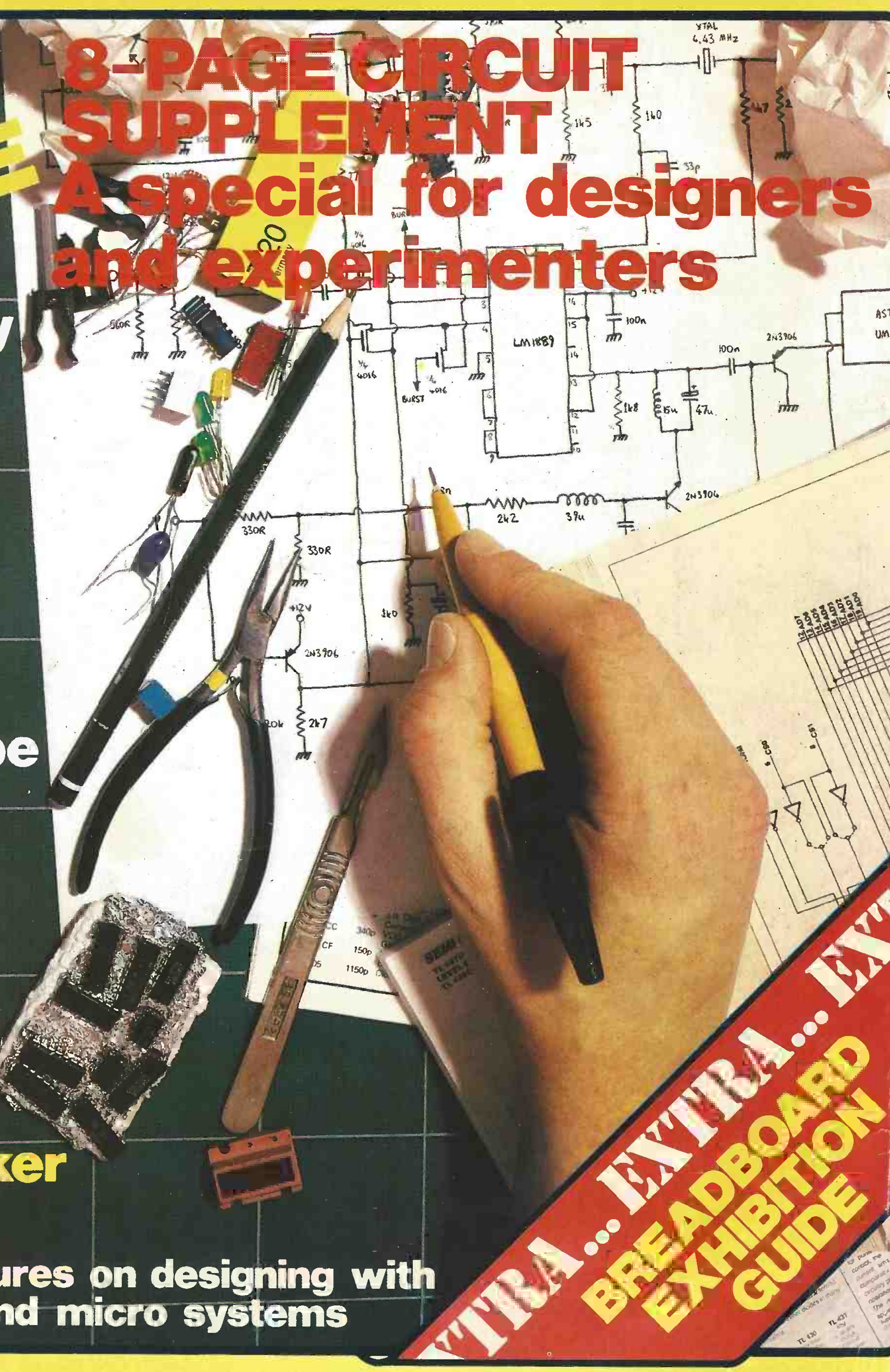
electronics today

INTERNATIONAL

DECEMBER 1982 85p



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Regular Features on designing with transistors and micro systems

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BREADBOARD EXHIBITION GUIDE

electronics today INTERNATIONAL DECEMBER 1982 VOL 11 NO 12

EDITORIAL AND ADVERTISEMENT OFFICE
145 Charing Cross Road, London WC2H 0EE. Telephone 01-437 1002/3/4/5.
Telex 8811896.

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PUBLISHED BY:
Argus Specialist Publications Ltd.,
145 Charing Cross Road, London WC2H 0EE.
DISTRIBUTED BY:
Argus Press Sales & Distribution Ltd.,
12-18 Paul Street, London EC2A 4JS
(British Isles)
PRINTED BY:
QB Limited, Colchester.
COVERS PRINTED BY:
Alabaster Passmore.

OVERSEAS EDITIONS and their EDITORS
AUSTRALIA — Roger Harrison
CANADA — Halvor Moorshead
GERMANY — Udo Wittig
HOLLAND — Anton Kriegsman

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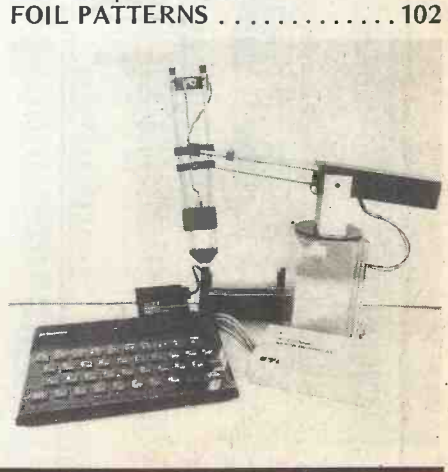
☐ Subscription Rates. UK £13.15 including postage. Airmail and other rates upon application to ETI Subscriptions Department, 513 London Road, Thornton Heath, Surrey CR4 6AR.

FEATURES

PROJECTS



INFORMATION

SWITCHES

TOGGLE: 2A, 250V.

SPST	33p
DPDT	44p

SUB-MIN TOGGLE

SPST on/off	54p
SPDT c/over	60p
SPDT centre off	85p
SPDT biased both ways	105p
DPDT 6 tags	75p
DPDT centre off	88p
DPDT biased both ways	145p
DPDT 3 positions on/on/on	185p
3-pole 2 way	205p

SLIDE 250V:

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

PUSHBUTTON 6A with 10mm Button

SPDT latching	99p
DPDT latching	145p
SPDT moment	99p
DPDT moment	145p

Mini Non Locking

Push to Make	15p
Push to Break	25p

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 65p
Mains DP 4A Switch to fit 45p
Spacers 4p. Screen 6p

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

THUMBWHEEL Mini front mounting

Decade Switch Module	220p
B.C.D. Switch Module	275p
Mounting Cheeks (per pair)	76p

VEROBOARD 0.1in

	clad	plain
2½ × 3¾"	80p	–
2½ × 5"	91p	–
3¾ × 3¾"	91p	–
3¾ × 5"	105p	87p
3¾ × 17"	380p	232p
4¾ × 17"	470p	–
Pkt. of 100 pins		50p
Spot face cutter		135p
Pin insertion tool		178p

VQ Board	180
DIP Board	360
Vero Strip	374

PROTO-DECs

Veroblock	405p
S-Dec	350p
Eurobreadboard	620p
Bimboard 1	575p
Superstrip SS2	1350p

VERO WIRING

PEN + spool	340p
Spare spool	75p
Combs	6p

DALO ETCH RESIST PEN Plus spare tip 90p

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

ULTRASONIC TRANSDUCER 40KHz 325 pr

COPPER CLAD BOARDS

	Fibre glass Single-sided	Double-sided	S.R.B.P. 9.5" × 8.5"
6" × 6"	90p	110p	95p
6" × 12"	150p	195p	

IDC CONNECTORS

	Female Header Socket	PCB Plugs with latch Pins Strt	PCB Plugs with latch pins Angle	Female Header Plug	PCB Pins Angled
10 way	90p	99p	85p	85p	
16 way	130p	150p	110p	78p	
20 way	145p	166p	125p	90p	
26 way	175p	200p	150p	110p	
34 way	205p	236p	189p	135p	
40 way	220p	250p	190p	150p	
50 way	235p	270p	200p	175p	
60 way	–	–	230p	220p	

EURO CONNECTORS

	Female Socket Strt. Pins	Female Socket Angle Pins	Male Plug Strt. Pins	Male Plug Angle Pins
DIN41617 31way	170p	–	–	175p
DIN41612 2×32 A+B	285p	325p	220p	295p
DIN41612 2×32 A+C	300p	340p	240p	300p
DIN41612 3×32 A+B+C	380p	386p	280p	400p

PANEL METERS

FSD 60 × 46 × 35mm

0-50µA, 0-100µA, 0-500µA, 0-1mA, 0-5mA, 0-10mA, 0-50mA, 0-100mA, 0-500mA, 0-1A, 0-2A, 0-25V, 0-50V AC, 0-300V AC, "S", "VU"

495p each

RELAYS

Miniature, enclosed, PCB mount. Our RL6 series.
S.P.C.O.
RL6-91 170Ω coil, 7V5 to 12V DC; 380V/6A AC; 1300VA/50W 210p
D.P.C.O.
43Ω coil, 4V2-7V DC; 250V AC; 5A; 1100VA/150W 218p
RL6-111 170Ω coil, 8V-14V; 250V AC 5A 220p
RL6-184 740Ω coil, 17V5-29V 250V 5A AC 222p

AMPHENOL PLUGS

IEEE 24 Way	560
Centronics Parallel 36 Way solder	530
Centronic Parallel 36 way IDC	560

BUZZERS, miniature, solid-state 6V; 9V & 12V 70p

LOUDSPEAKERS

Miniature, 0.3W: 8Ω
2in, 3½in, 2¾in, 3in 80p
2¾in 40Ω, 64Ω or 80Ω 80p

ASTEC UHF MODULATORS

Standard 6MHz	280p
Wideband 8MHz	425p

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Only £10 + 50p P&P

DIL SOCKETS

	Low Prof	Wire Wrap
8pin	8p	25p
14pin	10p	35p
16pin	10p	42p
18pin	16p	52p
20pin	20p	60p
22pin	22p	65p
24pin	25p	70p
28pin	28p	80p
40pin	30p	98p

EDGE CONNECTORS

	.1	.156
2 × 15 way	–	140p
2 × 18 way	180p	165p
2 × 22 way	198p	200p
2 × 23 way	190p	–
2 × 25 way	225p	220p
2 × 28 way	210p	–
2 × 30 way	245p	–
2 × 36 way	295p	–
2 × 40 way	315p	–
2 × 43 way	395p	–
2 × 75 way	650p	–

DIL PLUG (Headers)

	Solder	IDL
14pin	40p	99p
16pin	49p	105p
24pin	88p	178p
40pin	250p	255p

RIBBON CABLE

price per foot

	Grey	Color
10 way	12p	22p
16 way	18p	32p
20 way	25p	40p
24 way	35p	50p
34 way	48p	60p
40 way	55p	75p
50 way	65p	90p
64 way	85p	110p

ZIF DIL SOCKETS

24 pin	575p
28 pin	820
40 pin	975p

ETI PROJECTS We stock most of the parts

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	165p	240p	380p
Double ended DIP (Header Plug) Jumper				
6 inches	185p	205p	300p	465p
12 inches	198p	218p	318p	480p
24 inches	210p	235p	345p	540p
36 inches	230p	250p	375p	585p
IDC Header Socket Jumper Leads 24"	20 pin	26 pin	34 pin	40 pin
Single ended	160p	200p	280p	300p
Double ended	290p	370p	480p	525p

ANTEX SOLDERING IRON

C-15W	460p	CX17W	475p
CCN-15W	485p	CX25W	500p
Spare tips, assorted sizes			85p
Spare Elements			210p
Iron stand with sponge			165p

Soldercon Pins 100 pins 70p; 500 pins 325p

D CONNECTORS: Miniature

	9 way	15way	25way	37way
Plugs				
Solder lugs	80p	110p	160p	250p
Angle Pins	160p	210p	250p	355p
W/Wrap Pins	120p	130p	195p	296p
Sockets				
Solder lugs	110p	160p	210p	350p
Angled Pins	165p	215p	280p	440p
W/Wrap Pins	150p	180p	240p	420p
Covers	85p	95p	95p	110p

25 way 'D' CONNECTOR Jumper Lead Cable Assembly

18" long, Single end, Male	495p
18" long, Single end, Female	525p
36" long, Double Ended, M/M	1025p
36" long, Double Ended, F/F	1050p
36" long, Double Ended, M/F	995p

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32.768KHz	100
100KHz	235
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455KH	370
1MHz	275
1.008M	275
1.28MHz	392
1.6MHz	395
1.8NHz	395
1.8432M	200
2.0MHz	225
2.4576M	209
3.278M	160
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.80MHz	200
4.194304M	200
4.433619M	100
5.0MHz	180
5.185MHz	300
5.24288M	380
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.86723M	175
9.00MHz	150
10.0MHz	175
10.24MHz	200
10.7	160
12.0NHz	175
12.528M	300
14.31814M	170
16.0MHz	200
18.0MHz	180
18.432M	200
20.0MHz	150
19.968MHz	160
24.0MHz	170
24.930MHz	325
26.69M	160
27.648M	170
27.145M	180
38.66667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	250

BBC MICRO UPGRADE

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Complete Upgrade Kit from Model A to Mod. B	£45

range of Connectors & Cables available. Send SAE for list

PIEZOI TRANSDUCERS PB2720 55p

TRANSFORMERS: Prim. 240V

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

pcb mounting. Miniature, Split Bobbin
3VA: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 2x15V-0.1A 200p
6VA: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 2x15V-0.2A 270p

Standard Split Bobbin type:
6VA: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 2x15V-0.25A 220p
12VA: 2x4.5V-1.3A; 2x6V-1A; 2x9V-0.6A; 2x12V-0.5A; 2x15V-0.4A; 2x20V-0.3A 295p (35p p&p)
24VA: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 2x15V-0.8A; 2x20V-0.6A 330p (60p p&p)
50VA: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-1.5A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A 465p (60p p&p)
100VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 2x25V-2A; 2x30V-1.5A 820p (75p p&p charge to be added over and above our normal postal charge).

VOLTAGE REGULATORS

	+ve			–ve	
1A	**T03**	Metal case			
5V	7805	145p		7905	220p
12V	7812	145p		7912	220p
15V	7815	145p		7915	220p
18V	7818	145p			
1A	**TO220**	Plastic casing			
5V	7805	40p		7905	45p
12V	7812	40p		7908	60p
15V	7815	40p		7912	45p
18V	7818	40p		7915	45p
24V	7824	40p		7918	45p
				7924	45p
100mA	**TO92**	Plastic casing			
5V	78L05	30p		79L05	60p
6V	78L62	30p			
8V	78L82	30p			
12V	78L12	30p		79L12	60p
15V	78L15	30p		79L15	60p

CA3085	95p
LM300H	170p
LM304H	170p
LM305H	140p
LM309K	135p
LM317K	320p
LM317KP	99p
LM317H	280p
LM323K	500p
LM325N	240p
LM326N	240p
LM337	175p
LM723	35p
TAA550	50p
TBA625B	75p
TDA1412	150p
78H05 + 5V/5A	550p
78H12 + 12V/5A	580p
78HG +5V to +25V 5A	599p
79HG-2.25V to 24V 5A	695p

CMOS

4000	10	4075	13	4541	140
4001	10	4076	60	4543	80
4002	12	4077	13	4544	150
4006	60	4078	16	4548	40
4007	14	4081	13	4549	375
4008	32	4082	13	4553	245
4009	24	4085	60	4554	180
4010	24	4086	60	4555	35
4011	10	4089	125	4556	35
4012	16	4093	20	4557	320
4013	20	4094	70	4558	120
4014	46	4095	95	4559	395
4015	40	4096	70	4560	180
4016	20	4097	290	4561	104
4017	32	4098	75	4562	465
4018	45	4099	110	4566	165
4019	25	4180	95	4568	250
4020	42	4161	99	4569	175
4021	40	4162	99	4572	30
4022	40	4163	99	4580	460
4023	13	4174	99	4581	250
4024	32	4175	105	4582	99
4025	13	4194	105	4583	99
4026	80	4408	780	4584	48
4027	20	4409	780	4585	99
4028	39	4410	725	4597	330
4029	45	4411	675	4598	280
4030	15	4412	775	4599	280
4031	125	4415	480	40085	90
4032	80	4419	280	40097	45
4033	125	4422	770	40098	193
4034	140	4435	850	40100	215
4035	46	4440	999	40101	130
4036	275	4450	350	40102	140
4037	115	4451	350	40103	176
4038	110	4490	350	40104	95
4039	250	4500	675	40105	110
4040	40	4501	28	40106	46
4041	40	4502	40	40107	80
4042	40	4503	40	40108	450
4043	40	4504	76	40109	100
4044	40	4505	185	40110	300
4045	105	4506	35	40114	240
4046	46	4507	35	40161	194
4047	40	4508	130	40163	85
4048	40	4510	40	40174	85
4049	25	4511	45	40175	85
4050	25	4512	50	40181	220
4051	45	4513	199	40182	90
4052	45	4514	115	40192	90
4053	60	4515	115	40193	85
4054	60	4516	55	40194	90
4055	85	4517	275	40195	72
4056	85	4518	40	40244	195
4057	1015	4519	30	40245	195
4059	435	4520	60	40257	195
4060	46	4521	110	40373	240
4061	1195	4522	125	40374	245
4062	995	4526	70	45106	595
4063	85	4527	65		
4066	24	4528	70		
4067	395	4529	150		
4068	14	4530	90		
4069	16	4531	130		
4070	13	4532	70		
4071	13	4534	465		
4072	13	4536	275		
4073	16	4538	90		
		4539	110		

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0.2" Bi colour Red/Green	65
Green/Yellow	78
0.2" Tri colour Red/Green/Yellow	85
Hi-Brightness Red	59
Flashing red 0.2" red	55
Square LEDs, Red, Green, Yellow	30
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Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	48
SFH205 Detector	118
TIL32 Infra Red	58
TIL78 Detector	60
TIL38	60
TIL100	80
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ISOLATORS	
IL74	55
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TIL322 .5" CC	115
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DL707 .3" CA	99
FND357 Red	120
FND500	115
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.6" Green CA	215
.3" ±1 Red CA	150
.3" ±1 Green CA	150
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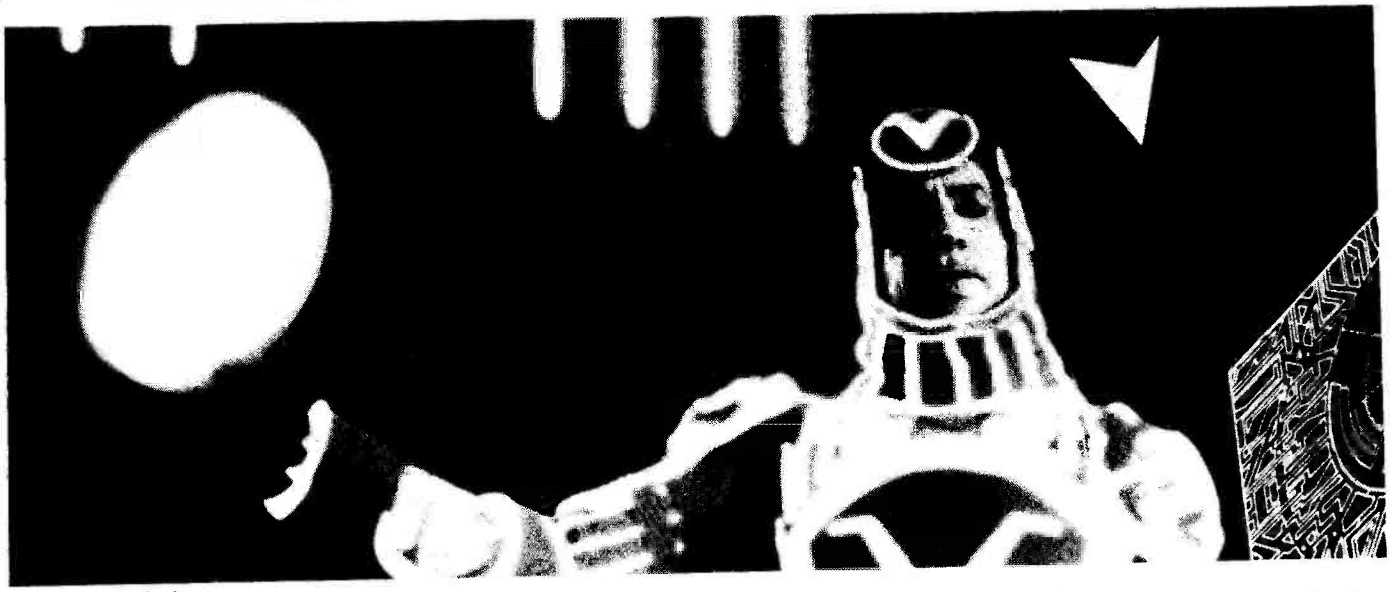


Walt Disney Productions

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

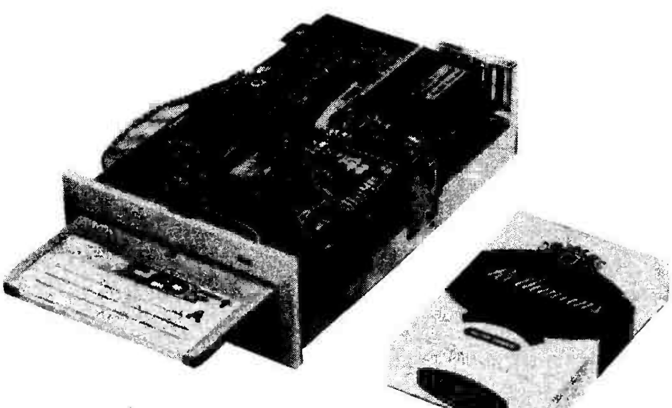
DIGEST

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 Gobal 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 OMNIBLOCK, 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

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 Datac 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 subjcts 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 1 GHz. 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" × 1.0" × 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:

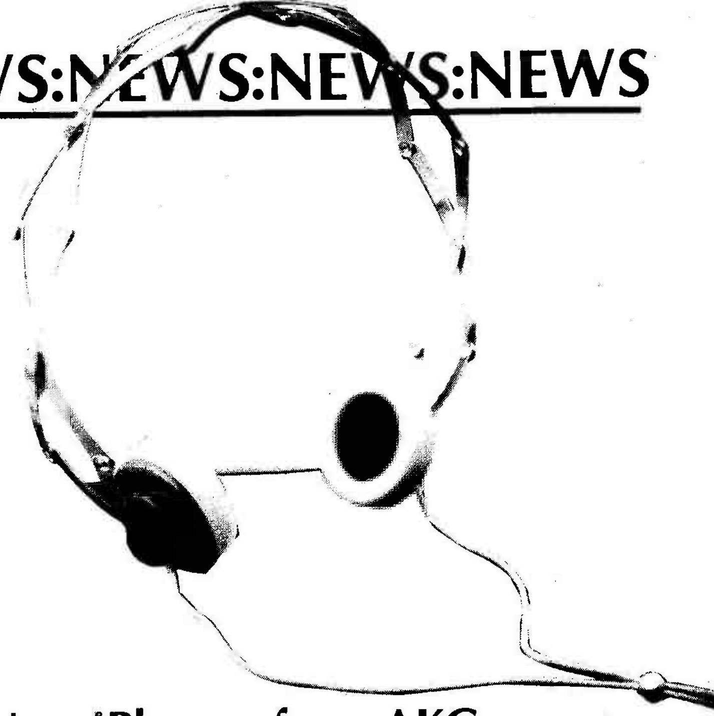
- flexibility: service can be introduced at very short notice and expanded or reconfigured equally quickly
- diversity: digital operation allows many different services, such as speech, telex, facsimile or data, to be integrated on the same transmission path while advanced services can be added quickly 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 probably 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 multi-national, engaged in news disemination 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 monolothic 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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Slew rate	>30 V/uS
Gain	x 23
Rin	30K
Vs max	± 70V

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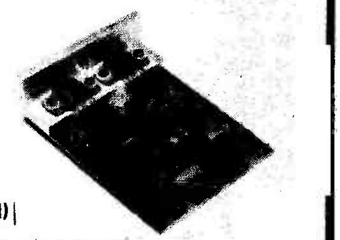

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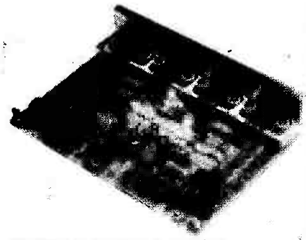

PFA200 180W into 8Ω
300W into 4Ω

PFA200 Specification

Bandwidth	10Hz-100KHz ± 1dB
Output power into 8Ω	150W (Vs ± 60V)
THD (20Hz-20KHz)	< 0.005%
THD (1KHz at 150W)	0.002% typ
SNR	120dB
Slew rate	>30 V/uS
Gain	x 23
Rin	30K
Vs max	± 70V

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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.

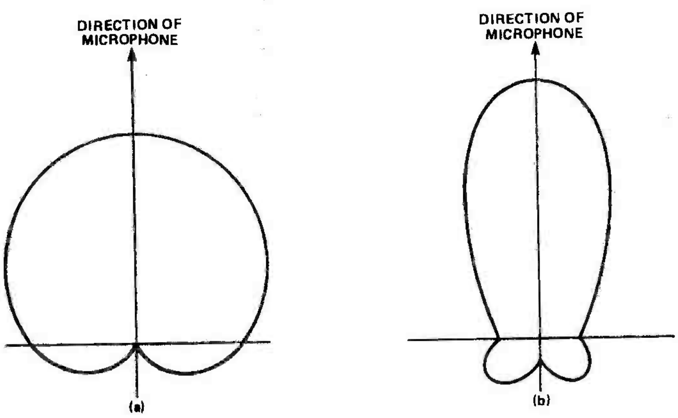


Fig. 1 Cardioid polar response (a) and super-directional response (b) obtained from a pair of out-of-phase cardioids. The response is at a nominal 1 kHz and changes for other frequencies.

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 omni-directional 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 omni-directional 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 hyper-cardioid, 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.

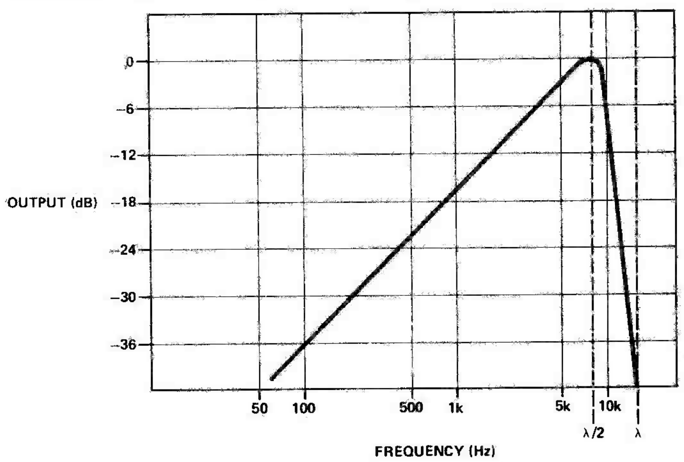


Fig. 2 The frequency response for a pair of out-of-phase cardioids (mounted in line) peaks at the frequency at which the half-wavelength equals the spacing between them. Below, it decreases at 6 dB/octave, requiring high gain at low frequencies to equalise. Above, the response drops rapidly to zero at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

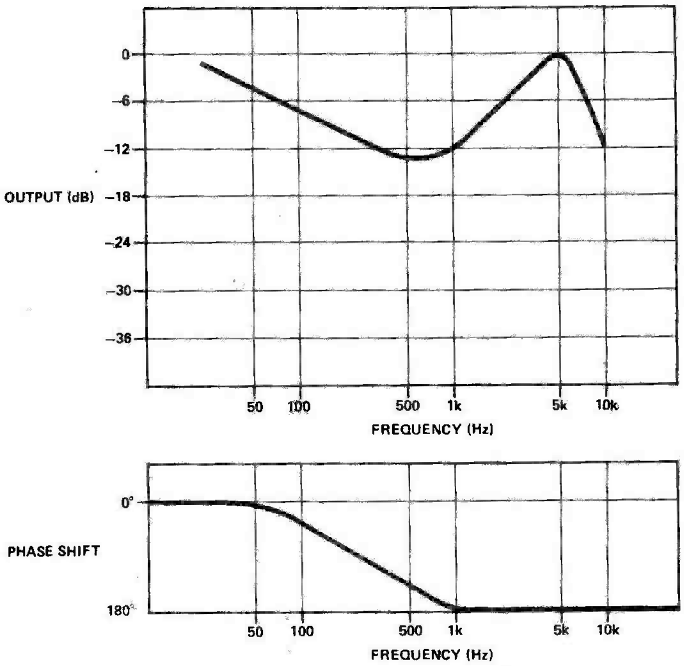


Fig. 3 The response of a cardioid pair when the phase is progressively rotated from 180° to 0° below the mid-range. The bottom chart shows the phase rotation.

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 ciruit, 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 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

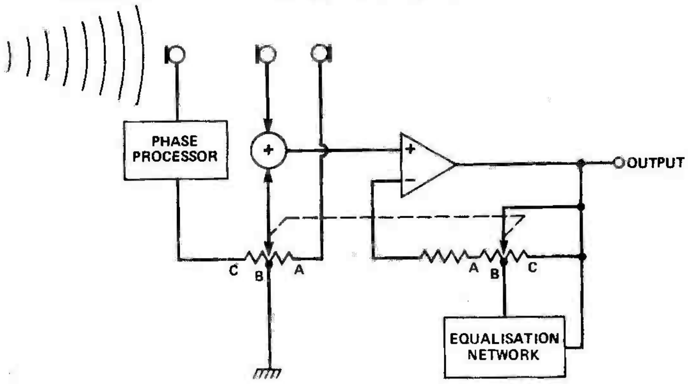


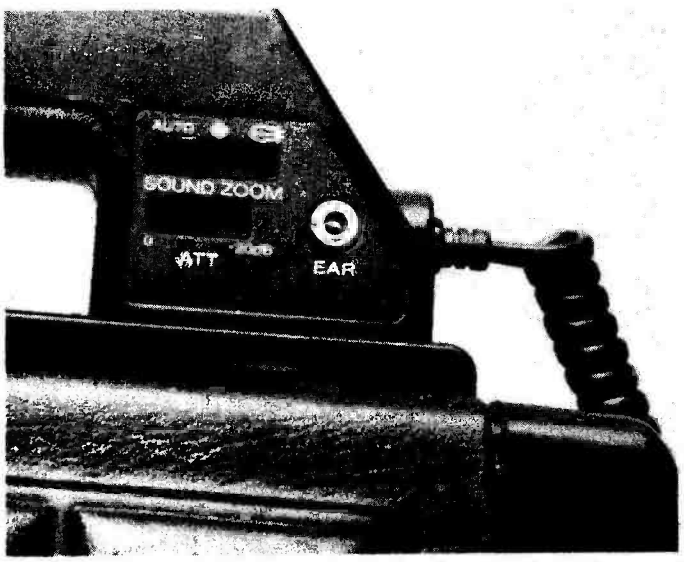
Fig. 4 Block diagram of the JVC zoom microphone.

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. ETI



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

CHRISTMAS PRESENTS GALORE

HOME LIGHTING KITS

These kits contain all necessary components and full instructions & are designed to replace a standard wall switch and control up to 300w. of lighting.

TDR300K	Remote Control Dimmer	£14.30
MK6	Transmitter for above	£ 4.20
TD300K	Touchdimmer	£ 7.00
TDE/K	Extension kit for 2-way switching for TD300K	£ 2.00
LD300K	Rotary Controlled Dimmer	£ 3.50

HOME CONTROL CENTRE

This New Remote Control Kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains wiring which are received by receiver modules connected to the same mains supply and used to switch on the appliance addressed. Receivers are addressed by means of a 16-way keyboard, followed by an on or off command. Since pushing buttons can become rather boring, the transmitter also includes a computer interface so you can programme your favourite micro to switch lights, heating, electric blanket, make your coffee in the morning, etc., without rewiring your house. JUST THINK OF THE POSSIBILITIES. The KIT includes all PCBs and components for one transmitter and two receivers, plus a drilled box for the transmitter.

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Additional Recievers XK111 £10.00

ELECTRONIC LOCK KIT XK101

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

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Electric lock mechanism for use with latch locks and above kit

£13.50

3-NOTE DOOR CHIME

Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 x 71 x 35mm) and full instructions. Requires only a PP3 9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK102. **£5.00**

MW RADIO KIT

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

LIGHT DIMMER KIT

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This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (-50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day. 7 days a week.

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DLZ1000K
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"OPEN-SESAME"

The XK103 is a general purpose infra-red transmitter/receiver with one momentary (normally open) relay contact and two latched transistor output. Designed primarily for controlling motorised garage doors and two auxillary outputs for drive/garage lights at a range of up to 40 ft. The unit also has numerous applications in the home for switching lights, TV, closing curtains, etc. Ideal for aged or disabled persons.
The Kit comprises a mains powered receiver, a four button transmitter, complete with pre-drilled box, requiring a 9V battery and one opto-isolated solid state switch kit for interfacing the receiver to mains appliances. As with all our kits, full instructions are supplied.

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MK6 SIMPLE INFRA RED TRANSMITTER
Pulsed infra red source complete with hand-held plastic box. Requires a 9V battery **£4.20**
MK7 INFRA RED RECEIVER
Single channel, range approx. 20ft. Mains powered with a triac output to switch loads up to 500W at 240V ac. **£9.00** (RC500K –Special Price for MK6 and MK7 together **£12.50**
MK8 CODED INFRA RED TRANSMITTER
Based on the SL490, the kit includes all components to make a coded transmitter and only requires a 9V (PP3) battery and keyboard. 8 x 2 x 1.3cms **£5.90**
MK10 16-WAY KEYBOARD
For use with MK8 and MK18 to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) kit. **£5.40**
MK11 10-Channel + 3 Analogue o/p IR Receiver
Based on ML922 decoder IC. Functions include on/standby output, toggle, control of volume, tone and lamp brightness. Includes its own mains supply. **£12.00**
MK12 16-CHANNEL IR RECEIVER
For use with MK8 kit with 16 on/off outputs, which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Latched or momentary outputs – please specify when ordering. Includes its own mains supply. **£11.95**
MK13 11-WAY KEYBOARD For use with MK8, MK18 and MK11 kits. **£4.35**
MK16 Mains Powered IR Transmitter
Mains powered for continuous operation – single channel, for applications such as burglar alarms, automatic door openers, etc. Range approx. 6 ft. **£2.50**
MK17 12V d.c. IR RECEIVER
For use with MK6 or MK16. Relay output with DP 3 Amp change-over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 6-13V d.c. **£9.50**
MK18 HIGH POWER IR TRANSMITTER
Similar to MK8 but with range of approx. 60ft. **£6.20**
Ancillary Kits : MK2 Solid State Relay
Opto-isolated with zero voltage switching. No. triac supplied. **£2.60**
MK15 DUAL LATCHED SOLID STATE RELAY
Comprises 2 x solid state relays and latch for use with momentary version of the MK12. 2 output triacs required (not supplied). **£4.50**

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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).

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.

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 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 taped, 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!

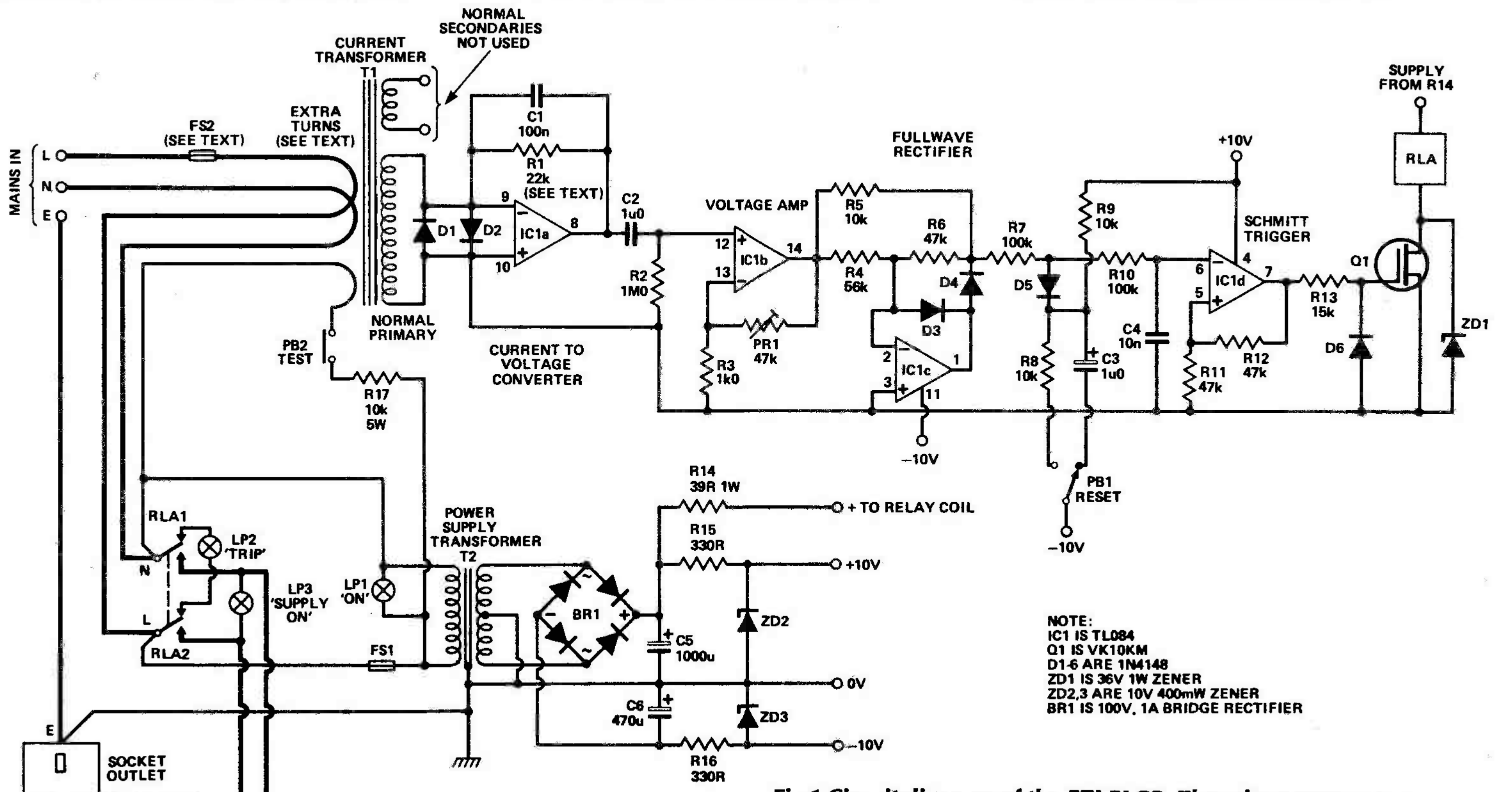


Fig 1 Circuit diagram of the ETI ELCB. The relay contacts are shown in the 'tripped' position.

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 miliseconds (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

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 lowing 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.

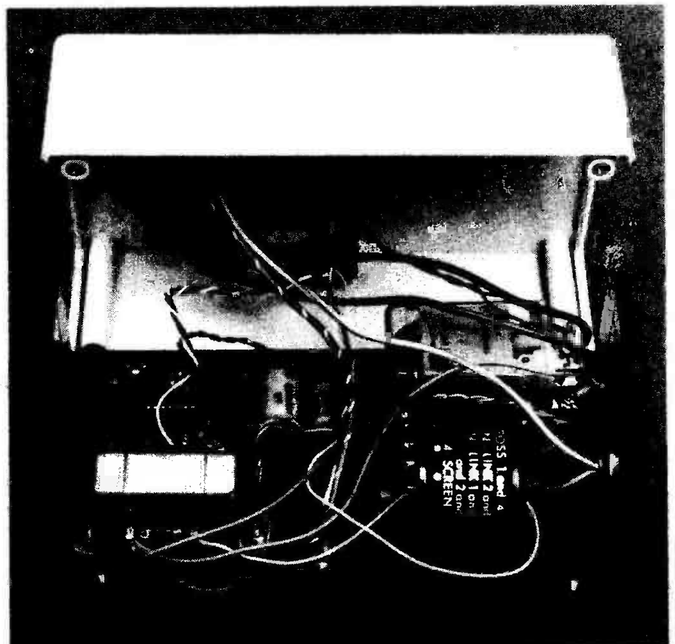
When the input to IC1c is negative the output of IC1c will be positive, D3 is now non-conducting and the inverting input of IC1c will again be held at 0 V, but this time via R5 and R6: the output from the circuit will again be positive. The values of R4, 5 and 6 are chosen to give approximately equal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

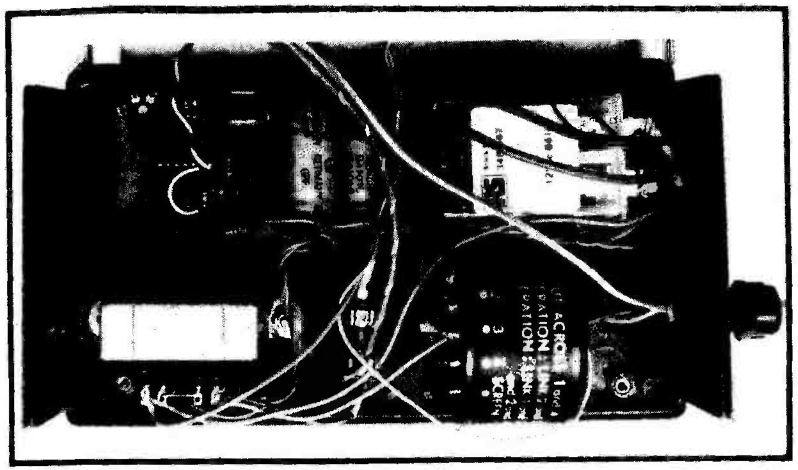
The output from the rectifier circuit passes via R7 and R10 to the inverting input of IC1d. This section of IC1 is connected as a Schmitt trigger. Its function is to stay in one of two states until the input reaches a voltage level sufficient to change it to the other.

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.





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.

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 mm^2 flex (1.0 mm^2 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.

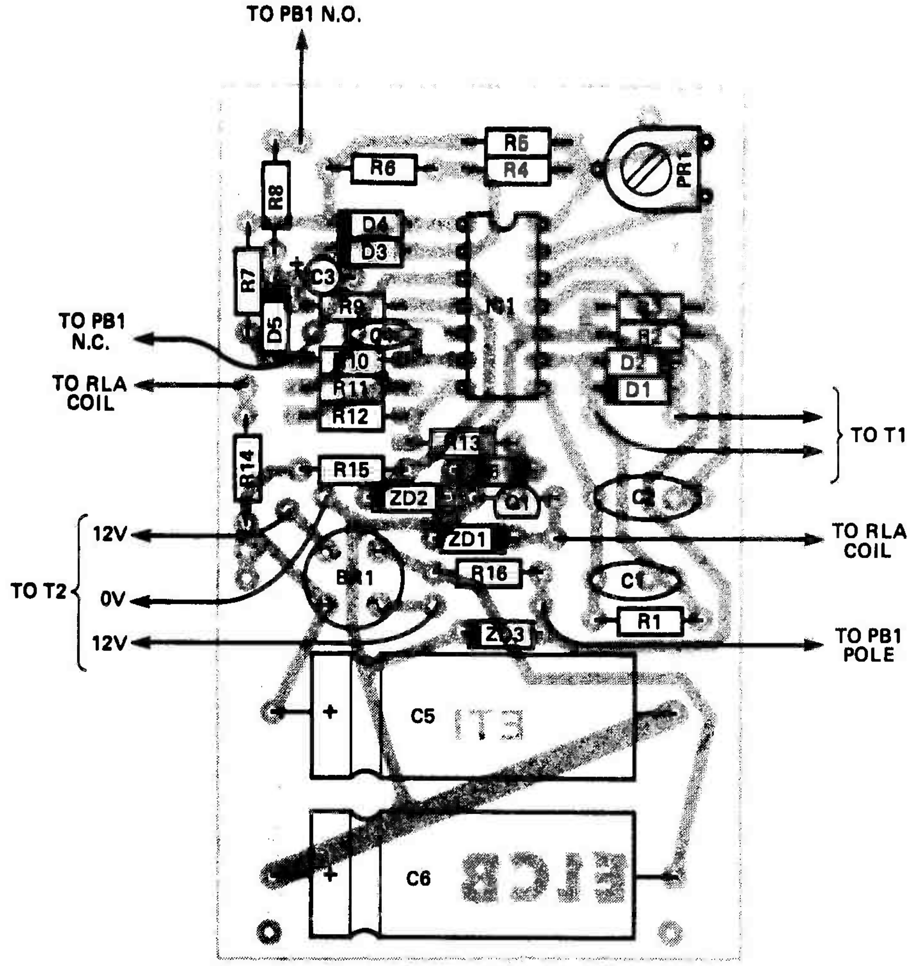


Fig. 2 Component overlay for the ELCB.

PARTS LIST

Resistors (all ¼W, 5%, except where stated)

R1	22k (see text)
R2	1M0
R3	1k0
R4	56k
R5, 8, 9	10k
R6, 11, 12	47k
R7, 10	100k
R13	15k
R14	39R 1 W (or four 150R ¼W in parallel)
R15, 16	330R
R17	10k 5 W wirewound

Potentiometer

PR1	47k miniature horizontal preset

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
ZD1	36 V 1 W zener
ZD2, 3	10 V 400 mW zener
BR1	100 V, 1 A miniature potted bridge rectifier

Miscellaneous

T1	toroidal mains transformer with extra windings (see text)
T2	12-0-12 6 VA transformer
PB1	one-pole changeover momentary action push-button
PB2	one-pole push-to-make momentary-action push-button
FS1	250 mA 20 mm fuse and chassis-mounting fuseholder
RLA	two-pole relay, 12 V coil, contacts rated at 250 V, 10 or 20 amps (see text)
LP1	amber mains neon (panel-mounting)
LP2	red mains neon (panel-mounting)
LP3	green mains neon (panel-mounting)

PCB (see Buylines): flush-mounting mains wall outlet socket; cable gland to suit mains cable; case, West Hyde BOC 450 (188 × 110 × 70 mm), nylon bolts, wire, cable ties, hardware etc.

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 . . . **ETI**

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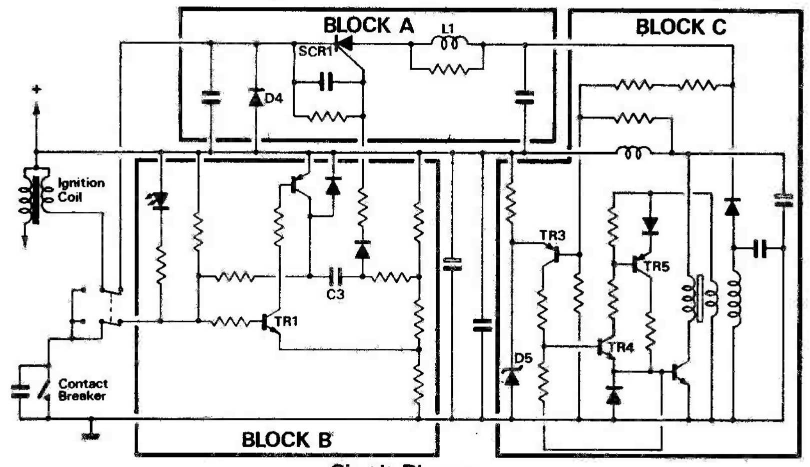

Circuit Diagram

The discharge circuit in block A is the heart of the system. It looks simple but outperforms any other by far. A 2 µF 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 invertor 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	500µS	160µS
Output Voltage		
clean spark plug	38kV	26kV
fouled spark plug	26kV	17kV
Voltage Rise Time to 20kV	25µS	30µS

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**
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TWIN OUTPUT UNIT **£36.45**
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TWIN OUTPUT KIT **£24.55**

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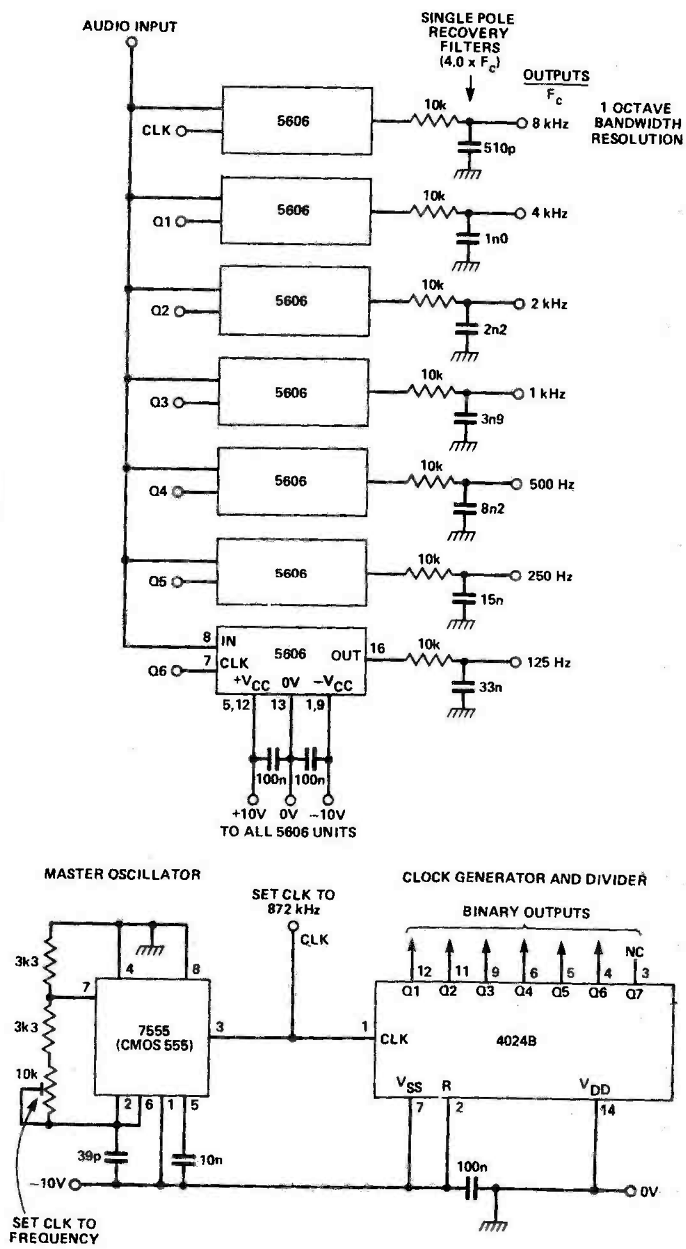
VISA

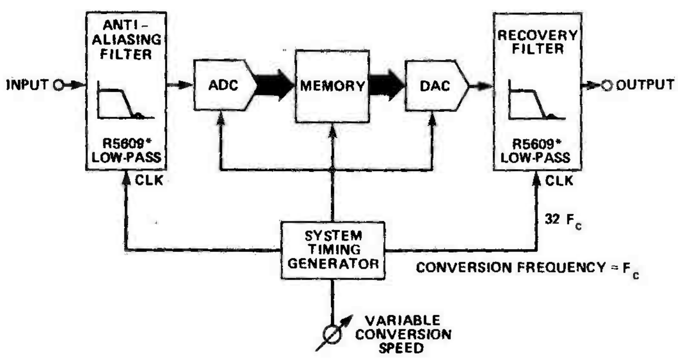
DESIGNER'S NOTEBOOK

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 ⅓ 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.

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

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

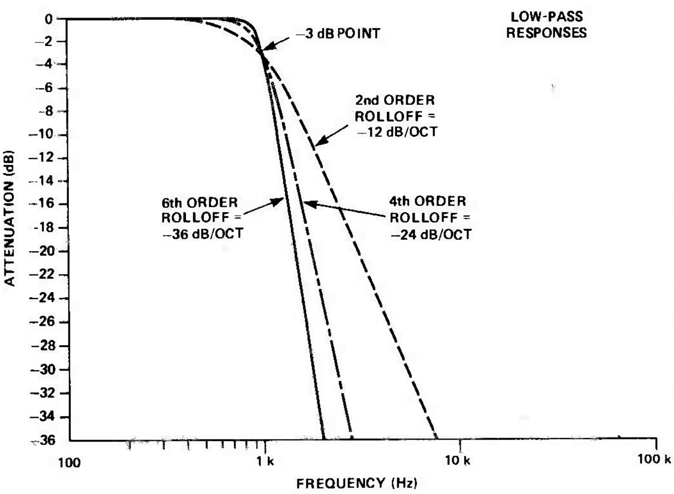
Audio Converter With Tracking Filter

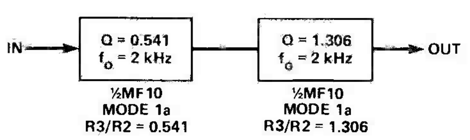
The R5609 is a steep low-pass filter which can be used as an anti-aliasing filter and recovery filter in an audio converter, such a digital delay line. If the clock for the filter is derived from the system clock and the A-to-D converter, then the low-pass filter frequency will track any changes in the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

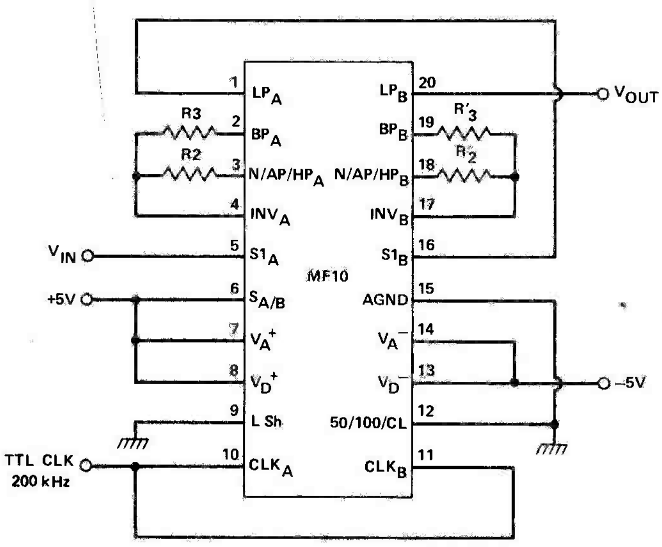
Low-Pass Response Using the MF10

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 R3 = 10k. Then R2 = 18.48k (15k + 3k6 would do). For the second stage let R2 = 10k, then R3 = 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).





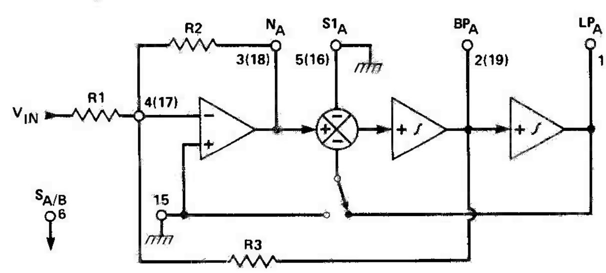


LOW-PASS FILTER RESPONSE	1st STAGE		2nd STAGE		3rd STAGE	
	f_o	Q	f_o	Q	f_o	Q
2nd ORDER BUTTERWORTH (FLAT RESPONSE)	1.0 F	0.707				
2nd ORDER CHEBYCHEV (3dB RIPPLE)	0.84 F	1.304				
4th ORDER BUTTERWORTH	1.0 F	0.54	1.0 F	1.306		
4th ORDER CHEBYCHEV	0.443 F	1.076	0.95 F	5.58		
6th ORDER BUTTERWORTH	1.0 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

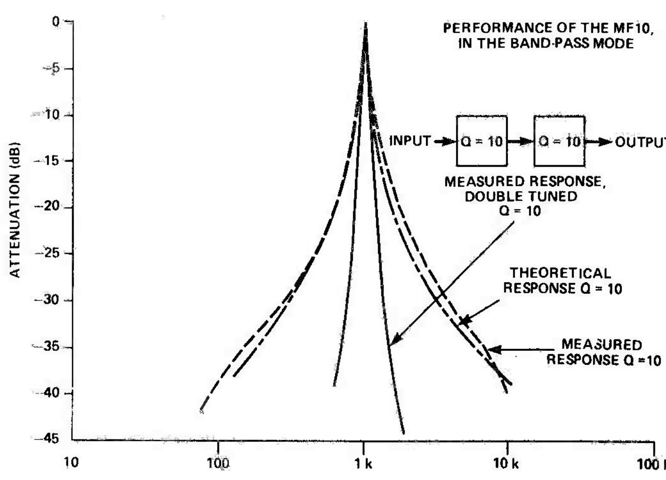
* For the equivalent highpass response, use the same Q factor but use the reciprocal of the frequency multiplier.

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, R3 = 100k and R2 = 10k. To give the filter unity gain at resonance, R1 = R3 = 100k. The external clock frequency determines the resonant frequency. By cascading two filters with a Q of 10, a very sharp resonance curve is producedasyou 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.



MODE 1



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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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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 **£195.00**

if purchased as a kit without TA2080 **£295.00**

Softy 1 with PSU

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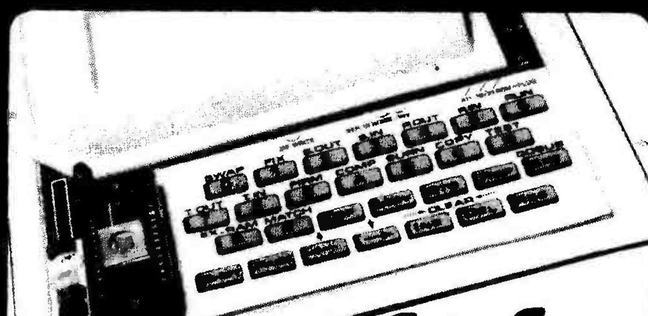
Ultra-Violet Eprom Erasers from **£33.00**



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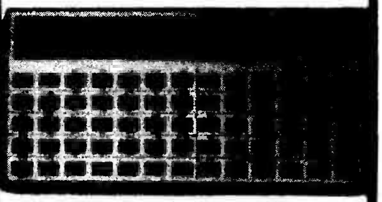

FX-702P the casio pocket computer/calculator, basic programming, 55 scientific functions, up to 1,680 program steps.
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MG-777 calculator with clock, 3 games and memory functions.
PRICE........£13.95

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AM535 – 1605KHZ radio watch supplied complete with good quality lightweight headphones.
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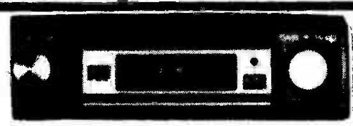
ALARM VERSION........£17.95



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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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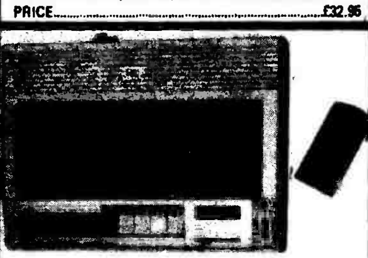

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Standard twin cassette deck, microprocessor control, 2 digit LED message counter, incoming call monitoring, answer only mode, 2-way conversation recording, can be used as an ordinary tape recorder remote control bleeper included.
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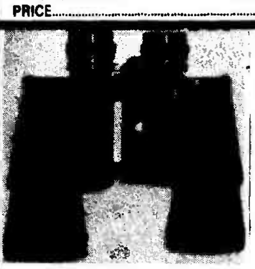

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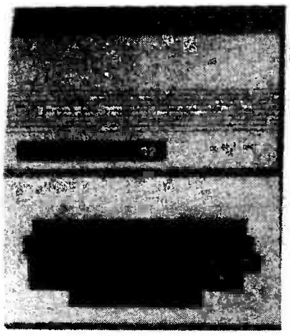

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A NEW BRITISH MADE COMPUTER

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DRAGON 32 MICROCOMPUTER........£189.95
SOFTWARE ON CASSETTES........£6.95 each
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30 CPS PARALLEL PRINTER........£205.95
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BBC MICROCOMPUTER

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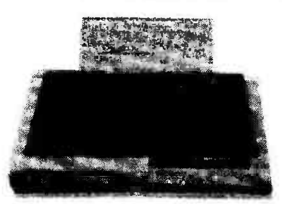

Dot matrix Parallel printer suitable for use with, DRAGON 32, BBC and all other computers with centronic compatible parallel interface. Speed 30 CPS, Double width char., standard char., tractor feed, very good graphic capabilities, selectable line spacing.
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80 column, 80 CPS, dot matrix printer with high res. graphic capabilities, tractor feed, parallel interface.
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RIBBON FOR MX80........£6.00
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Dual time, alarm, chronograph with lap time in metal case and stainless steel bracelet. 5 year non stop lithiam battery.
PRICE........£8.95

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Dual time, alarm, chronograph in black resin case. 5 year non stop lithiam battery.
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SANYO SM12H-12 inch green monitor.
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14 inch colour TV.
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SANYO SM12H-12 inch green monitor.
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BMC 12A-12 inch green monitor.
PRICE........£79.95
14 inch colour TV.
PRICE........£228.95
SANYO SMC14H-14 inch high ves. colour monitor.
PRICE........£431.95

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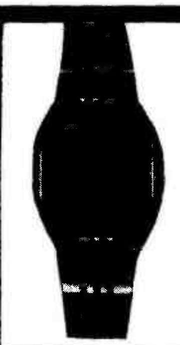
CASIO AX-250



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, battery, 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, +, −, ×, ÷, and constant calculations. Stainless steel bracelet, lithiam battery.
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CASIO M-321

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, lithiam 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 lithiam battery.
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CASIO WS-70

50 meter water resistant, watch in metal case. Dual time, alarm, chronograph, countdown timer, attractive stainless steel bracelet.
PRICE........£19.95

2 CHANNEL HAND HELD FM-CB RIG

27 MHZ FM (U.K. SPEC) Transreceiver, 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 inpute range, 1 nA to 1 mA
- 35 volt output capability
- high output impedance
- typically less than ±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 sufix have different temperature ranges and guaranteed current ratio tolerances over those ranges.
C suffix: 0 to 70 deg C, ±10% over full range
I suffix: −40 to 85 deg C, ±8% over full range
M suffix: −55 to 125 deg C, ±7% over full range

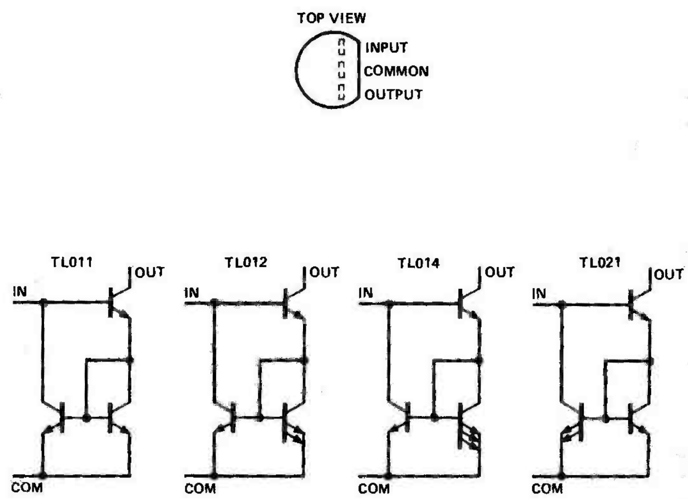


Fig. 1 Pin out and simplified internal circuitry of the TL011, TL012, TL014, TL021.

Electrical characteristics: TL011, etc	min	typ	max
Input voltage (V) (note 1) $I_{IN} = 1$ uA	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) $I_{IN} = 1$ uA	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.

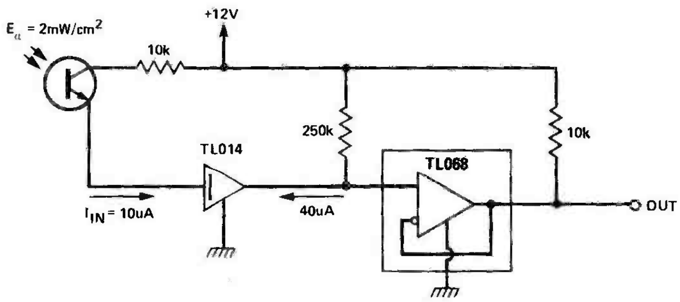


Fig. 2 A phototransistor amplifier using a TL014.

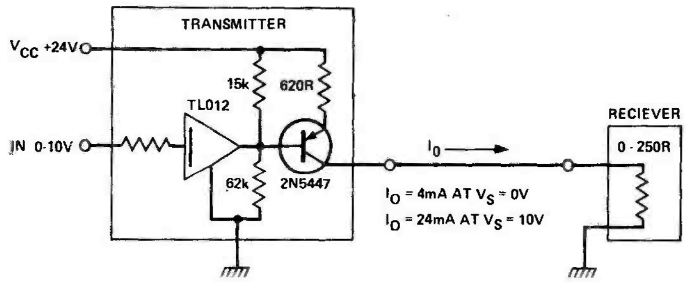


Fig. 3 A two wire current-mode transmitter using the TL012.

AD536, AD636 (Analogue Devices) RMS to DC Convertors

- true RMS to DC conversion
- dB output with 60 dB range (50 dB 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.

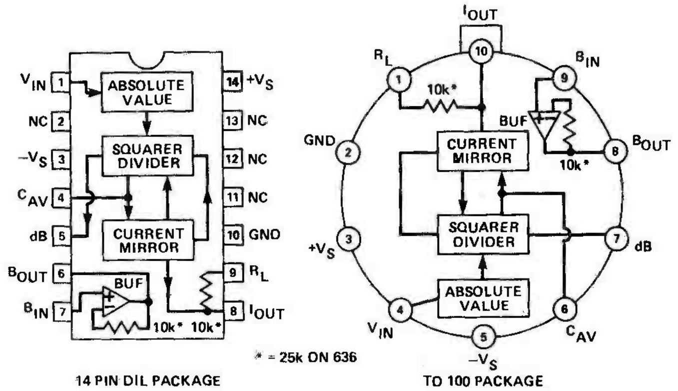


Fig. 4 (right) Pin out of the AD536 and AD636.

Electrical characteristics		**AD536** (note 1)	**AD636** (note 1)
Input	peak max. for rated performance	±20 V for ±15 V supply ±5 V for +5 V supply	±5 V for ±5 V supply ±5 V for ±2V5 supply
	max safe input	±25 V	±12 V
	input resistance	approx 17 kΩ	approx 7 kΩ
Accuracy	without ext. trim	+5 mV ±0.5% (7 V RMS	+5 mV ±1% (200 mV RMS
	with ext. trim	±3 mV ±0.3% input)	±3 mV ±0.3% input)
Frequency response (note 2)	V_{IN} = 10 mV	6 kHz	12 kHz
	V_{In} = 100 mV	40 kHz	80 kHz
	V_{IN} = 1 V	100 kHz	130 kHz (V_{IN} = 200 mV)
Averaging time const.	multiply by value of C_{AV} in uF	25 mS per uF	25 mS per uF
Output from buffer	max output voltage (min = 0)	+10 V (±15 V supply) +2 V (±5 V supply)	+1V4 (±3 V supply) 1V (+3, −5 V supply)
	current	+5 mA, −130 uA	+5 mA, −130 uA
I_{OUT}	scale factor	40 uA per volt RMS (+25%)	100 uA per volt RMS (+20%)
	voltage compliance	$-V_S$ to $+V_S - 2$ V	$-V_S$ to $+V_S -$ V
dB output	scale factor	−3 mV per dB (1 V RMS = 0 dB)	−3 mV per dB (0V1 RMS = 0 dB)
	error	±0.5 dB	±0.5 dB
	I_{REF} range	5 uA to 80 uA	2 uA to 8 uA
Crest factor	error with 3:1 peak: average signal level	−0.1%	−0.2%
Power supplies	minimum voltage	±3 V or +5 V	+3/−5 V (note 3) or +5 V
	maximum	±18 V or +36 V	±12 V or +24 V
	current (quiescent)	1 mA (max 2 mA)	800 uA (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 +2 V/−2V5 but will not give specified performance.

Normal Mode of Operation

Only one external component, C_{AV} is needed. For 50 Hz operation, C_{AV} should be at least 0u7. C_F is an optional output ripple filter, and would normally be twice the capacity of C_{AV} if used, though this will increase the setting time.

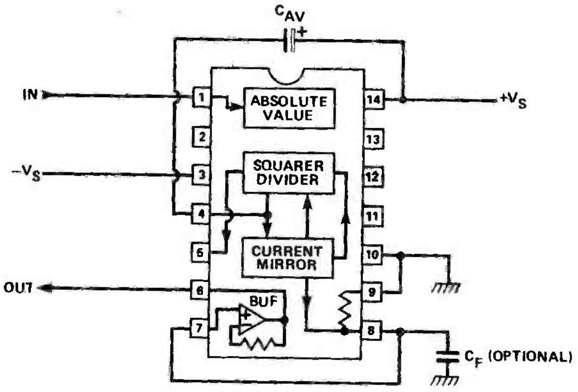


Fig. 5 Normal mode of connection of the AD536 and AD636.

Circuit for dB Output

VR1 should be adjusted to give the correct 0 dB point, and I_{REF} should be within the range quoted in the main specifications table. An inverting and amplifying stage could be used to obtain a positive-going suitably scaled output, and also to compensate for temperature drift.

Component Values	AD536	AD636
R1	27k	22k
BR1	470k	100k
C1	1n	10n
V_{REF}	2V5	1V2

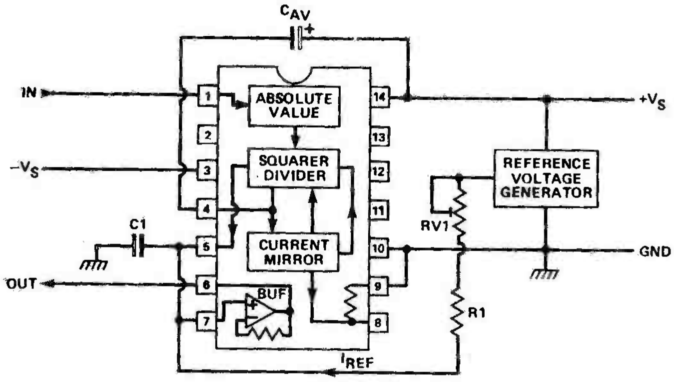


Fig. 6 Output connections for dB output.

Single Supply Connections

Note that only AC signals can be measured in this mode.

Component values	AD536	AD636
R1	20k (10k+10k)	20k
R2	10k	39k
R_L	10k to 1k	10k to 1k
C1	1u	3u3
C2,C3	100n	100n

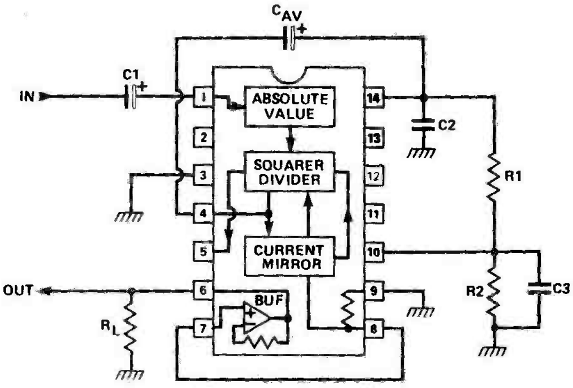


Fig. 8 Connections for a single supply rail.

Connections to trim errors

VR2 adjusts the total offset; ground the input and adjust VR2 to obtain zero output.

VR1 adjusts the gain; after adjusting VR2, apply a DC input of full scale and adjust VR1 to give the same output.

Component Values	AD536	AD636
R1	249 (180+68)	100
R2	470k	470k
VR1	470	220
VR2	47k	470k

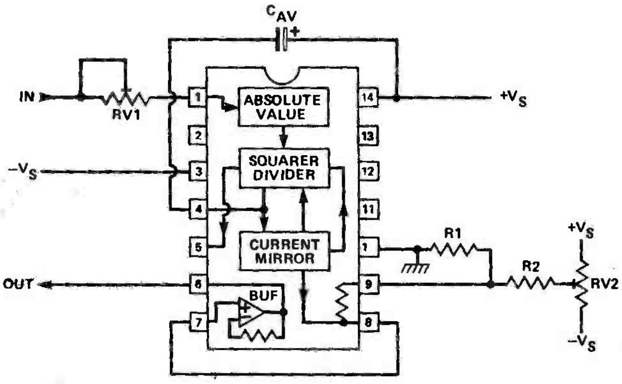


Fig. 9 Connections necessary to trim out errors.

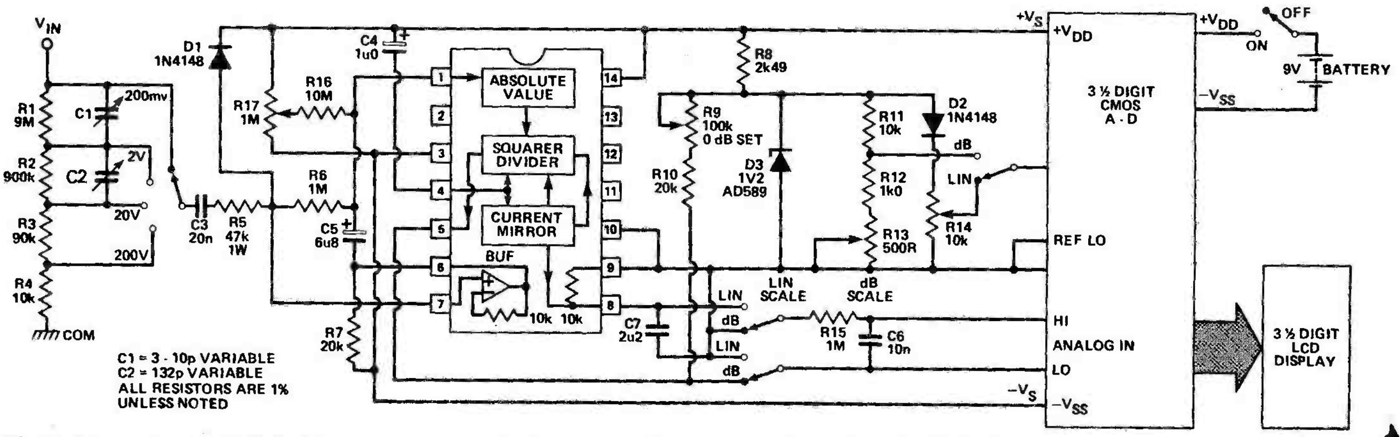


Fig. 7 A complete AC digital voltmeter using the AD636 and a 7106 (or similar) ADC/LCD driver.

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: ± 3 V to ± 18 V

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 attentuated 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_mF (and hence pole frequency) is approximately linear, but becomes exponential when V_{CQ} is positive.

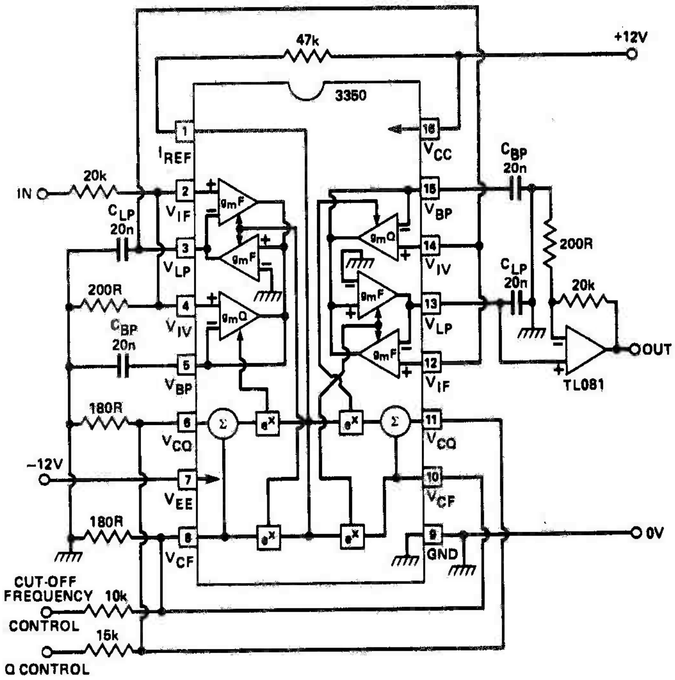


Fig. 10 CEM 3350 pin out and configuration as voltage controlled four-pole low-pass filter. Band-pass outputs could be cascaded by connecting V_{IV} and V_{IF} in the second section to V_{BP} in the first section, and taking the output to the op-amp from V_{BP}.

Electrical characteristics: CEM 3350 (Supplies ± 12 V, I_{REF} 400 uA)	**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 (MΩ) (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 by 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 aportion 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: $+60\text{ mV} < V_{CF} < +240\text{ mV}$
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.

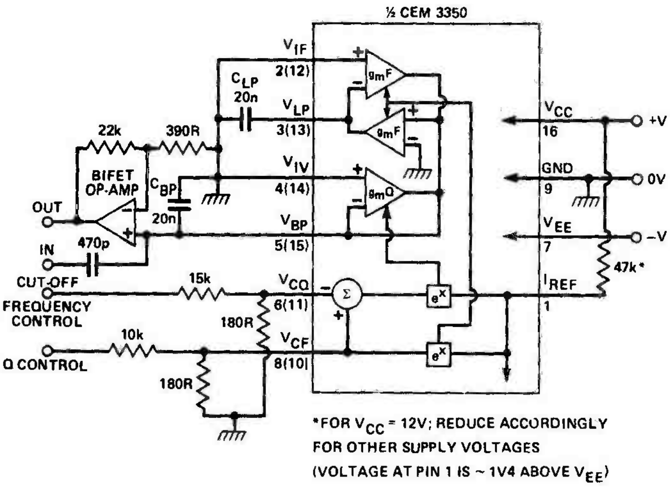


Fig. 11 High-pass filter using CEM 3350: response will fall by 12 dB per octave below the cut-off frequency.

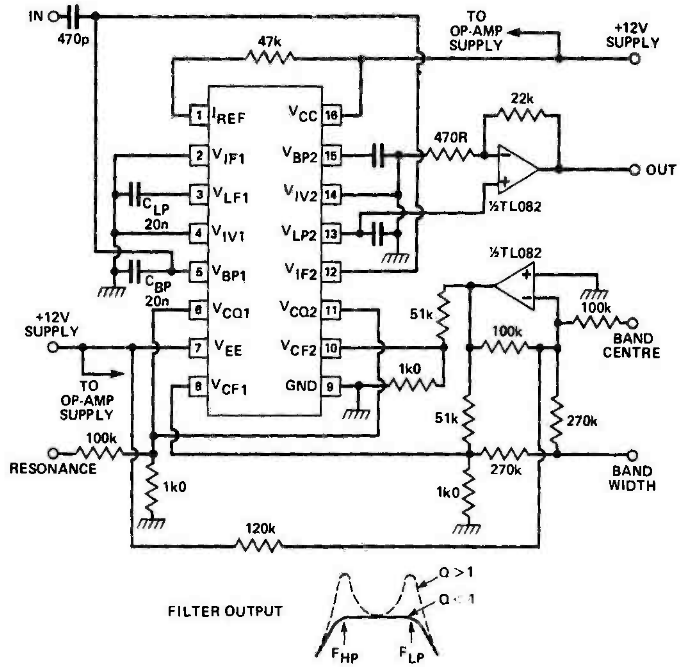


Fig. 12 (above) Low-pass and a high-pass filters can be combined to give a band-pass filter with a voltage-controlled band width. The circuit shown is an example of series interconnection; parallel interconnection is also possible.

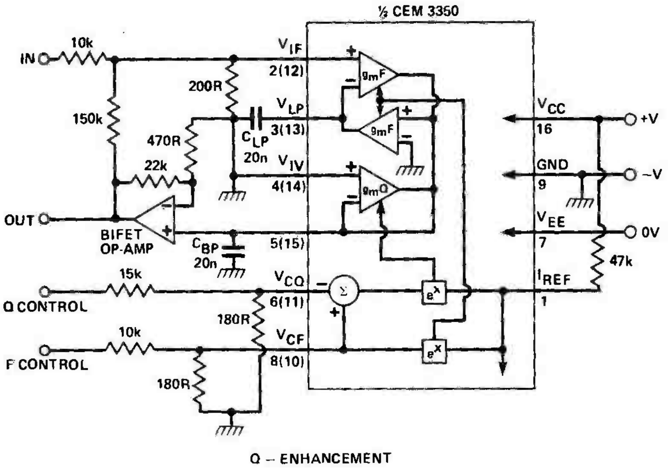


Fig. 13 (left) The Q of the circuit may be enhanced above the normal maximum of 100–200 by applying regenerative feedback as shown: but beware too much feedback, as this will cause oscillation at the resonant frequency.

Available from Digisound Ltd.

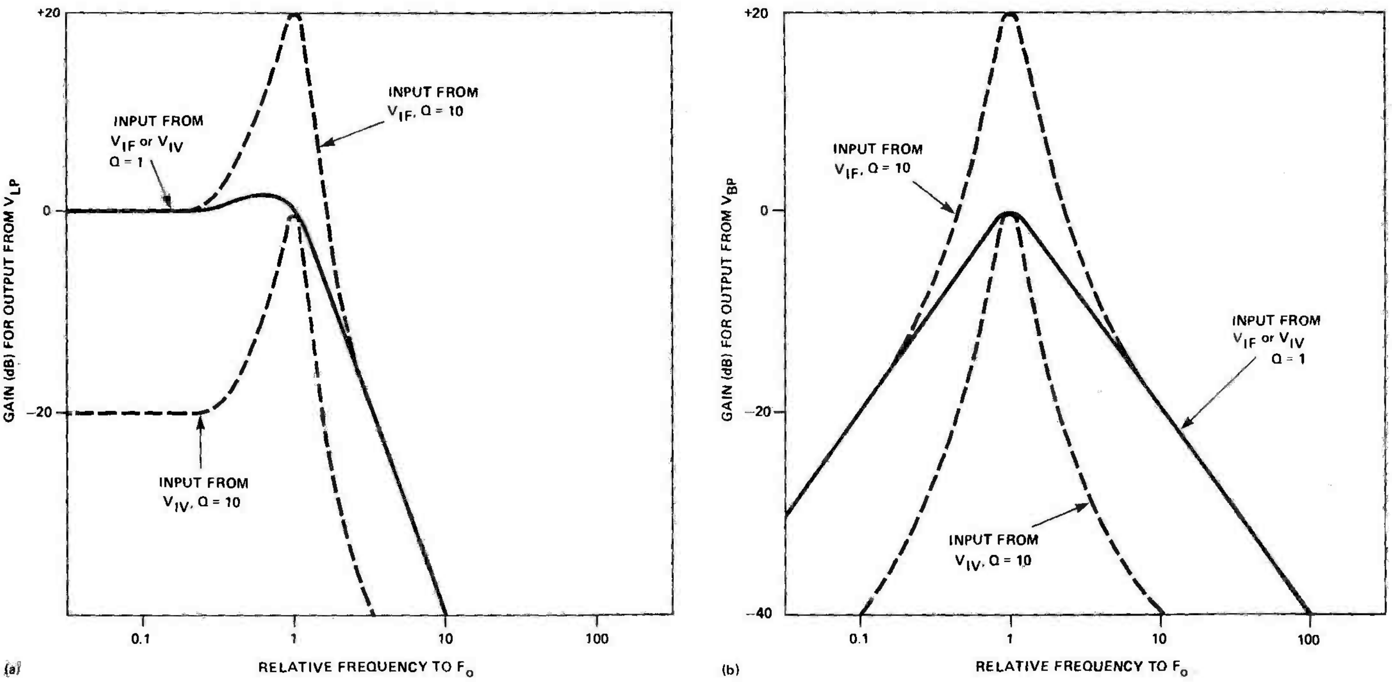


Fig. 14 Low-pass (a) and band-pass (b) responses for sections, with Q = 1 and Q = 10. In the case of curves with V_{IF} or V_{IV} input, other input has been grounded.

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 uS setting time

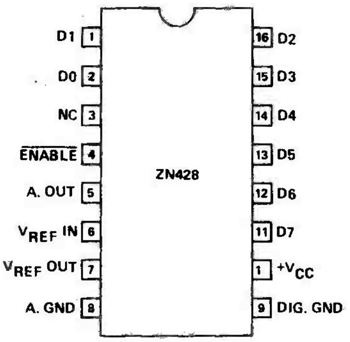
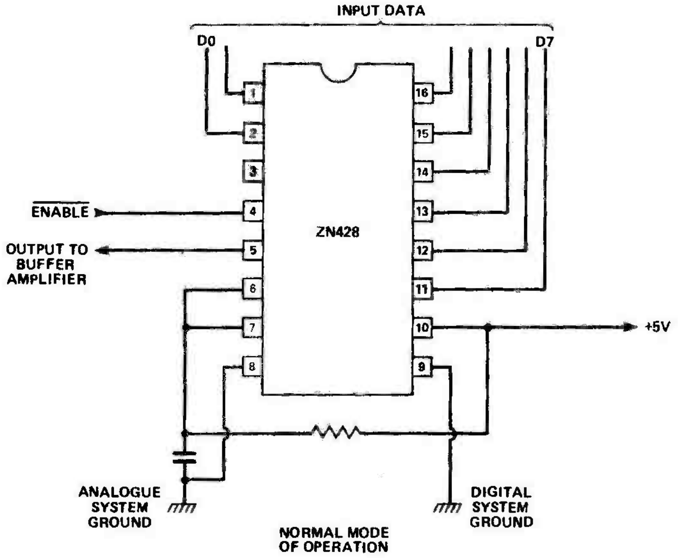


Fig. 15 ZN428 pin out.



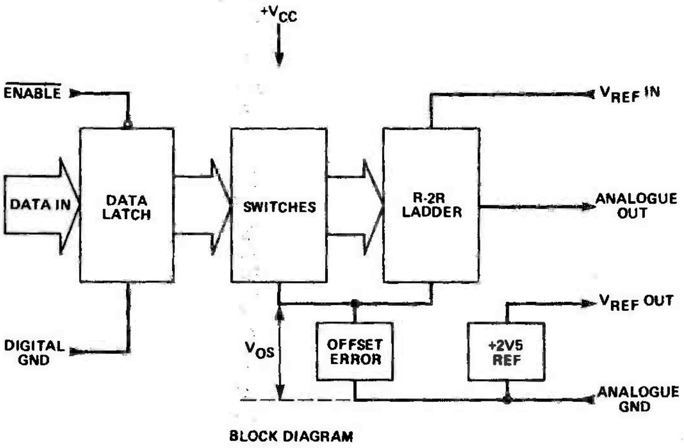


Fig. 16 (above) Normal mode of operation of the ZN428.

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_{REG} 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 (uS)		0.8 (note 4)	1.25 (note 5)
	output resistance (kΩ)		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 ±4V5 supply voltage
- no special anti-static handling of op-amp required
- internally trimmed offset voltage.

Absolute maximum ratings:

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

Available from Rapid Electronics, and other suppliers.

Electrical Characteristics: LF 347 (supply voltages: ±15V)	min	typ	max
DC voltage gain (V/mV)	50	100	
Slew rate (V/uS)		13	
Output voltage swing, load = 10k (V)	12	13.5	
Gain-bandwidth product (MHz)		4	
Input resistance (ohms)		10^{12}	
Common mode rejection ratio (supply voltage ±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 20kHz, supply voltage ±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.

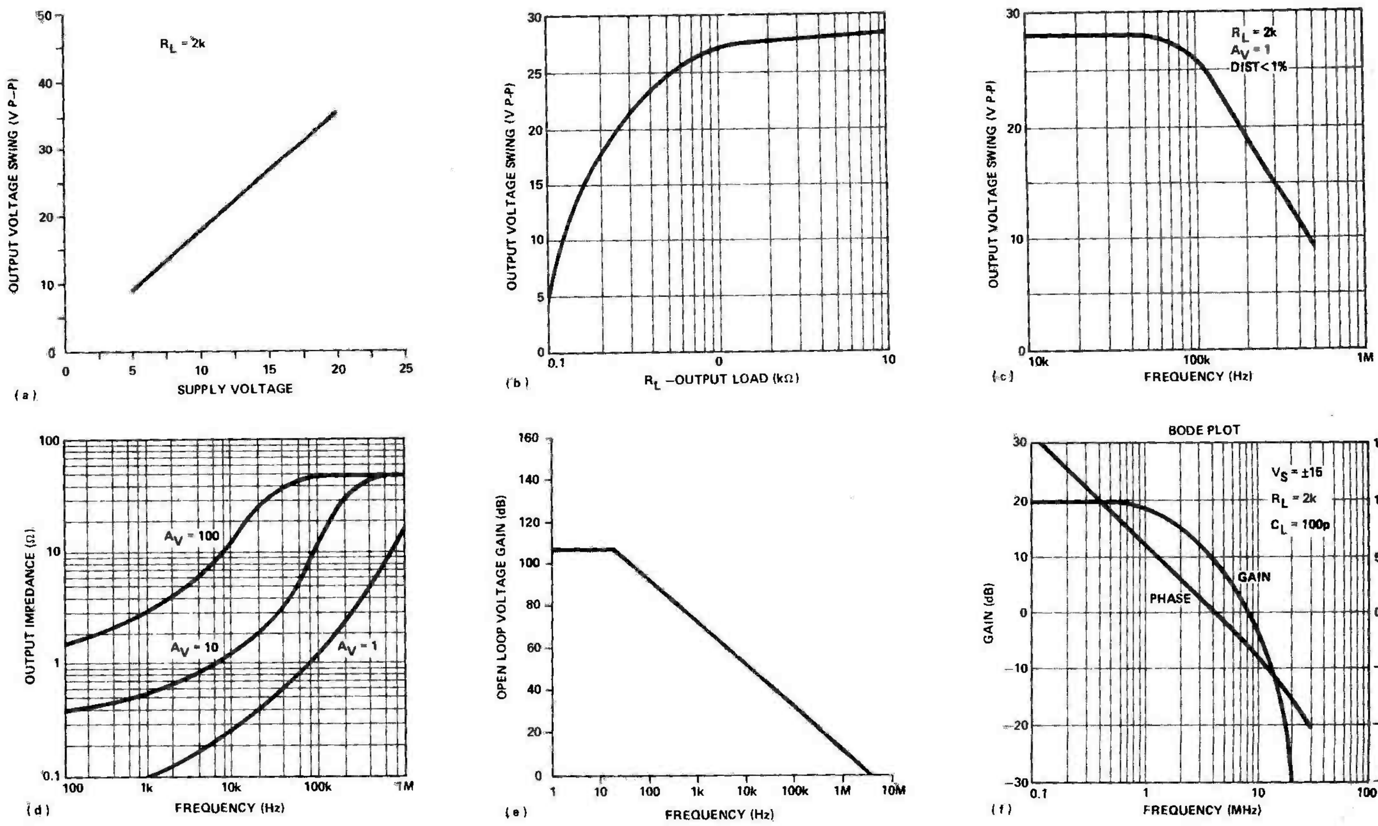


Fig. 18 Output voltage swing vs. supply (a) and output load (b), undistorted output vs. frequency (c), output impedance vs. frequency (d), open loop frequency response (e), and bode (f) plot for LF347.

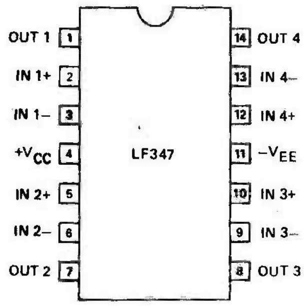


Fig. 19 Pin out of LF347.

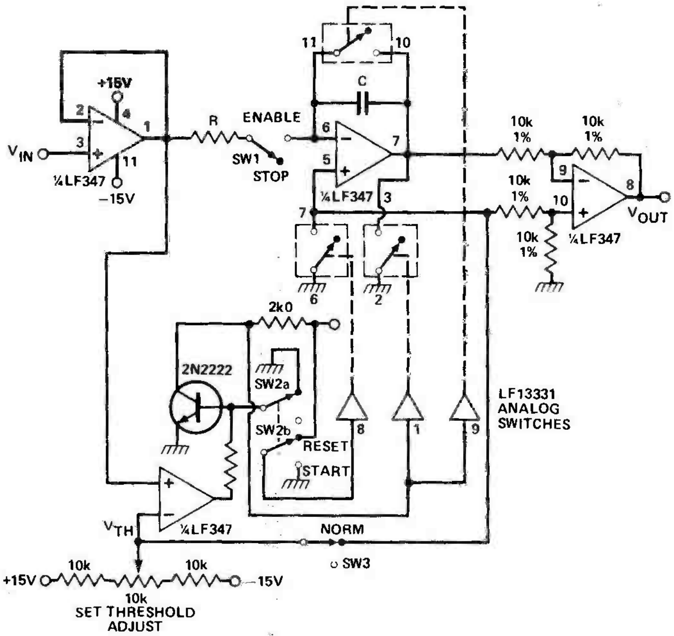
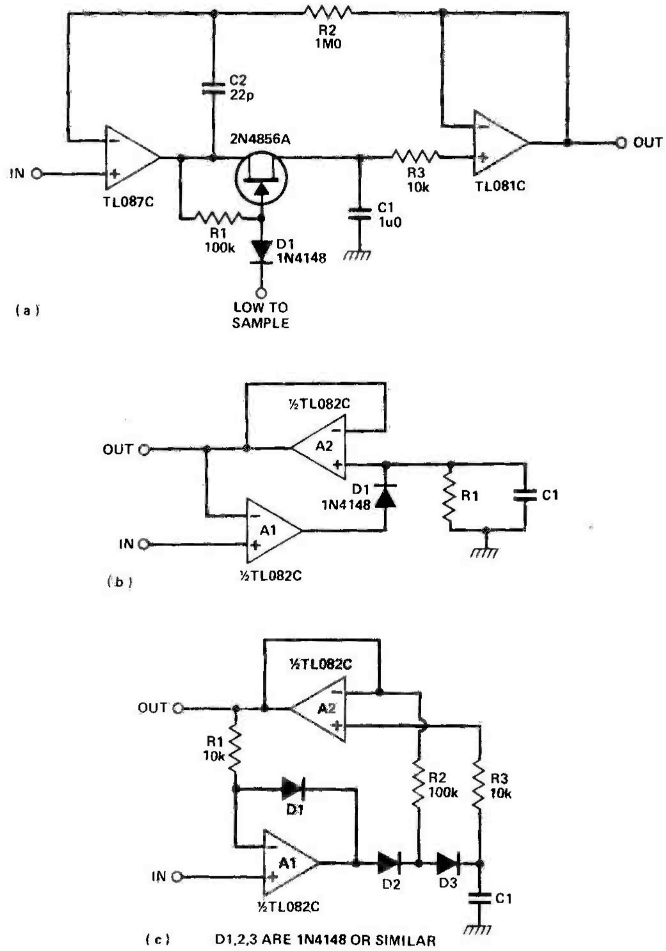


Fig. 20 Example of a long-time integrator, with reset, hold and starting threshold adjustment, using LF347s.

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.



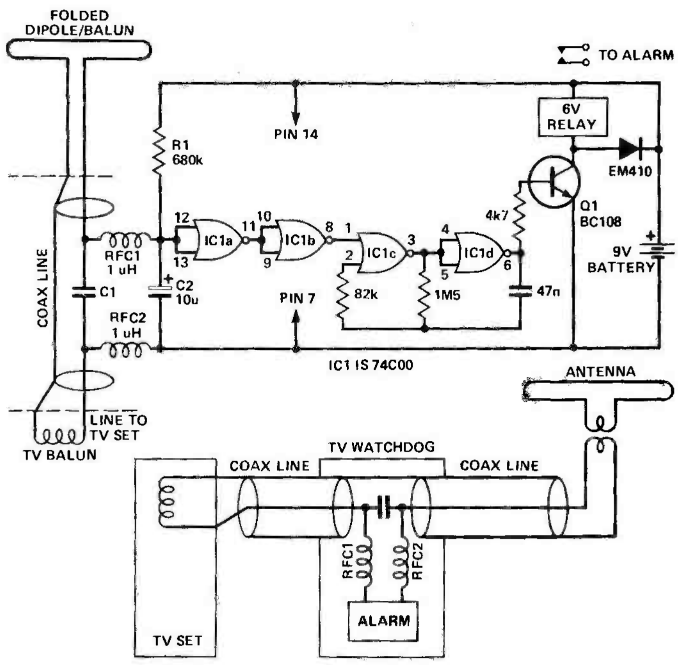
TV Alarm

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.

ETI

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

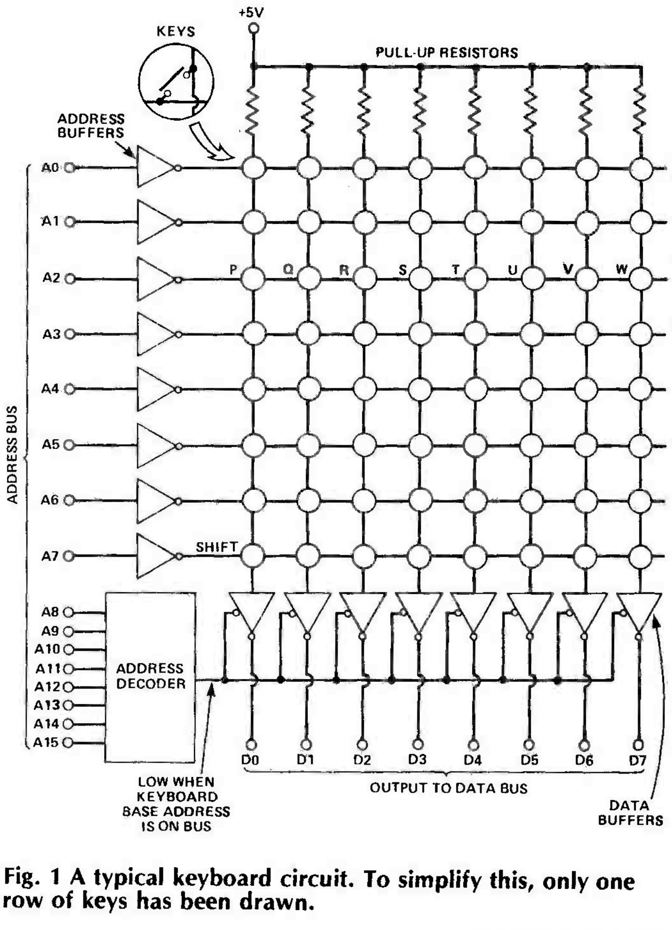


Fig. 1 A typical keyboard circuit. To simplify this, only one row of keys has been drawn.

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 pushbuttons, 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!

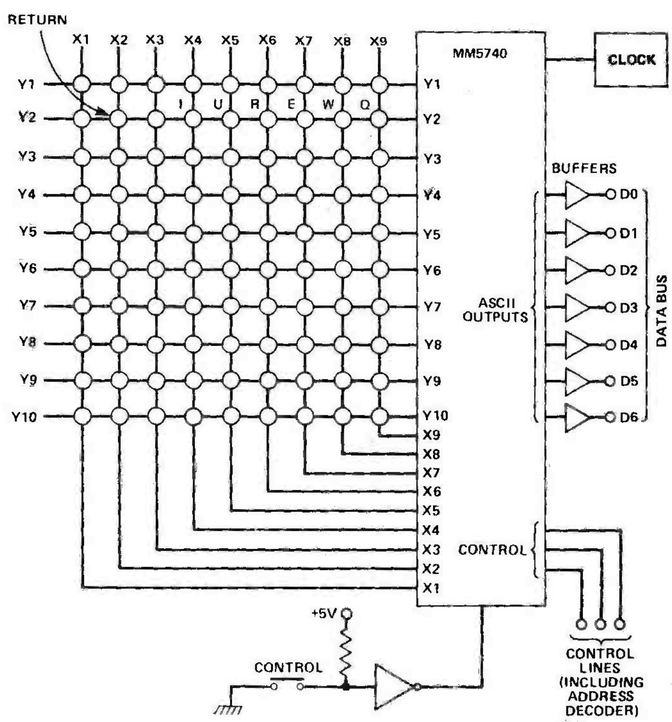


Fig. 2 A keyboard circuit using an ASCII encoder (simplified circuit; only a few keys drawn).

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 Silentype 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

Low nibble \ 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.

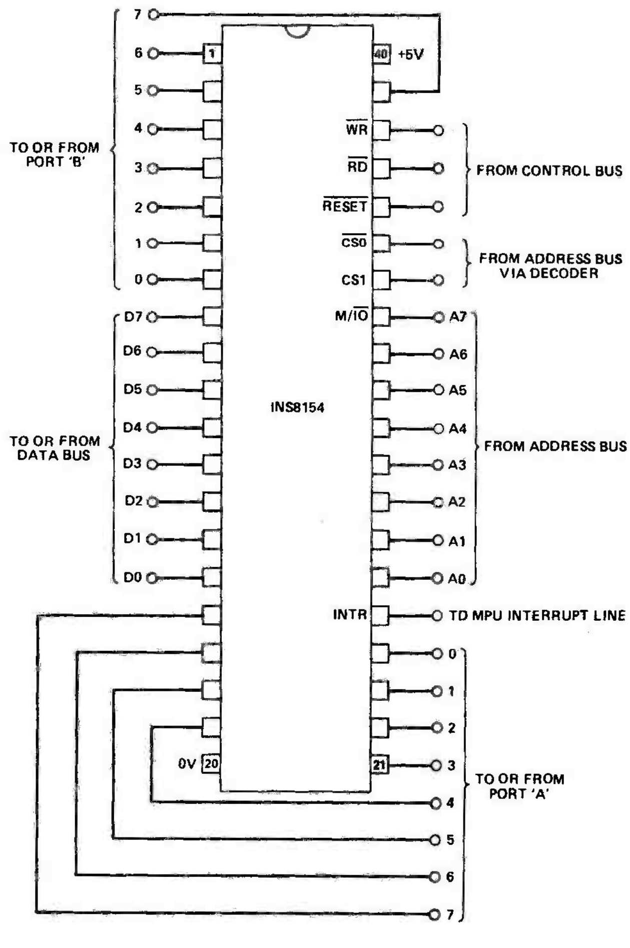


Fig. 3 Pin connections for the INS8154 I/O device.

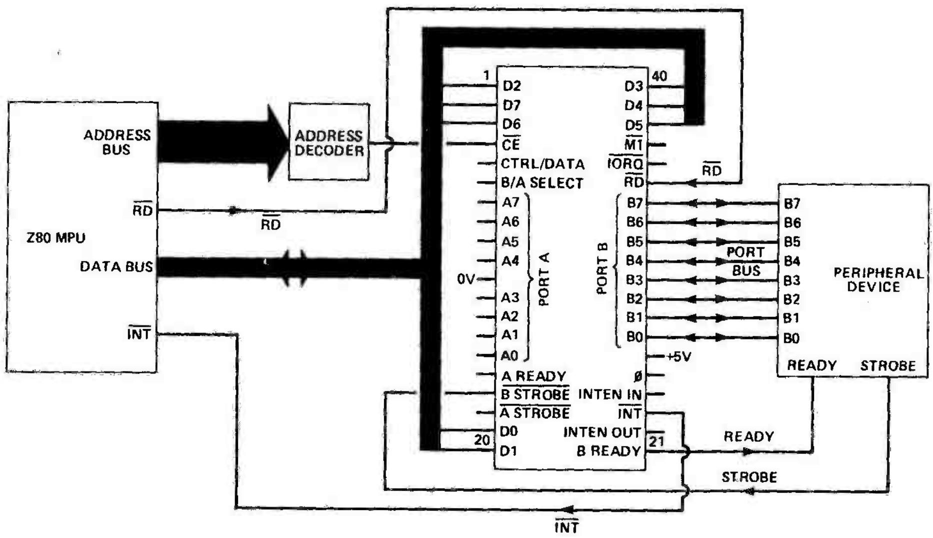


Fig. 4 The Z80 PIO, showing its main connections when linking the Z80 to a peripheral device.

two 'Serial' inputs which allow two sets of input data to be fed directly to the MPU. This feature of built-in I/O is quite enough for simple control applications and may dispense with the need for a separate I/O IC.

The Acorn System 1 is a well-established control computer. It has sockets for two 8154s, the second of which is used for I/O between the CPU and the cassette recorder. As with the keyboard, an I/O device has to be 'located' in a certain part of memory: we say that it is 'memory-mapped'. When addressing the 8154, the top eight address bits (A15 to A8) are used for establishing the base address of the IC in the way we have already described. The IC has two chip-select inputs, one of which (CS1) is active-high, and the other ($\overline{CS0}$) is active-low. Either or both inputs can be used to enable the chip, making it easier to work out an economical address-decoding circuit.

The M/$\overline{IO}$ input is unusual, for as well as being an I/O device, the 8154 carries 128 bytes of RAM. This memory/IO combination is handy for control systems, for which 128 bytes may be all the RAM that is needed. The M/$\overline{IO}$ input is usually controlled by line A7. The remaining lines (A6 to A0) are decoded inside the 8154. To operate the 8154 as RAM, the M/$\overline{IO}$ input is made high. If the base address is A000 (as in the Acorn System 1), RAM extends from A080 to A0FF (bit A7 always high for memory operations). To use the IC for I/O the M/$\overline{IO}$ input is made low (bit 7 always low for I/O). This section of the IC thus comes in the range A000 to A0FF. Actually, only a few of these addresses are used. Some of the addresses are used to initiate certain modes of operation; others are used when sending or receiving data. The method of programming the IC is too complex to go into here, but we can outline what it is possible to do.

Data is passed between the CPU and the IC by way of the eight-bit data bus. Data is passed between the IC and the outside world (TTL levels only) by the 16 I/O lines. These are organised as two eight-bit ports, A and B. Each port can be controlled and addressed separately. Reading and writing to the device is totally under the control of the MPU. The registers in each port can be instructed by the MPU to act as outputs, or as inputs. It is also possible to control each line of a port individually, so that some of them are inputs and others are outputs.

When data is being output, it is transferred to the IC and appears on those lines which have been selected as outputs. The data stays there, even though the original signals may have been removed from the data bus and the MPU is busy doing something else. The data can remain until the external device is ready for it, allowing the asynchronous transfer of data, as mentioned earlier. When the CPU reads from input lines, the data it receives is that which is being transmitted from the peripheral at that instant.

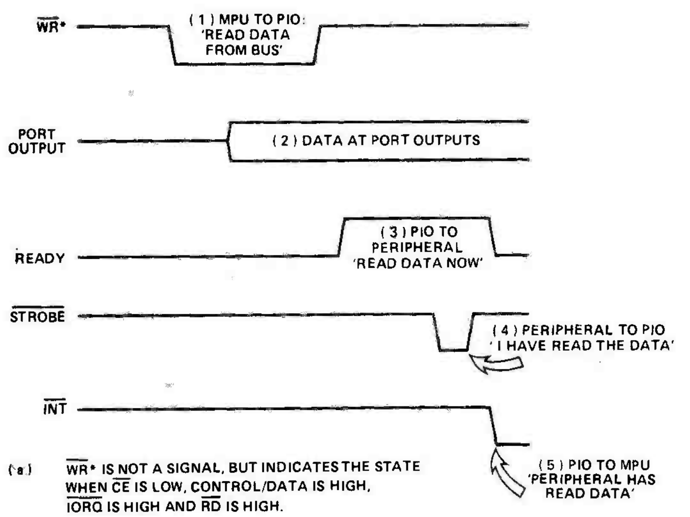
The Hardware Handshake

Obviously there can be problems in transmitting data through an I/O. How does the MPU know that the peripheral has received the data which has been sent to it? It is no use for the MPU to send a new set of data until it is sure that the peripheral has actually received the previous set. Conversely, how does the MPU know that there is a set of data waiting at the input port? How does the peripheral know when this data has been read by the MPU? Again, it is no good the peripheral inputting data to a port if the CPU has switched that port to the output function.

In some systems the sequence of operations and their timing may be such that complete transfer of data is assured. In other systems it is necessary to provide for signals to be sent between the MPU and a peripheral to control the flow of data. This is known as 'handshaking'.

The Z80-PIO (Fig. 4) has special control inputs and outputs and the necessary logic circuits to provide for handshaking. Like the 8154, it has two eight-bit ports, each of which can be individually programmed to act as an input port or an output port. Port A can also be programmed as a bidirectional port, allowing direct communication between the peripheral and the data bus. Alternatively, the individual lines of the port can be set for input or output, as described for the 8154. Figure 5a shows how data is sent from the MPU to a peripheral. As soon as data has been written to the IC and has appeared at an output port, the READY output goes high: this is a signal to the peripheral. When the peripheral receives this signal it knows that it must read the data. As soon as it has read the data, the peripheral puts a low pulse on the $\overline{STROBE}$ line. This causes the IC to generate a low pulse on the $\overline{INT}$ line. This goes to the MPU, telling it that the data has been read. The MPU may now send a further byte of data to the peripheral.

When inputting data (Fig. 5b), the peripheral begins by making $\overline{STROBE}$ low. The $\overline{INT}$ pulse generated by the I/O device interrupts the MPU to tell it that there is data to



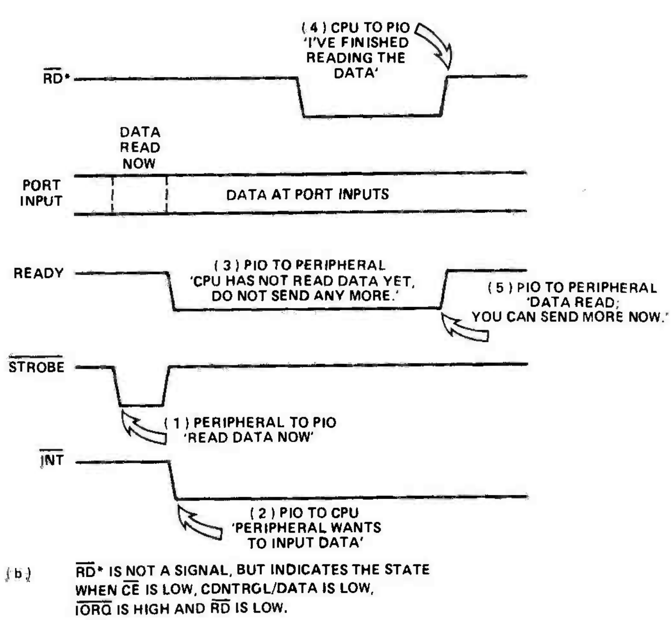


Fig. 5 Timing diagram for the transfer of data between the MPU and peripheral. Output handshaking (a) and input handshaking (b) are shown.

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 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 INTR line has the same function as the INT line, but Fig. 3 shows that there are no special control lines to correspond with READY and 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 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

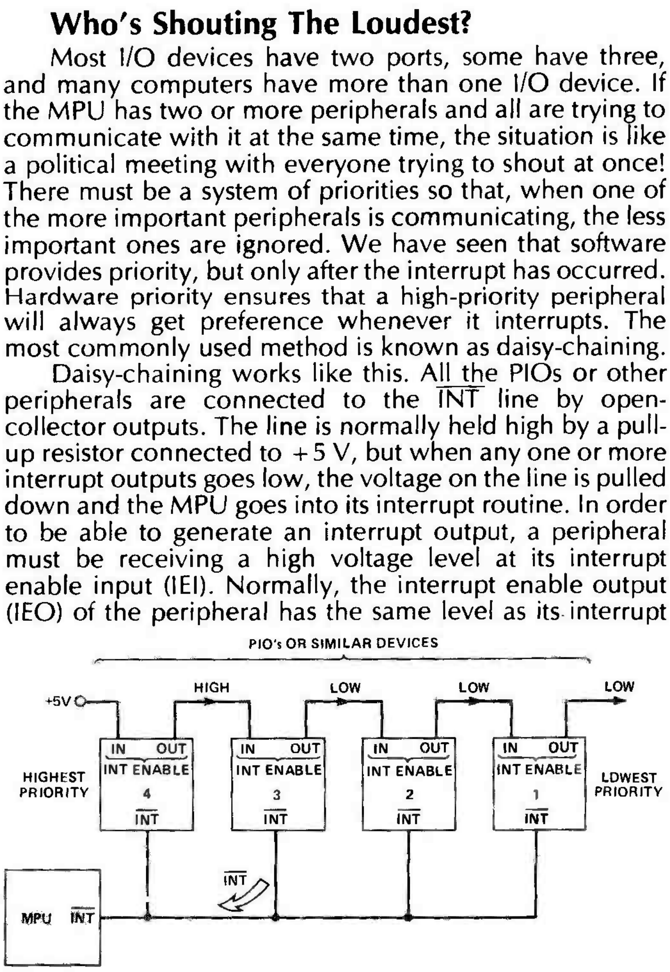


Fig. 6 Daisy-chain priority control: all PIOs are connected to the INT line. PIO no. 3 is interrupting and passing a low signal to nos. 2 and 1 to prevent them interrupting.

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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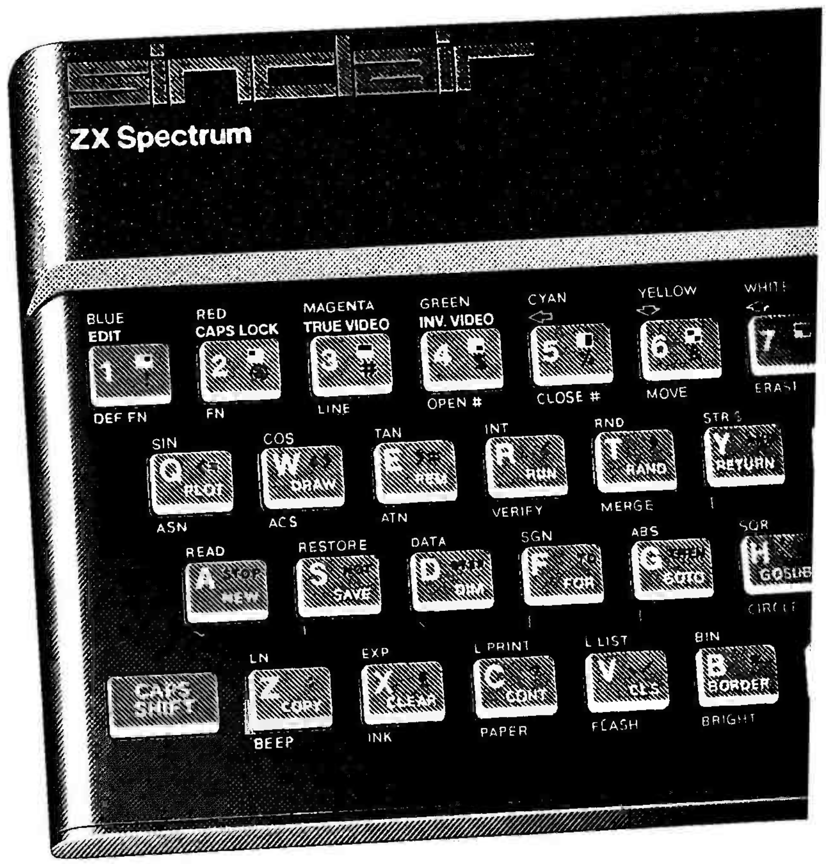

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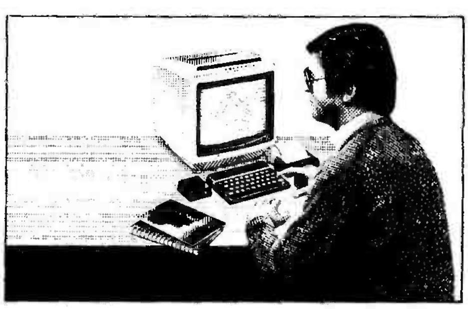

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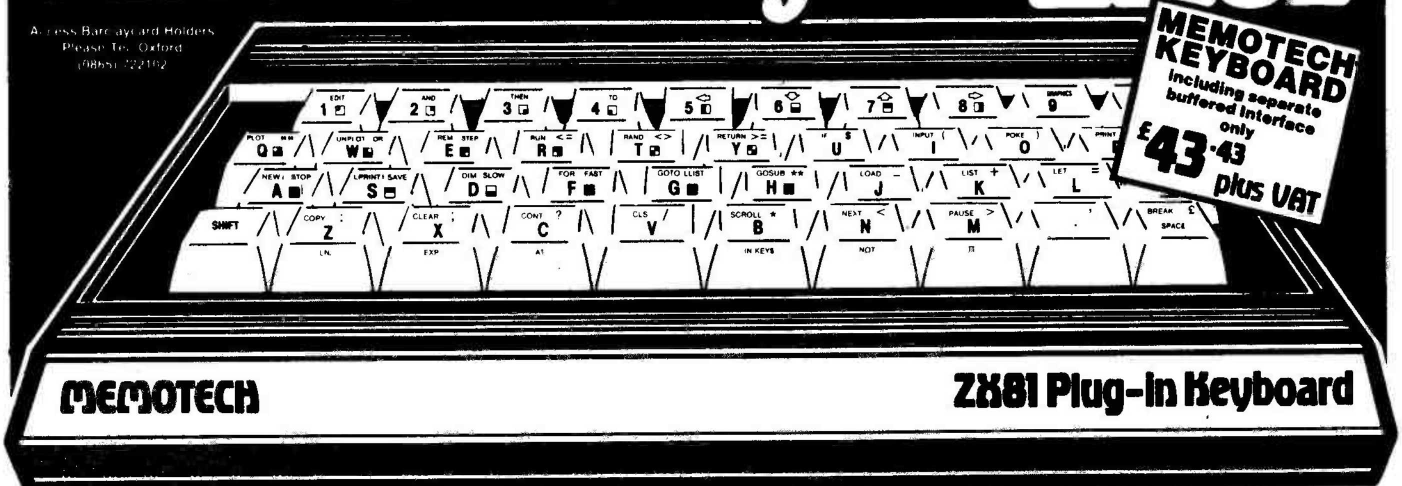

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CORTEX PART 2

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 $1\frac{1}{2}$ 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 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.

TABLE 1

SIZE	DDEN	TRANSFER RATE (kHz)	DIVISION RATIO (IC87)	MONOSTABLE PERIOD (uS)	COMMENTS
0	0	125	12	3.0	$5\frac{1}{4}$" single density
1	0	250	6	1.5	$5\frac{1}{4}$" 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 ($\overline{CS}$ A and $\overline{CS}$ C) are used for the Asynchronous Communications Controllers (ACCs), the third ($\overline{CS}$ 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 ($\overline{CS}$ D).

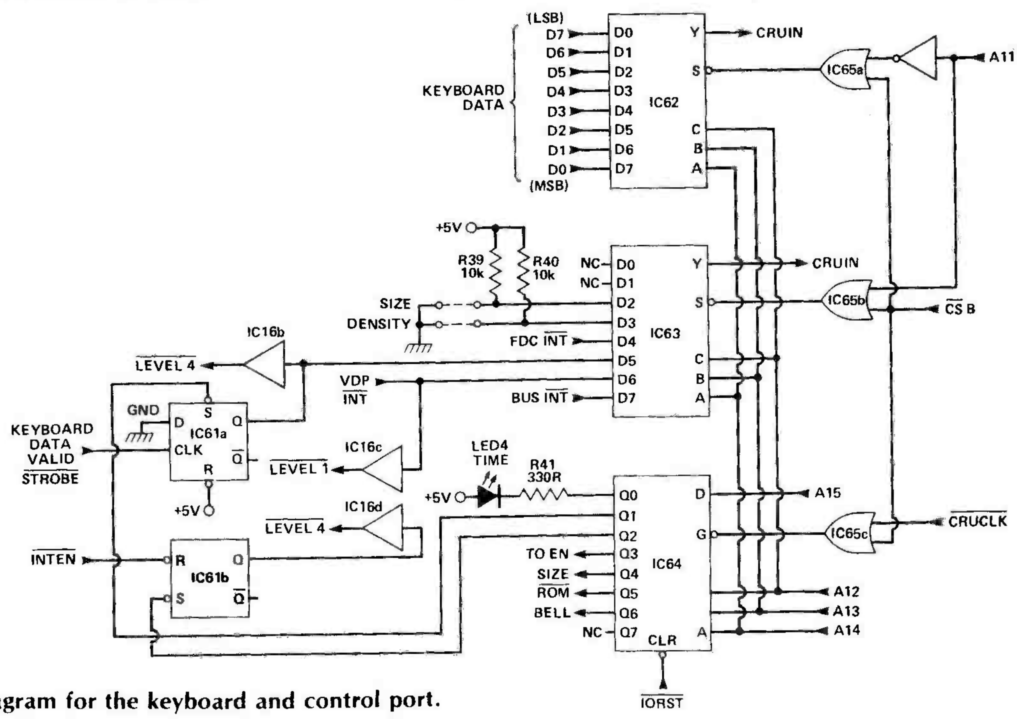


Fig. 1 Circuit diagram for the keyboard and control port.

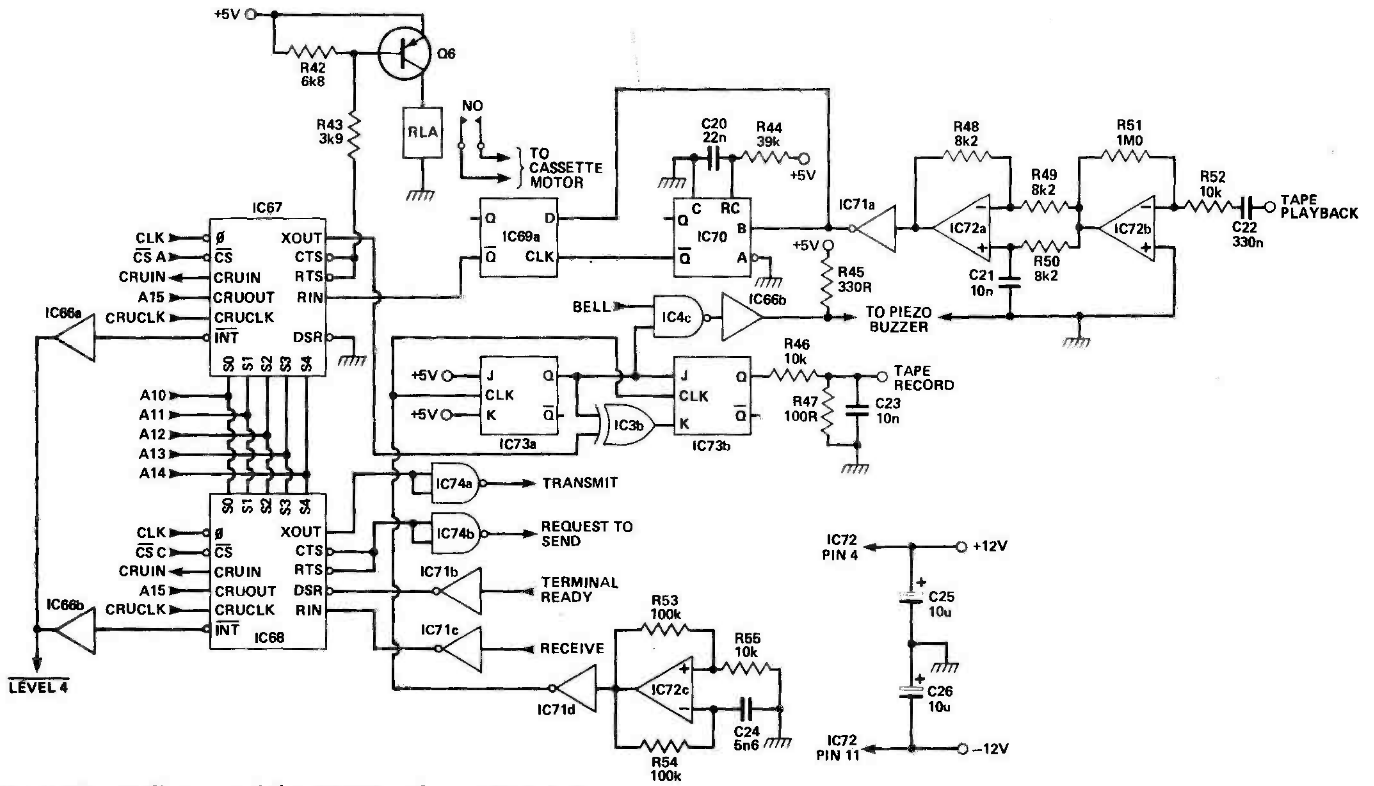


Fig. 2 Circuit diagram of the RS232 and cassette interfaces.

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-flip 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 (5¼") drives require a motor control signal to start and stop the disc rotating. Upon starting, the disc will not be ready 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.

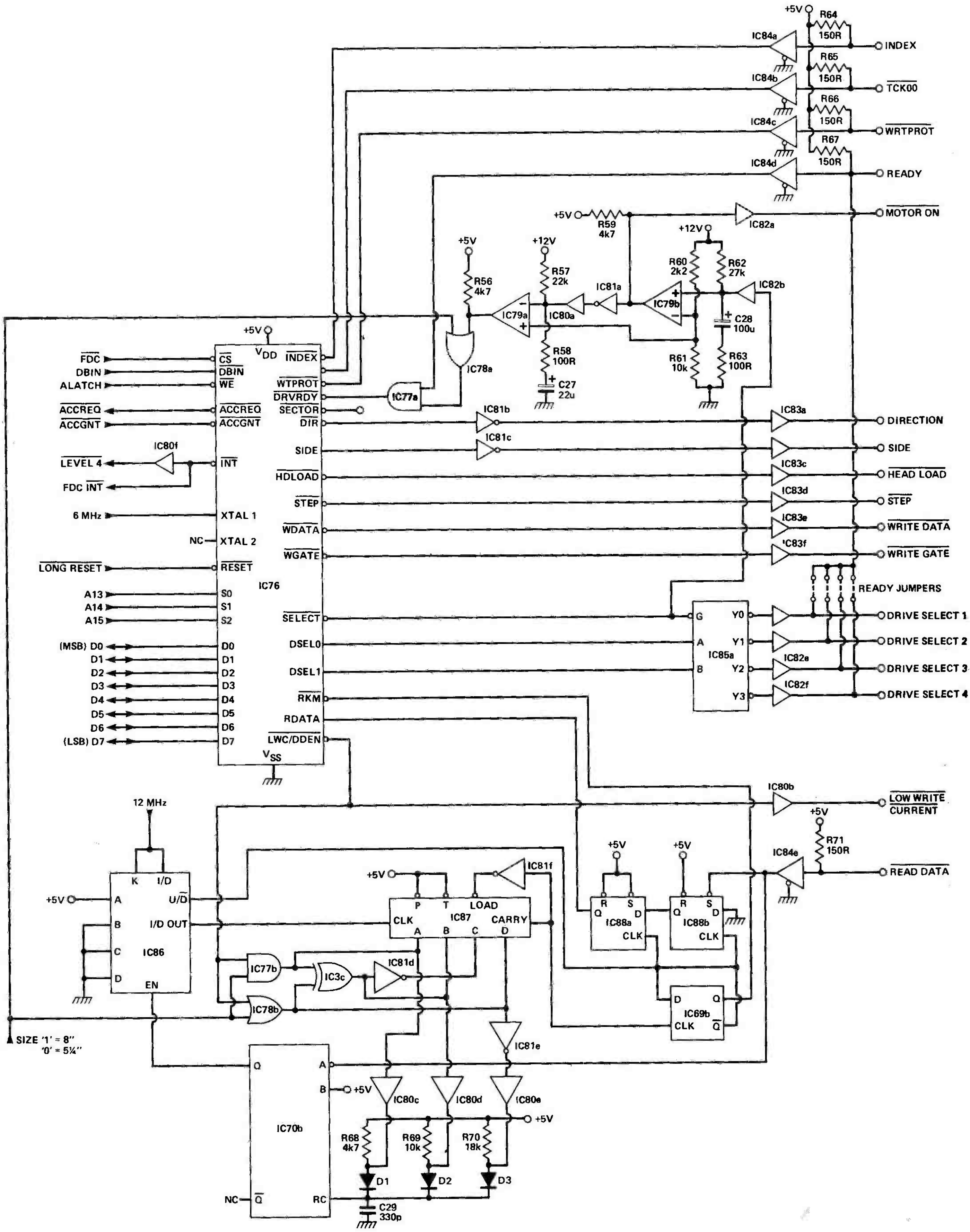


Fig. 3 Circuit diagram for the floppy disc controller section.

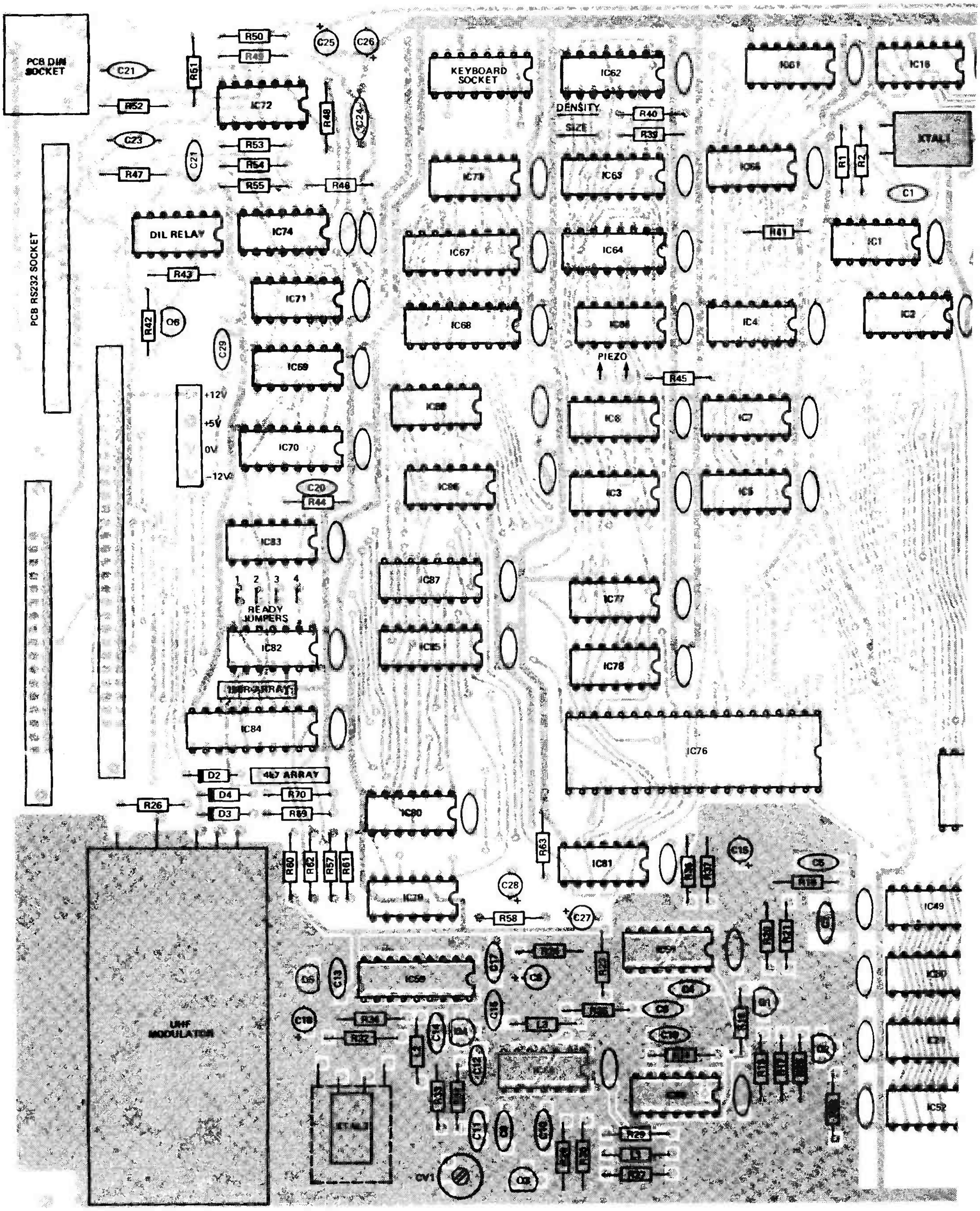
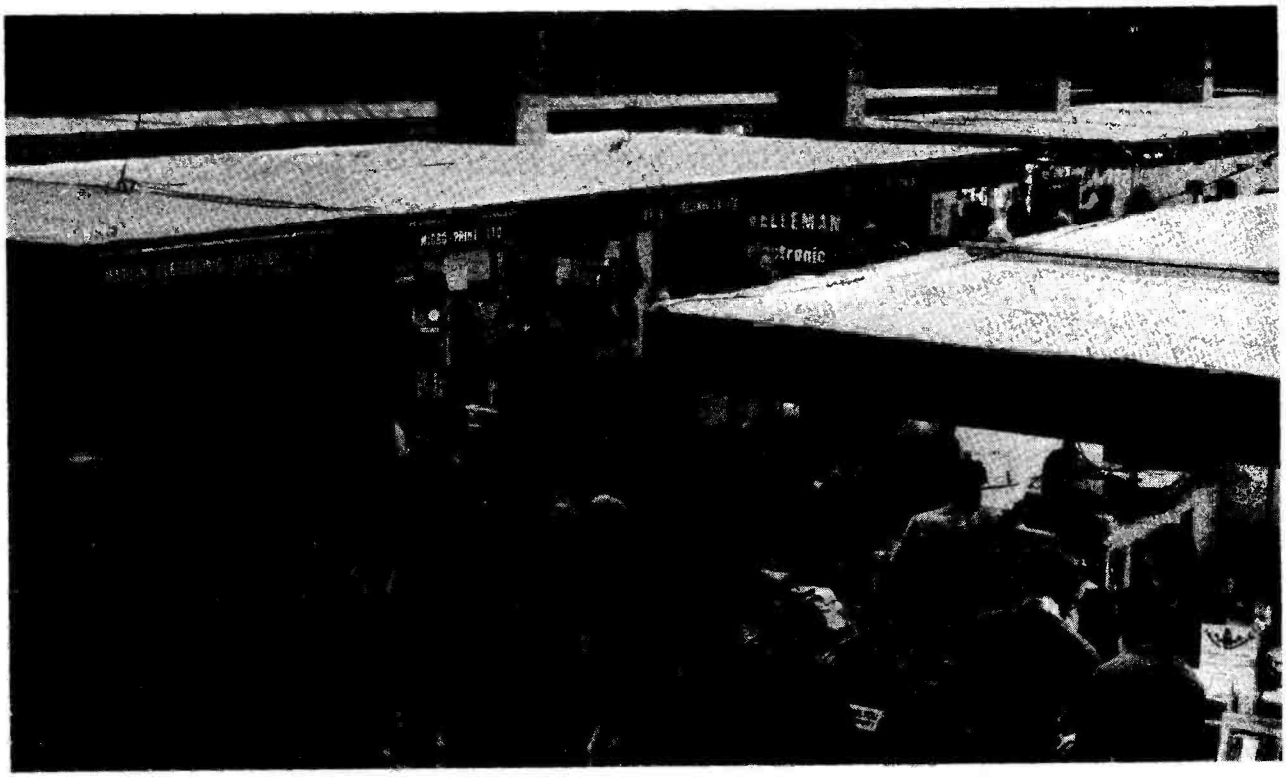


Fig. 4 Component overlay for the Cortex main board. Note that the numerous unmarked capacitors are for supply decoupling and are 47n ceramics. The grey tracks are those on the top (component) side of the board. Some changes in the IC numbering have occurred since last month due to a board redesign. To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

BREAD BOARD 82

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 wil 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 he 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.**

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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 hobbiest. 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.

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

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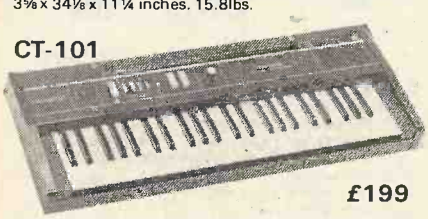
49 instrument sounds over 4-octaves, with a 4 voice memory function. 3 vibrato settings and sustain. 3⅝ x 34⅛ x 11¼ inches. 15.8lbs.

CT-101



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4-voice memory function. Vibrato and sustain.
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Identical to the CT-101 but in addition has easy-play auto chords and 16 rhythm accompaniments. 17.6lbs.

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NEW 4 OCTAVE EASY-PLAY
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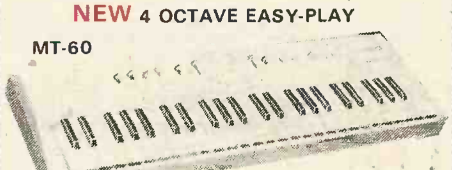

£149

25 voices with sustain and vibrato. 8 rhythm accompaniments with 'Intro/fill-in' function. Easy-play auto chords, bass and arpeggio. 2⅝ x 25 x 7⅜ inches. 5.5lbs.

MT-40

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3 octaves plus a 15-note bass keyboard with automatic function. 22 voices, with sustain/vibrato. 6 auto rhythms with dual 'fill-in'. 2½ 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

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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. 1⅛ x 11¾ x 3 inches. Weight 15.4oz.

VL-10 Tiny executive version of the VL-1 with one voice. ½ x 7¾ x 2½ inches. Weight 4.3oz. **£26.95**

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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 37¾ x 13½ inches. Weight 27.6lbs.

CT-601 Identical to the CT-701 but without the programming and teaching functions. **£395**

NEW
MINI PROGRAMMABLE
MT-70

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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. 2¾ x 25 x 7⅜ inches. Weight 6lbs.

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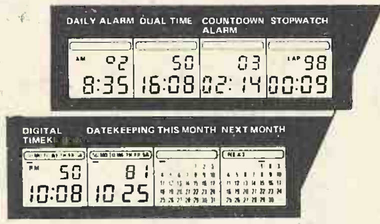

AX-250 (left) £24.95

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When playing real golf counts strokes at each hole. Totals strokes over 9 holes.
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Distance from hole indicator. Select golf club.
Select direction of swing.
Bunkers and out of bounds
Stroke counter
Memorises lowest score.

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GM-30 Destroyer/submarine sea battle game.
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Daily alarm function.
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Professional stopwatch, 1/100 sec to 24 hours.
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Daily alarm with pre-alarm; daily alarm with post-alarm; weekly alarm (or extra daily alarm); Hourly time signal; Calendar; pro. stopwatch.

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CA-951 Calculator. 2 melody alarms.
CA-95 Resin version of CA-951 **£19.95**.
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Calendar, alarm, time signal, pro. stopwatch.
Pacer signal for jogging and rhythmic sports.

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

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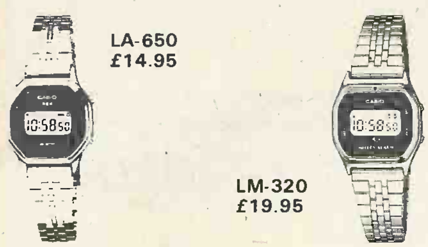

LA-650 £14.95

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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.

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LW-601 Time, calendar, alarm, hourly time signal, countdown alarm timer.

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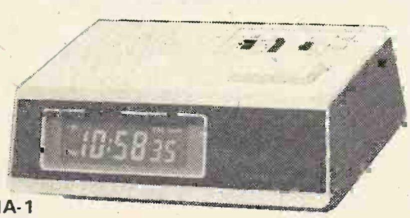

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An exciting and engrossing game **£14.95**

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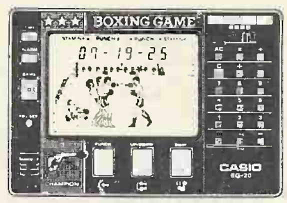

A new version of the very successful BG-15. Now has a full screen, with the calculator function relegated to one side! Clock and alarm function.

CALCULATOR GAMES

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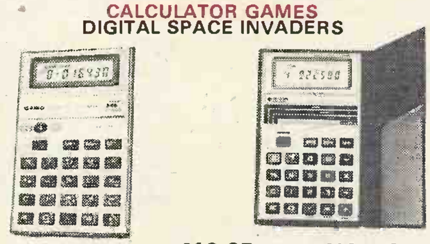
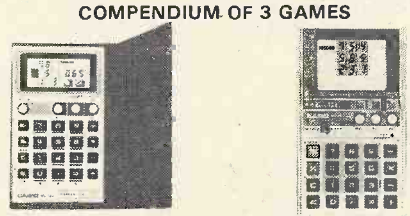


MG-880 £10.95 MG-885

COMPENDIUM OF 3 GAMES



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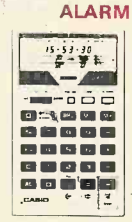
MG-777 has a built-in clock function.

ALARM CLOCK CALCULATORS



BG-15

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UC-365 £19.95 UC-360 £19.95

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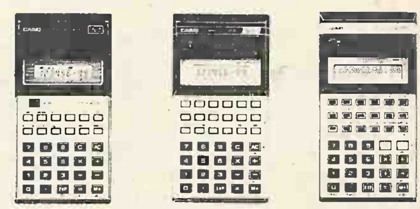
SCIENTIC CALCULATORS

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 = hyperbolics.



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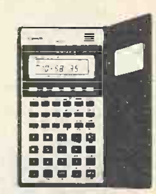

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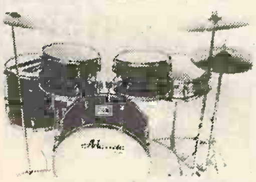

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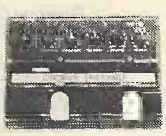

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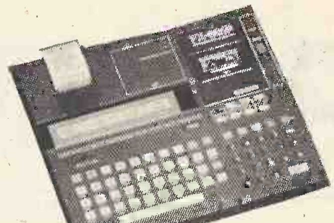

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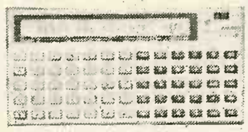

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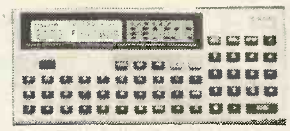

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Velleman have a design and development laboratory in their Belgium factory where new, exciting kits are regularly produced to add to their range. They undertake major development projects for large companies throughout Europe and this highly qualified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

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.

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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.

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Lectures and Demonstrations

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

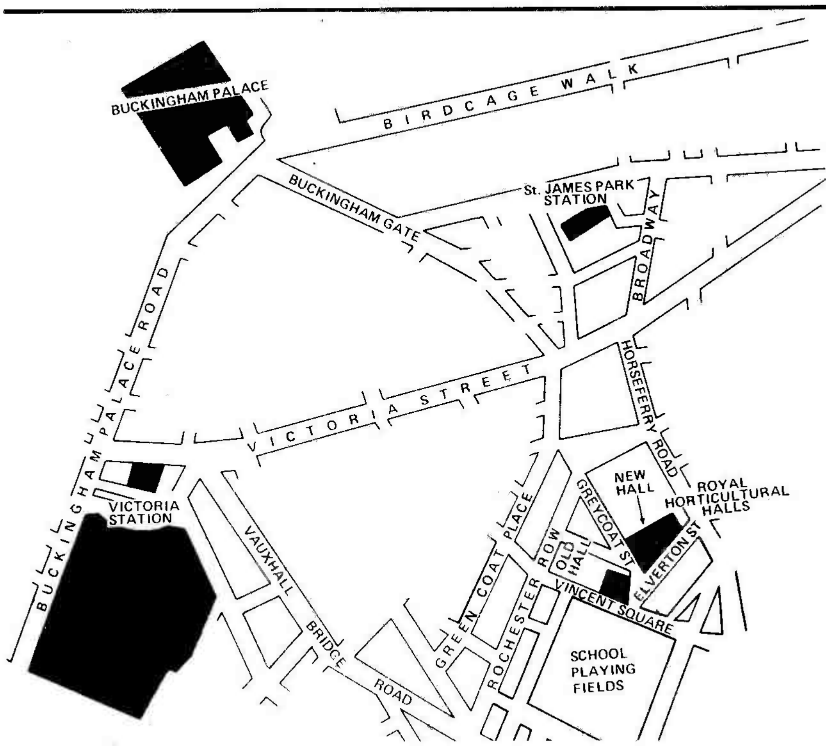
BICC-Vero
BICC-Vero Electronics will be giving audio-visual demonstrations of their new insulation displacement system called Speedwire, ideal for fast positive contacts. On alternate days, there will be lectures on wire-wrapping, an alternative system for solderless connections.

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.

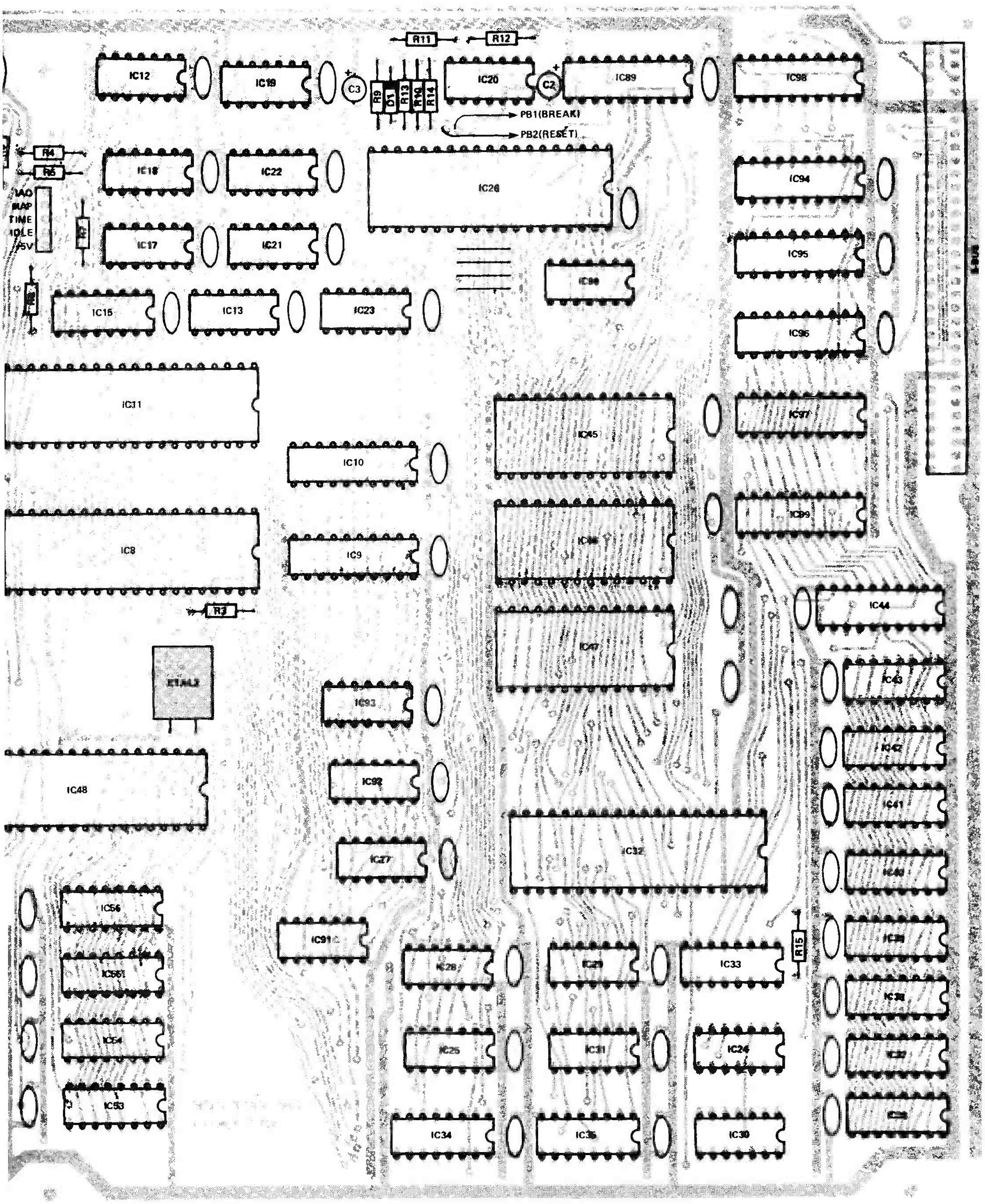


Other exhibitors will include:

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.

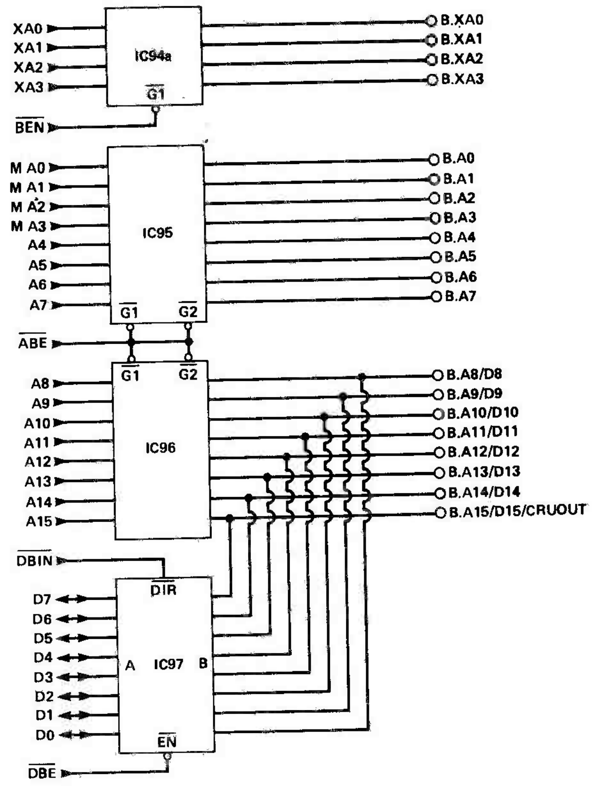
BREAD BOARD 82



labelling thus: IC6a to IC1c, IC6b to IC1d, IC6e to IC1e, IC12a to IC2b, IC1c to IC6c, 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



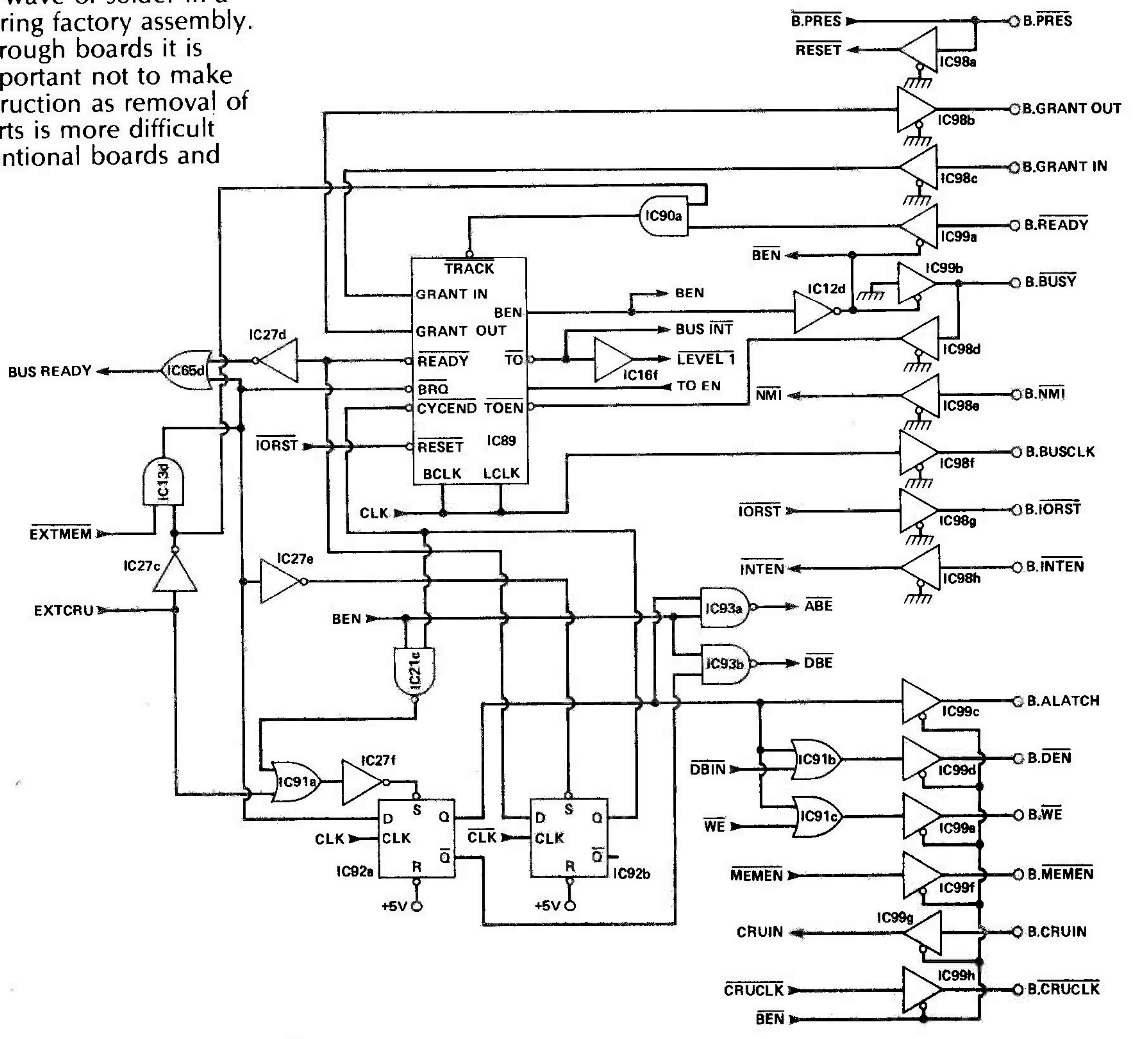


Fig. 5 Circuit diagram for the E-BUS interface.

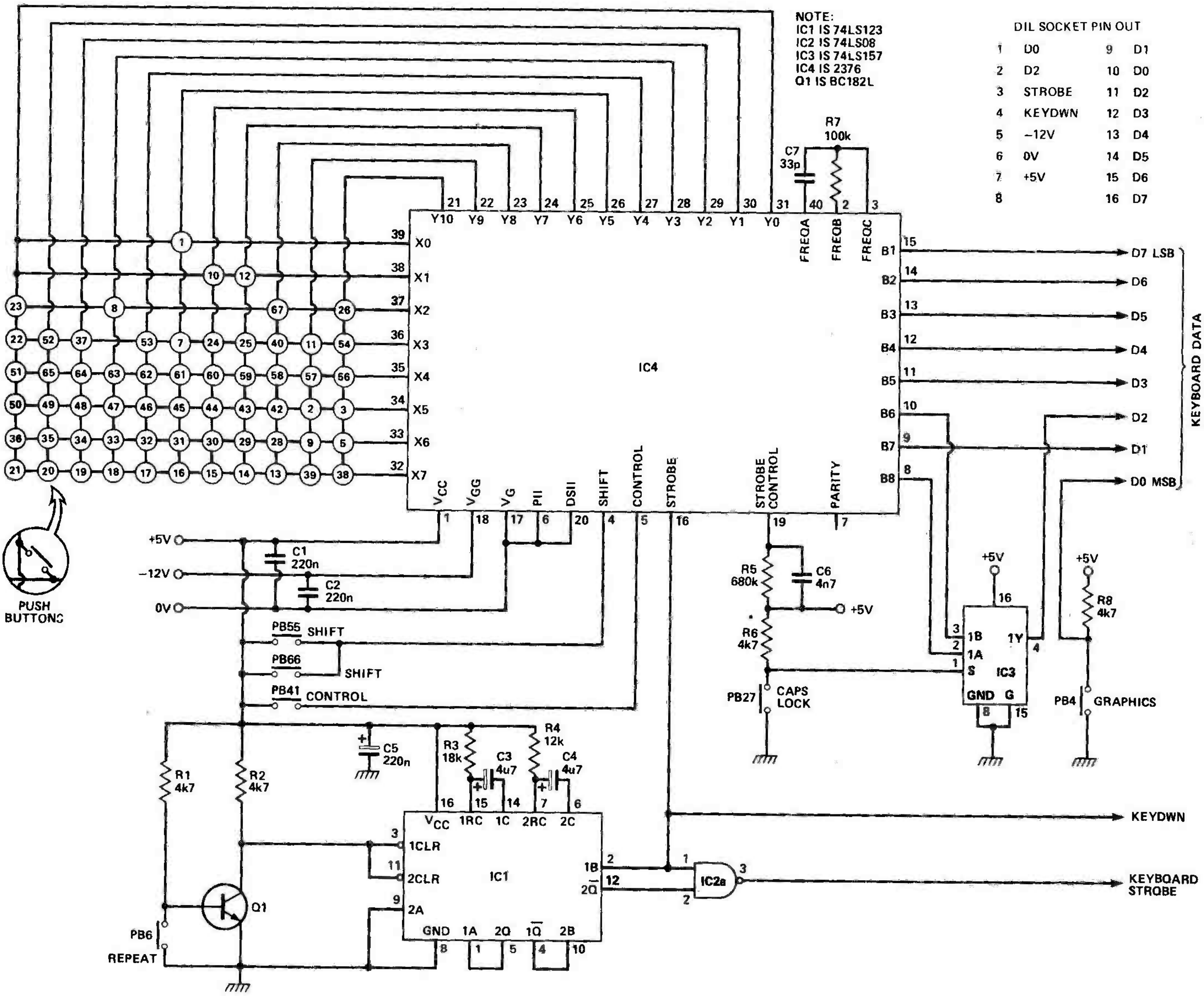


Fig. 6 Circuit diagram for the keyboard.

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 $\overline{\text{READY}}$.

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 $\overline{\text{READY}}$ line, the controller completes and issues a timeout interrupt.

The E-BUS has provision for a multibit interrupt code signalled by the $\overline{\text{INTEN}}$ signal. This interface only provides a single interrupt level using the $\overline{\text{INTEN}}$ 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 $\overline{\text{DEN}}$ or $\overline{\text{WE}}$ will be signalled, to show that either a data read or write is occurring and that data is now on the bus. The $\overline{\text{INTEN}}$ 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.

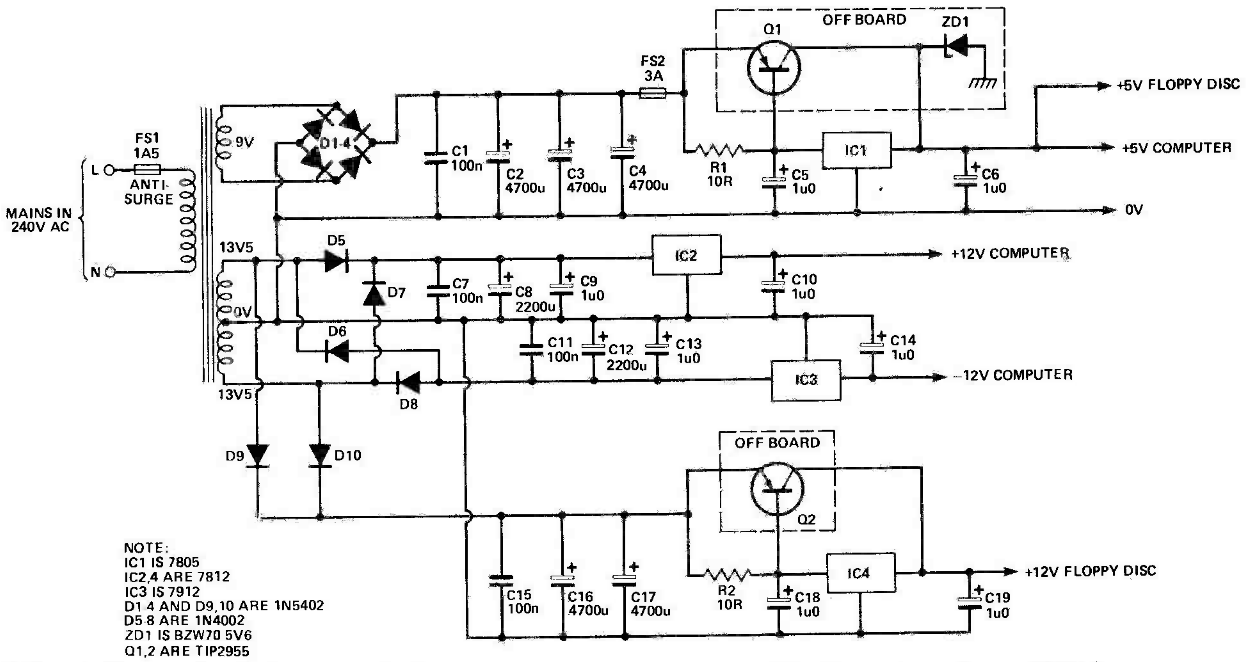


Fig. 7 Circuit diagram for the power supply.

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 orginating 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 ¼W, 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
4-6,9,10,7	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).

ETI

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SPECTRACOLUMN

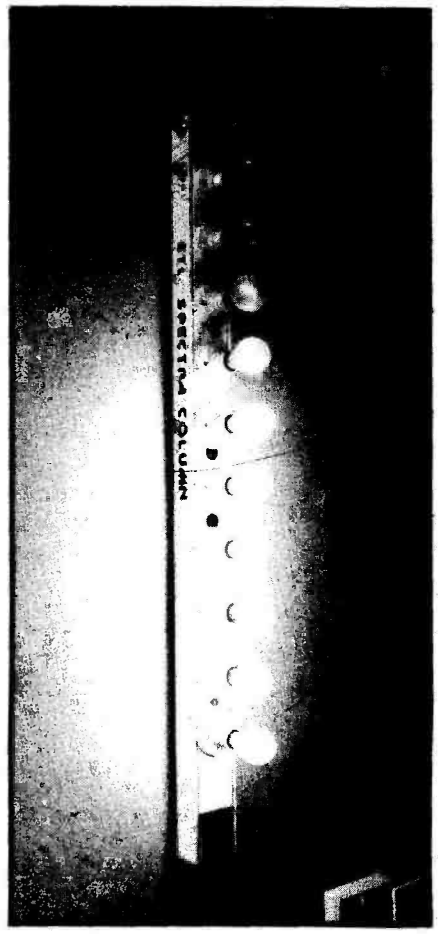
With this project we throw some light on the problem of how to jazz up your disco or party. This cost-effective, crammed-with-everything light column can be used singly or in groups to dazzle the dancefloor. Design by Rory Holmes.

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 . . .

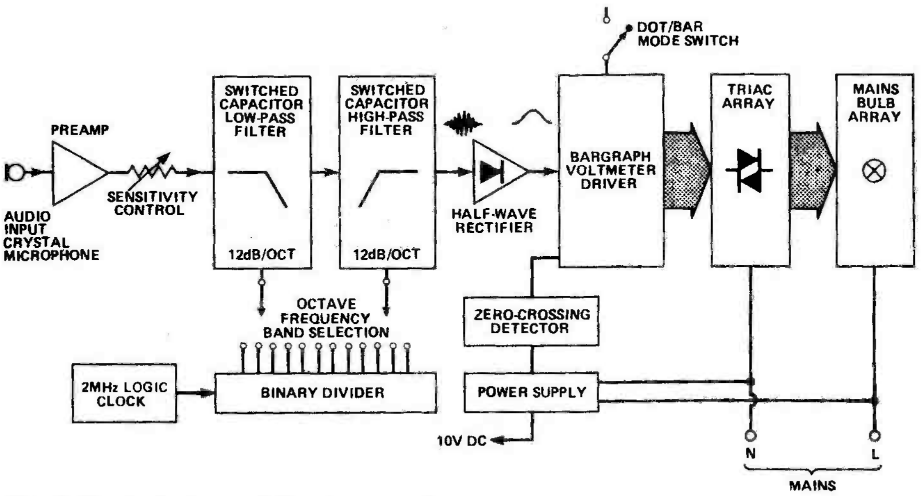


Fig. 1 Block diagram of the Spectracolumn.

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.

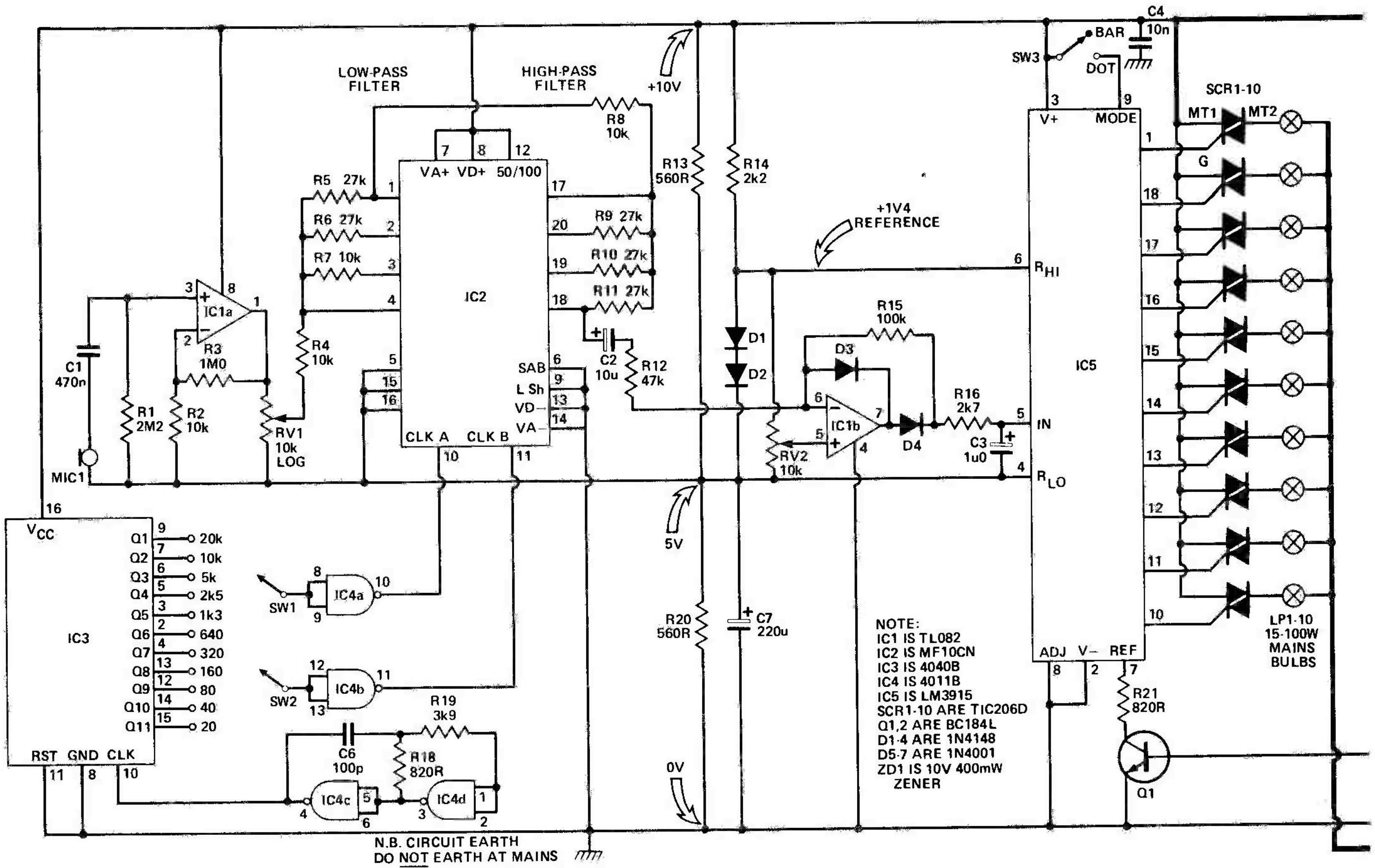


Fig. 2 Circuit diagram for the complete Spectracolumn.

TABLE 1

DIVIDER OUTPUTS	DIVIDED CLOCK	RESULTING FILTER F_C	STANDARD CENTRE
	FREQUENCY (Hz)		
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

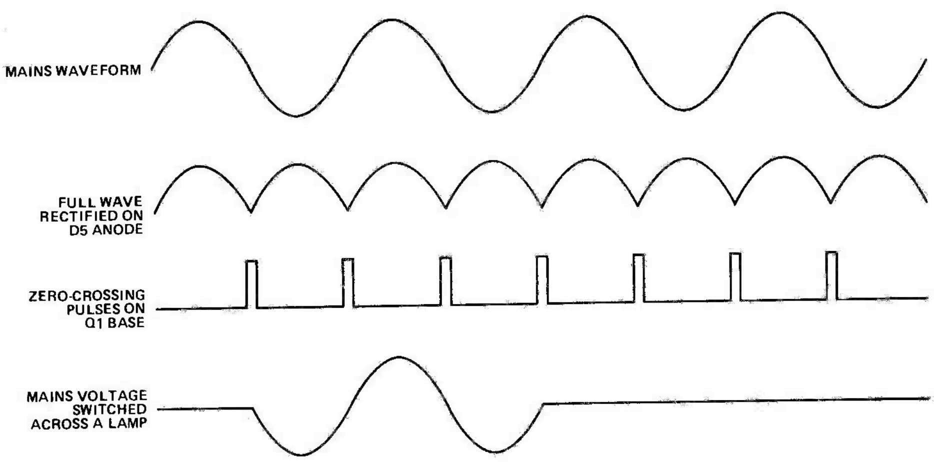


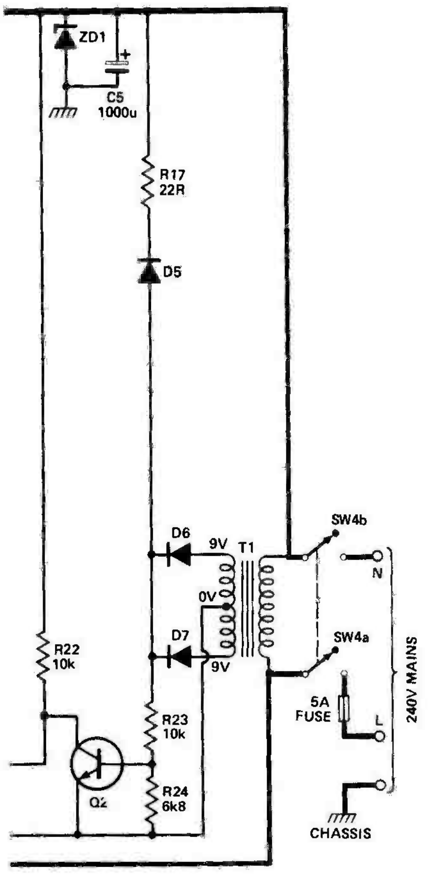
Fig. 3 Triac zero-crossing switching waveforms.

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



set at 20 Hz to 312 Hz, 312 Hz to 2.5 kHz, and 2.5 kHz to 20 kHz. As more Spectracolumns are added into the system the filter ranges can be instantly amended according to taste; but watch out for the current rating of your mains sockets!

Construction

All the components except the controls are mounted on our PCB. The triacs, the transformer, and even the microphone are mounted on board, as the overlay diagram of Fig. 4 illustrates. Assembly should begin first with the links, then resistors, followed by ICs and so on. IC sockets should be used as a good precaution, but note that IC5 is an 18-pin device and IC2 is a 20-pin DIL! Follow the overlay diagram for the orientation of all the components and solder in everything except the PCB-mounting transformer, the triacs, and the crystal mike.

The metal heatsink tab of the triacs has been used to form a screw terminal for the lamp connections (it's connected internally to the central leadout wire MT2). Hence the middle terminal lead of all the triacs must be completely cut off, which immensely simplifies board design too. The remaining two leads are inserted into the board and a 6BA

HOW IT WORKS

The block diagram of Fig. 1 illustrates the different parts of the system. Sound from a microphone is amplified and fed through both low-pass and high-pass filters (digitally controlled); the resulting audio signal is then rectified to produce a voltage envelope proportional to the sound intensity within the pre-defined frequency band. This envelope is displayed using a bargraph voltmeter IC to drive triac-switched mains bulbs which light up in a column according to the instantaneous sound level. A simple power supply provides both the 10 V DC rail and the 100 Hz signal for zero-crossing triac control.

Figure 2 shows the complete circuit diagram for the Spectracolumn. The audio signal provided by the music or other sound is picked up by the microphone insert MIC1 and amplified by IC1a, which is configured as a straightforward non-inverting amplifier with a gain of 100. The high input impedance required by the crystal mike is set by R1 to be about 2M0.

The audio input from this gain stage is taken via the sensitivity control RV1 (acting as a potential divider) to the input of the filter system at R4. The audio filter system is built out of an MF10 monolithic switched capacitor filter. This IC (featured in last month's Designer's Notebook) contains two identical second order (12 dB per octave) filter systems which can be configured in a number of different modes, with the filter corner frequency being determined by a single square wave clock input.

We have used the MF10 to construct both a low-pass and a high-pass filter, which are wired in cascade. The resistor values shown have been chosen to give a pass band gain of 3 and a Q of 1. The cut-off frequencies are set to be 1/50th of the applied clock signals, which can be independently varied for each filter. Using high and low-pass filters in cascade results in a band-pass type of response, where the bandwidth can be very effectively controlled using the two input clocks, and positioned in any part of the spectrum. The clock on pin 10 of the MF10 controls the low-pass filter determining the upper frequency limit, and the clock input on pin 11 determines the high-pass filter's corner frequency, thus setting the lowest frequency that will be passed.

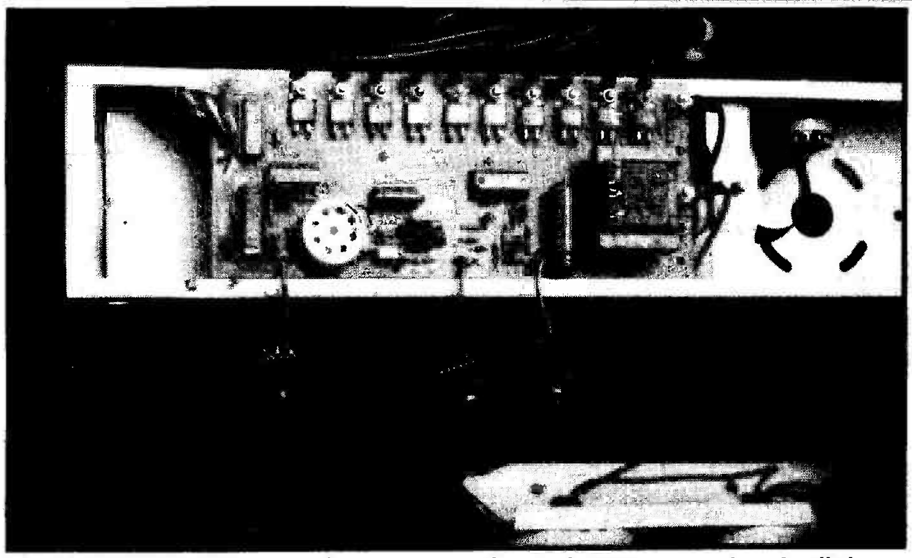
The clock signals are generated and selected using a separate block of CMOS logic circuitry. IC4c and d are configured as a standard CMOS astable to provide the master clock of 2 MHz. This clock is fed directly to the counter divider chip IC3 (a 4040). The Q outputs progressively divide the clock frequency by two to give those frequencies shown in Table 1. As music lovers will know, dividing the frequency thus will give us equal octave increments; the entire audio bandwidth is thus catered for using the 11 outputs of the 4040. The two remaining gates of IC4 take their inputs from the common pole of each 10-way rotary switch, SW1 and SW2, buffering the outputs from the divider chip and providing selectable clock frequencies to program the high and low-pass filters.

The band-pass filtered audio signal is coupled via C2 to a precision half-wave rectifier, built around IC1b. A positive-going audio envelope thus appears across C3. R16 determines the attack time constant and R15 the decay time-constant. Potential divider RV2 supplies an offset voltage derived from the 1V4 reference to the non-inverting input terminal of the op-amp IC1b. This allows a 'background' voltage level to be superimposed on the envelope voltage, giving an independent control of the light column's illumination. The 1V4 reference is created by the forward voltage drop across D1 and D2 which are biased by resistor R14; this reference is also used to feed the internal resistor chain of the LM3915 at pin 6 of IC5. The LM3915 converts the envelope voltage applied at the pin 5 signal input to an array of 10 switched outputs. Pin 4 is the earth reference for the signal and resistor chain voltages; it is tied to the 5 V 'pseudo earth' rail. This half supply-volts rail is derived from the low-impedance potential divider R13, 20.

Direct drive from IC5 to the triacs is achieved by tying the mains neutral to the positive rail on IC5 and the common MT1 terminals of all the triacs. The switched outputs of IC5, which provide constant current, are taken directly to the gates of the triacs and the bulbs are placed in series with the triacs in the returning mains live lead. Now, resistor R21 is normally used for setting the output drive current of the LM3915, going from the pin 7 reference to ground.

In our arrangement, however, it is switched to ground using Q1. Thus when Q1 is off, the constant current sources that drive the gates of triacs SCR1 to 10 will all be disabled, and the triacs cannot turn on. Q1 is driven by brief pulses derived from the zero-crossings of the mains cycle; in other words when the AC mains cycle reaches 0 V (which occurs 100 times per second), transistor Q1 turns on and allows the triacs to be triggered on only at this moment. The triacs automatically turn off again as the mains current falls away to zero, assuming there is no further drive signal. For the triac to turn on, then, the corresponding output from IC5 must be 'active' due to the sound level, and at the same time as a zero-crossing pulse occurs. By turning on the triacs and thus the lamp current flow only when the mains voltage is close to zero, the problems of radio frequency interference are effectively avoided.

The circuitry is powered from a 10 V supply rail, regulated by the 10 V zener diode ZD1, and decoupled by C5. The centre-tapped 9-0-9 V transformer is full-wave rectified by D6 and D7; Q2 is driven by the 100 Hz signal at the junction of D6 and 7 to detect the zero crossing points. As the voltage cycle falls down to zero the voltage on the base of Q2 also falls. When it goes below 0V6 Q2 will turn off (the zero crossing point), thus allowing Q1 to turn on. D5 and R17 isolate the full wave rectified DC from the 10 V power rail.



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

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 ohm-meter) 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 condensor 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 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 ¼W, 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).

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.

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

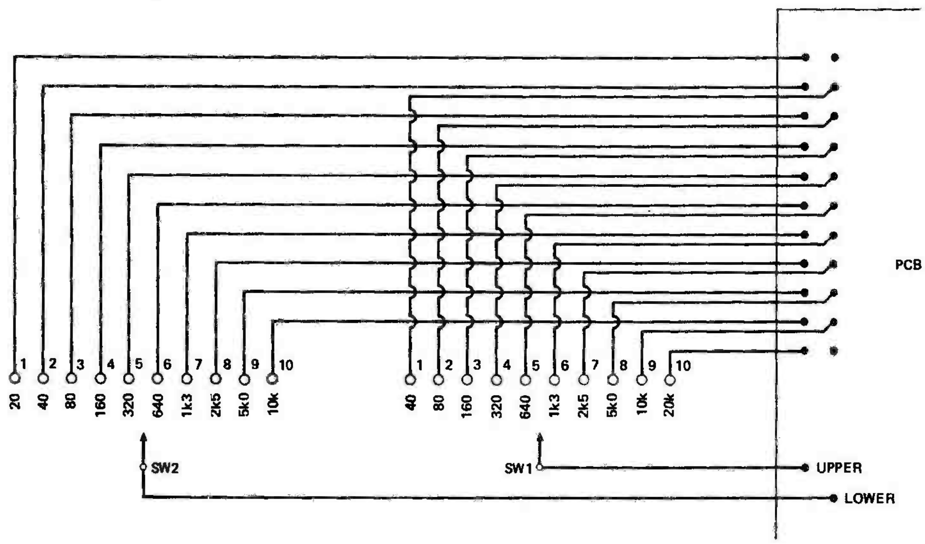


Fig. 4 This diagram shows how to wire up SW1 and SW2.

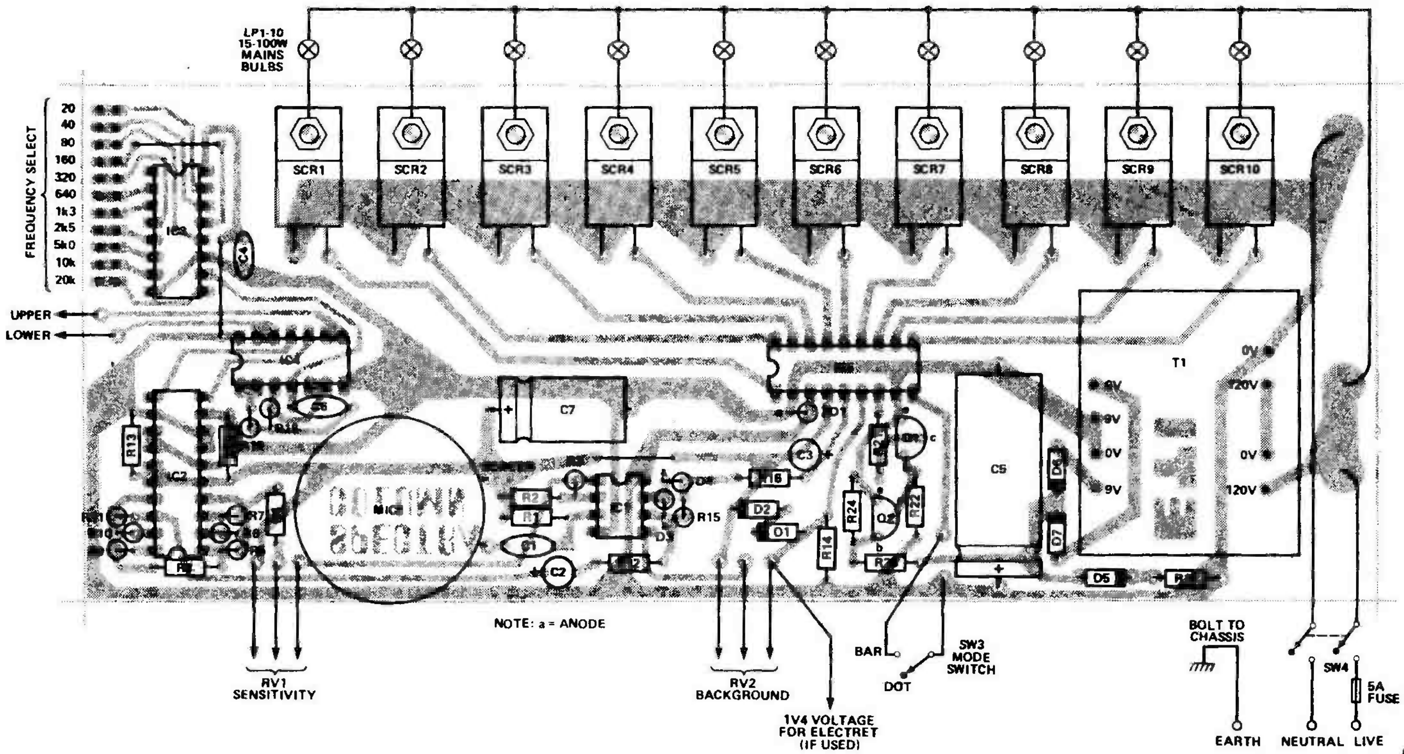
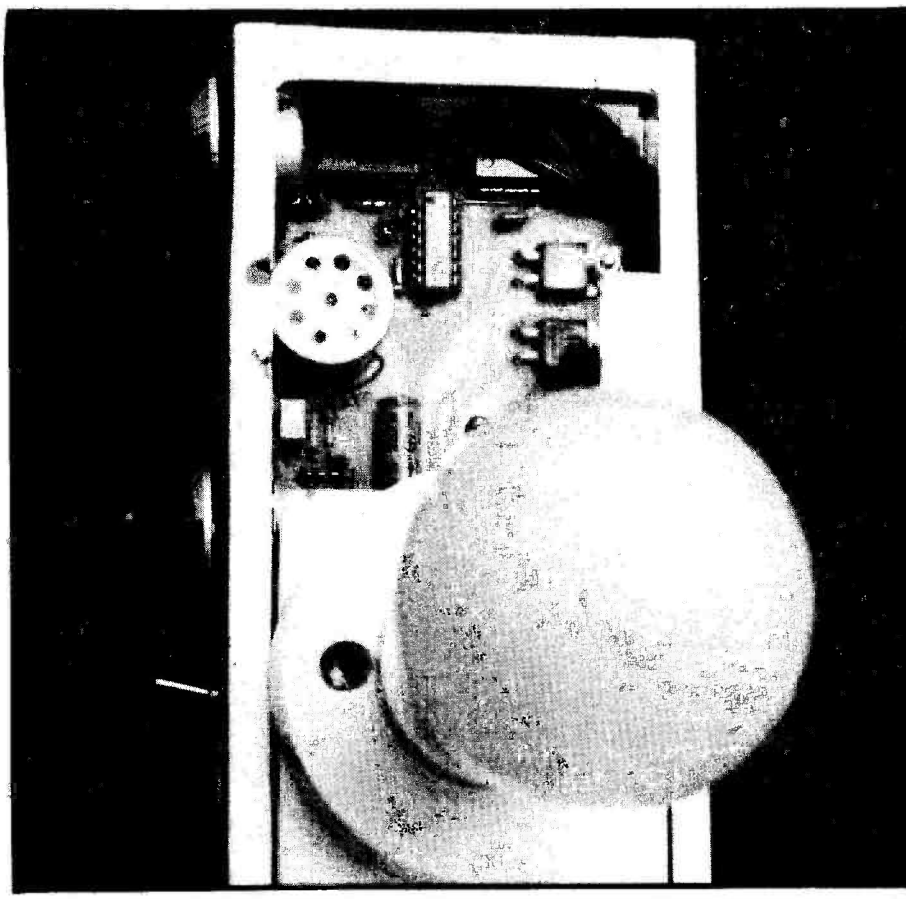


Fig. 5 Component overlay for the Spectracolumn. Use spade connectors for the triac and mains connections.

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.

ETI

CONFIGURATIONS

Transistors as amplifiers, transistors as multivibrators — now we consider transistors as sawtooth generators. If you want to know the timebase, ask Ian Sinclair.

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 oscillosope 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 performance. 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.

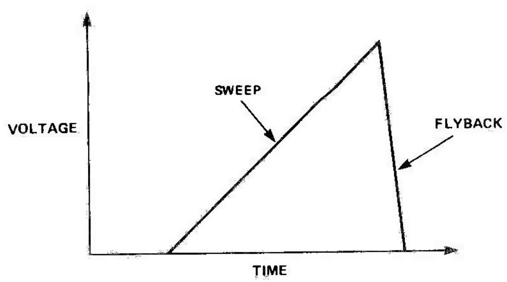


Fig. 1 The waveform of a perfect timebase — this should be a straight line.

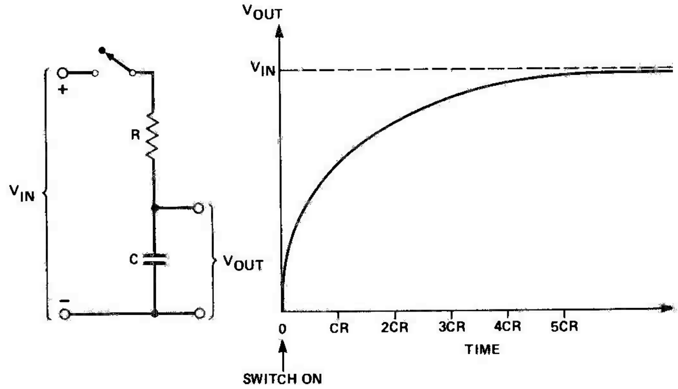


Fig. 2 Capacitor charging. When a capacitor is charged through a resistor the waveform is an exponential rather than a straight line.

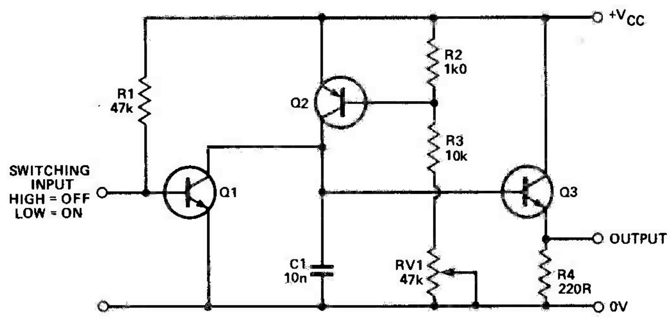


Fig. 3 Using a transistor in place of a resistor for capacitor charging. Since the current through the transistor remains constant, the sweep waveform is straight rather than exponential.

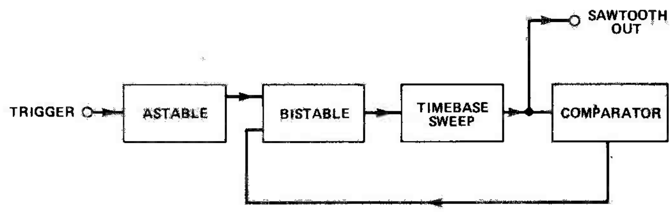


Fig. 4 Block diagram of an oscilloscope timebase.

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.

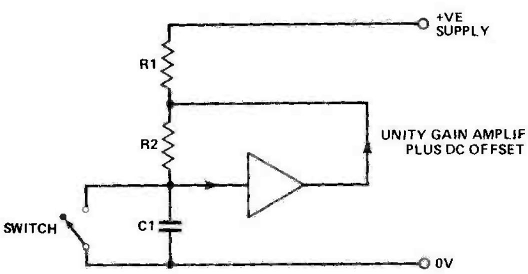


Fig. 5 The principle of the bootstrap timebase circuit.

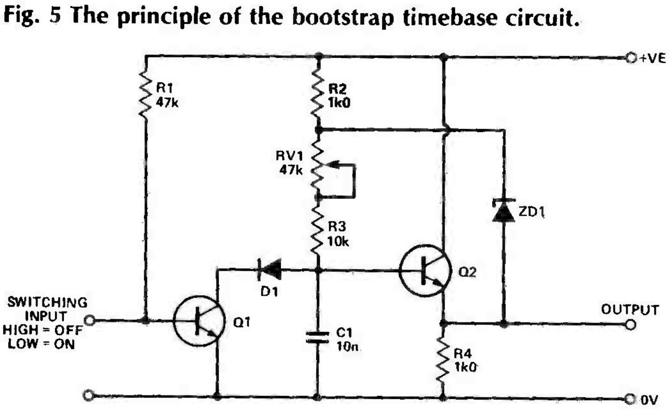


Fig. 6 A practical form of the bootstrap circuit, using an emitter-follower as the unity-gain amplifier.

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

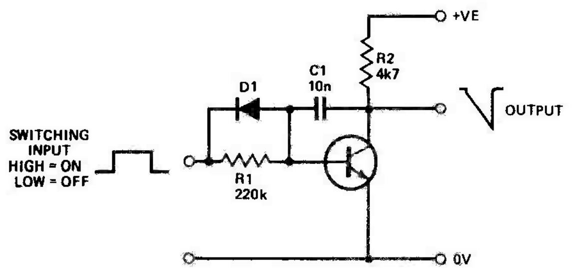


Fig. 7 The basic Miller timebase circuit.

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.

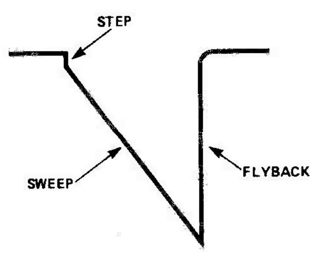


Fig. 8 The waveform from the simple Miller circuit.

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! **ETI**

Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

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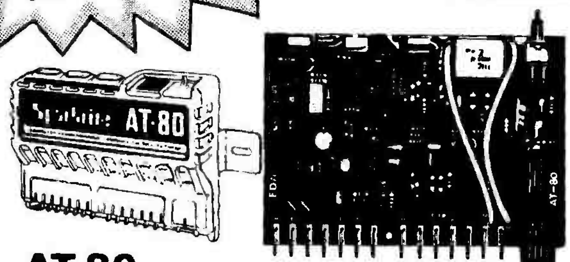

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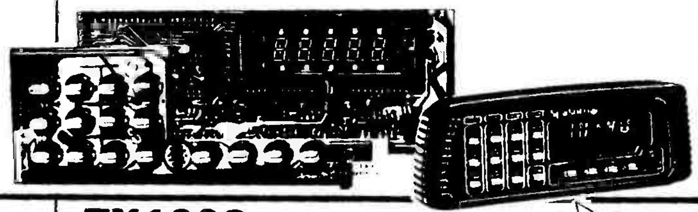

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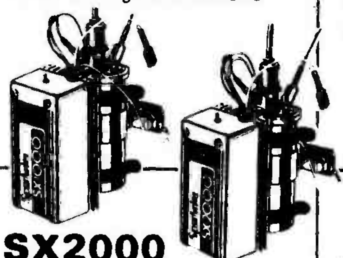

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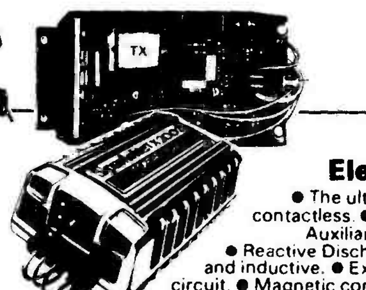

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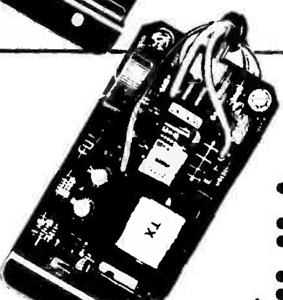

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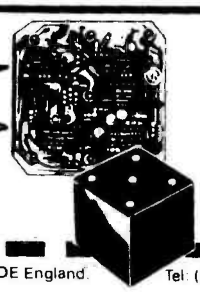

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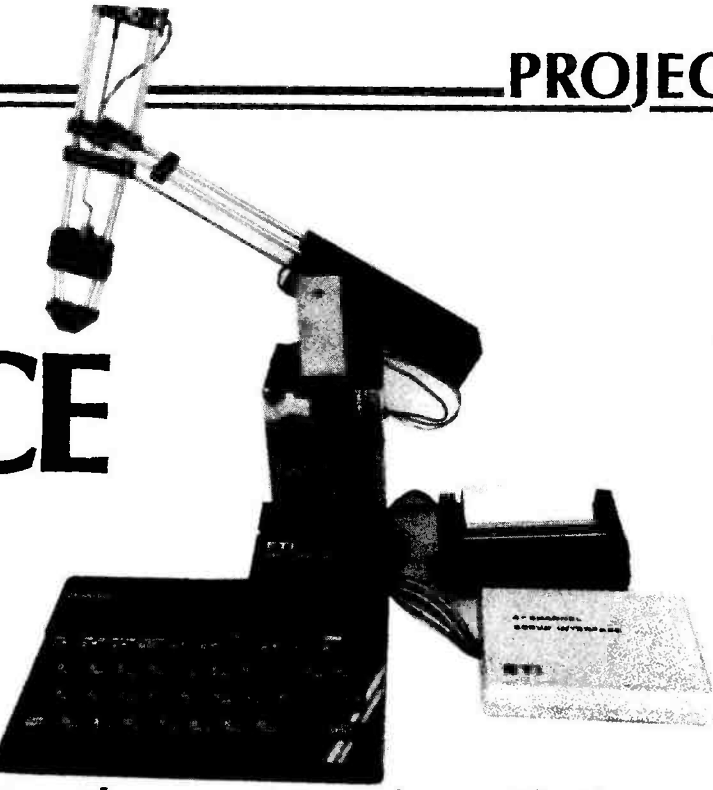
SERVO INTERFACE

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 ¼W, 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	47u 16 V 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 × 91 × 23 mm (see Buylines); case for plug — general purpose Vero potting box; 14-way ribbon cable.

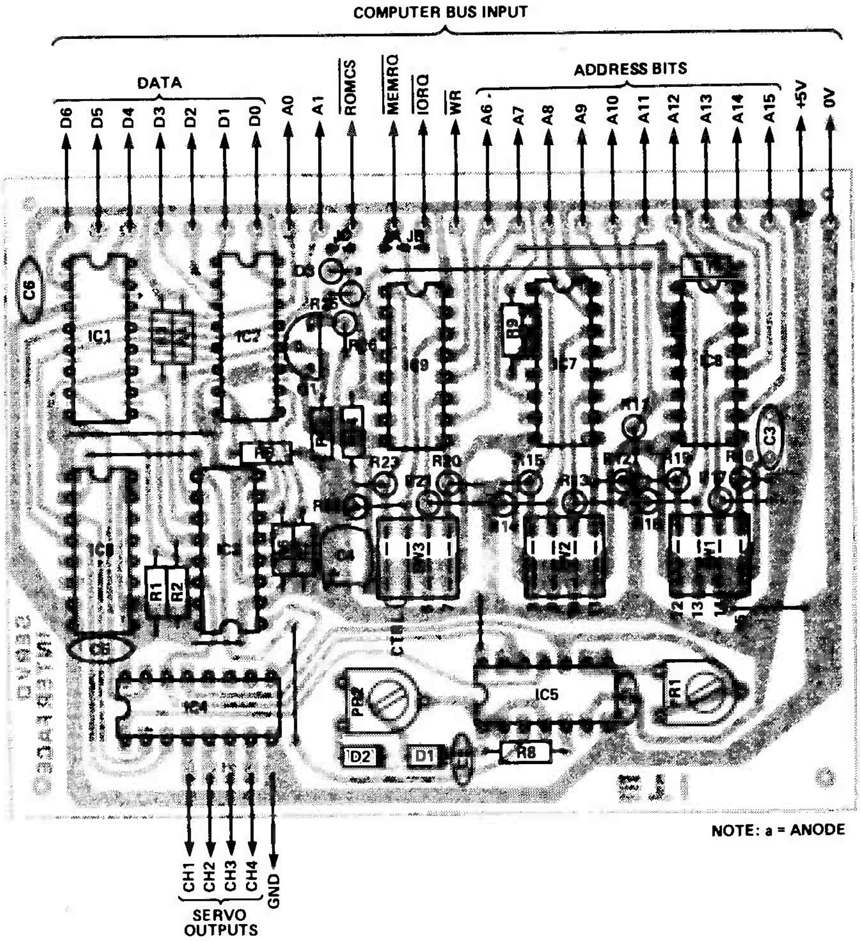
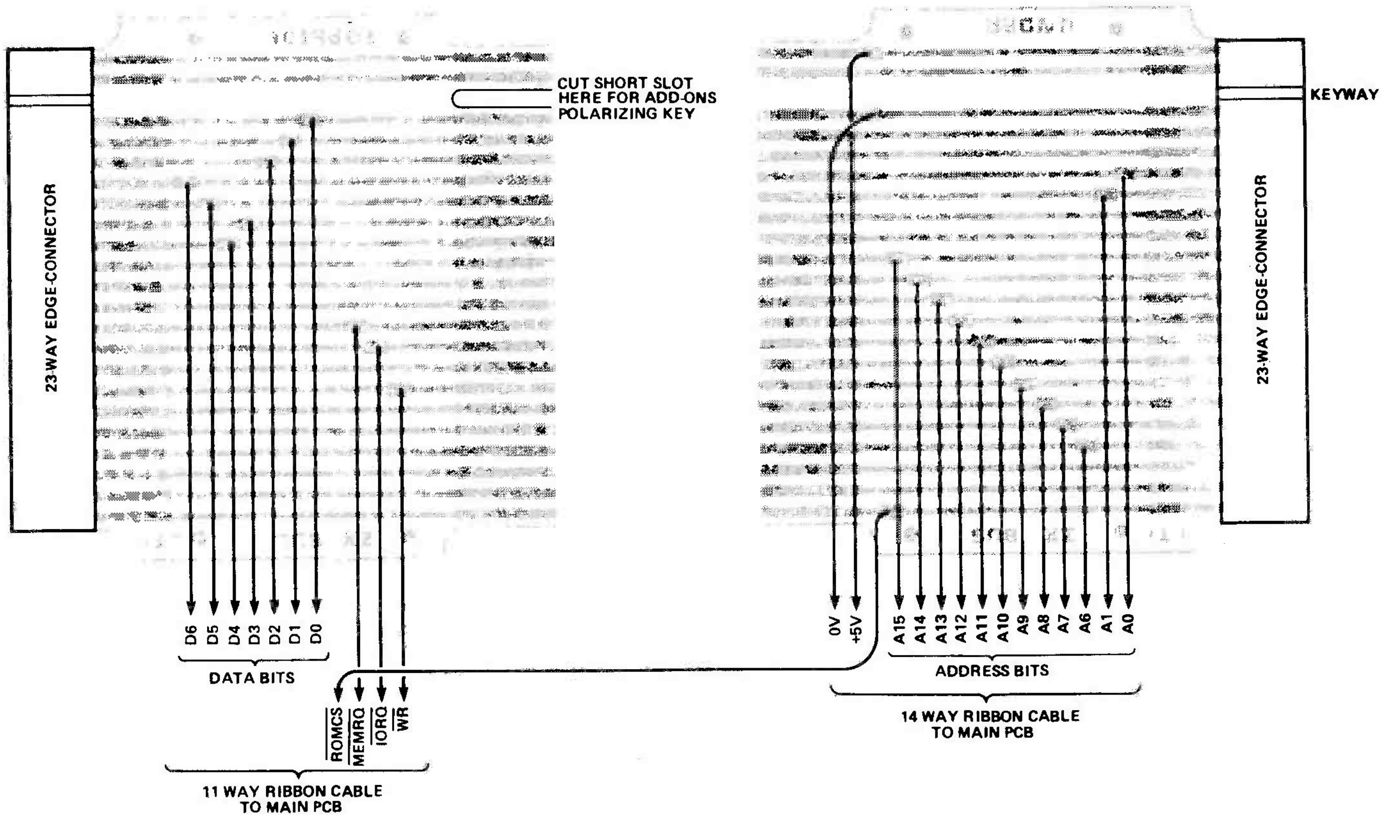


Fig. 1 (Right) Overlay for the servo arm interface board.

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.



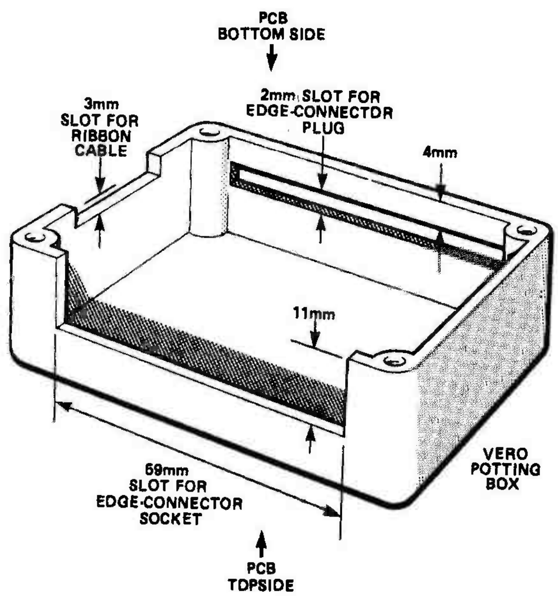
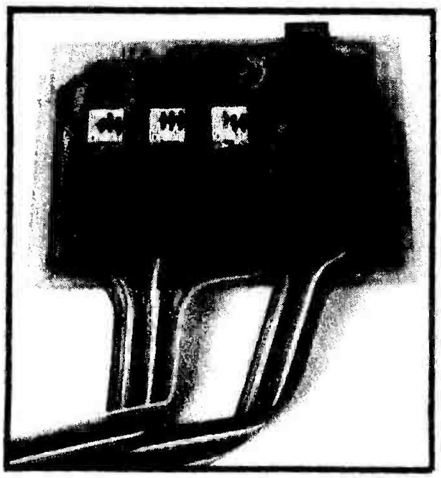


Fig. 3 Construction of the edge connector box.



A completed interface board; the ribbon cable colds 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.

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.

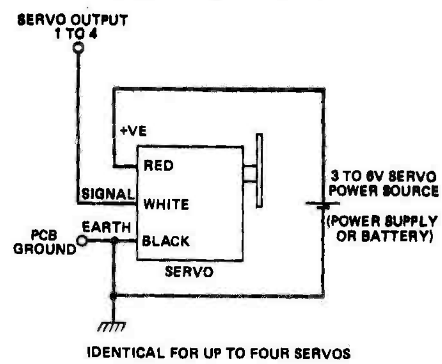
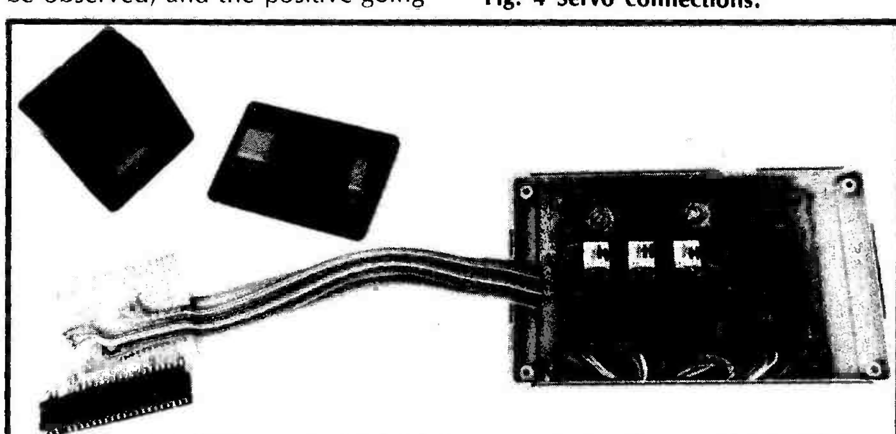


Fig. 4 Servo connections.



Rubber feet in the case help support the connector board.

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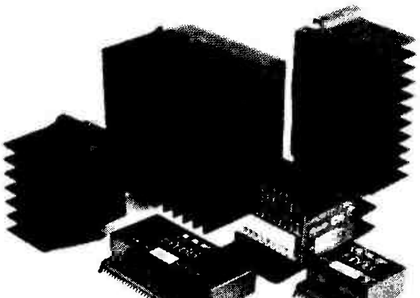

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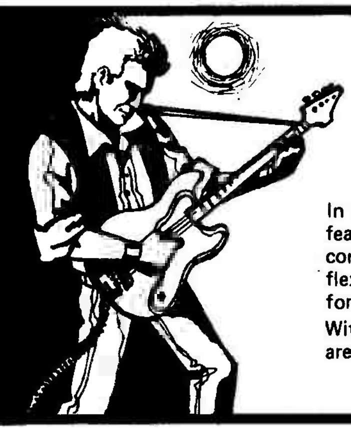

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Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
HY30	15	4-8	0.015%	<0.006%	± 18	76 x 68 x 40	240	£8.40
HY60	30	4-8	0.015%	<0.006%	± 25	76 x 68 x 40	240	£9.55
HY6060	30 + 30	4-8	0.015%	<0.006%	± 25	120 x 78 x 40	420	£18.69
HY124	60	4	0.01%	<0.006%	± 26	120 x 78 x 40	410	£20.75
HY128	60	8	0.01%	<0.006%	± 35	120 x 78 x 40	410	£20.75
HY244	120	4	0.01%	<0.006%	± 35	120 x 78 x 50	520	£25.47
HY248	120	8	0.01%	<0.006%	± 50	120 x 78 x 50	520	£25.47
HY364	180	4	0.01%	<0.006%	± 45	120 x 78 x 100	1030	£38.41
HY368	180	8	0.01%	<0.006%	± 60	120 x 78 x 100	1030	£38.41

Protection: Full load line. Slew Rate: 15v/μs. Risetime: 5μs. S/N ratio: 100db.
Frequency response (−3dB) 15Hz – 50KHz. Input sensitivity: 500mV rms.
Input Impedance: 100K Ω. Damping factor: 100Hz >400.

PRE-AMP SYSTEMS

Module Number	Module	Functions	Current Required	Price inc. VAT
HY6	Mono pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble	10mA	£7.60
HY66	Stereo pre amp	Mic/Mag. Cartridge/Tuner/Tape/ Aux + Vol/Bass/Treble/Balance	20mA	£14.32
HY73	Guitar pre amp	Two Guitar (Bass Lead) and Mic + separate Volume Bass Treble + Mix	20mA	£15.36
HY78	Stereo pre amp	As HY66 less tone controls	20mA	£14.20

Most pre-amp modules can be driven by the PSU driving the main power amp. A separate PSU 30 is available purely for pre amp modules if required for £5.47 (inc. VAT). Pre-amp and mixing modules in 18 different variations. Please send for details.

Mounting Boards
For ease of construction we recommend the **B6** for modules HY6–HY13 £1.05 (inc. VAT) and the **B66** for modules HY66–HY78 £1.29 (inc. VAT).

MOSFET MODULES

Module Number	Output Power Watts rms	Load Impedance Ω	DISTORTION T.H.D. Typ at 1KHz	I.M.D. 60Hz/ 7KHz 4:1	Supply Voltage Typ	Size mm	WT gms	Price inc. VAT
MOS 128	60	4-8	<0.005%	<0.006%	± 45	120 x 78 x 40	420	£30.41
MOS 248	120	4-8	<0.005%	<0.006%	± 55	120 x 78 x 80	850	£39.86
MOS 364	180	4	<0.005%	<0.006%	± 55	120 x 78 x 100	1025	£45.54

Protection: Able to cope with complex loads without the need for very special protection circuitry (fuses will suffice).
Slew rate: 20v/μs. Rise time: 3μs. S/N ratio: 100db
Frequency response (−3dB): 15Hz – 100KHz. Input sensitivity: 500mV rms
Input impedance: 100K Ω. Damping factor: 100Hz > 400.

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PSU 42X	1 x HY128	£15.90
PSU 43X	1 x MOS128	£16.70
PSU 51X	2 x HY128, 1 x HY244	£17.07

Model Number	For Use With	Price inc. VAT
PSU 52X	2 x HY124	£17.07
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
PSU 72X	2 x HY248	£22.54
PSU 73X	1 x HY364	£22.54
PSU 74X	1 x HY368	£24.20
PSU 75X	2 x MOS248, 1 x MOS368	£24.20

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

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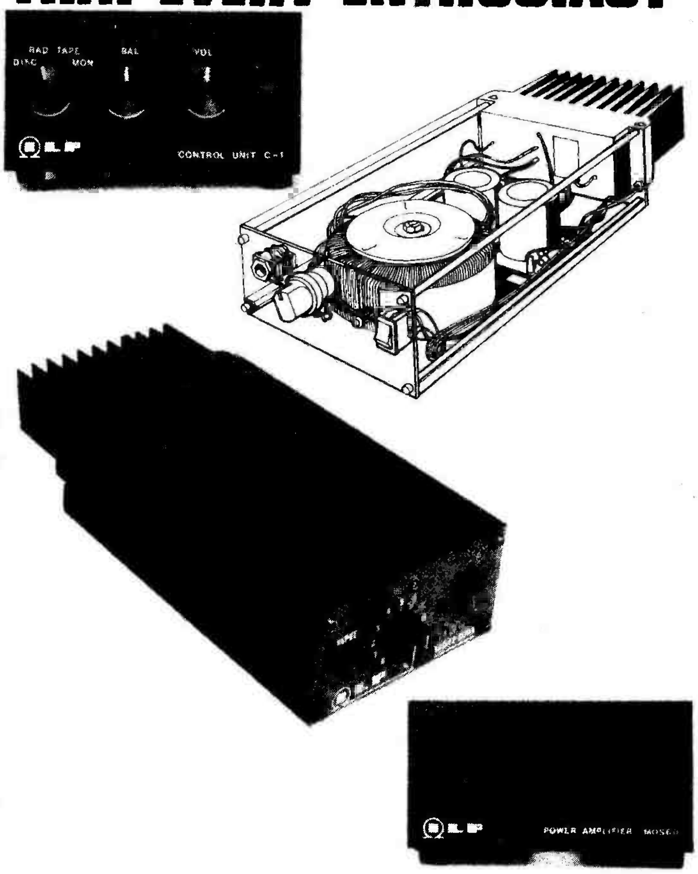

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US1X	60W/4Ω	Bipolar	Power	Slave	£59.95
US2X	120W/4Ω	Bipolar	Power	Slave	£79.95
US3X	60W/4–8Ω	MOS	Power	Slave	£69.96
US4X	120W/4–8Ω	MOS	Power	Slave	£89.95

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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 500 mV 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 (775 mV output into a 500 mV 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 accoustically 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 150 W 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 775 mV and the amp's input is 1 V.

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 +10 V and −10 V 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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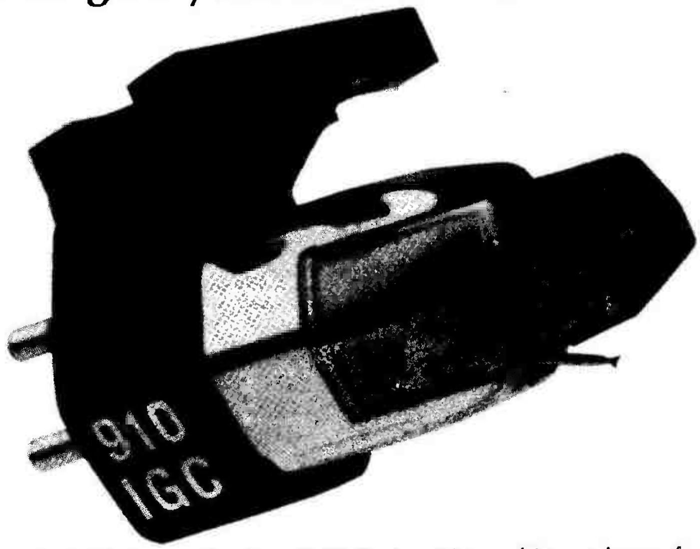
AUDIOPHILE

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 (x10^{-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 6–7 g.

Thus the 910IGC, with its compliance of 25 cu, 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 3 g and 12 g.)

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 6 g. 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.

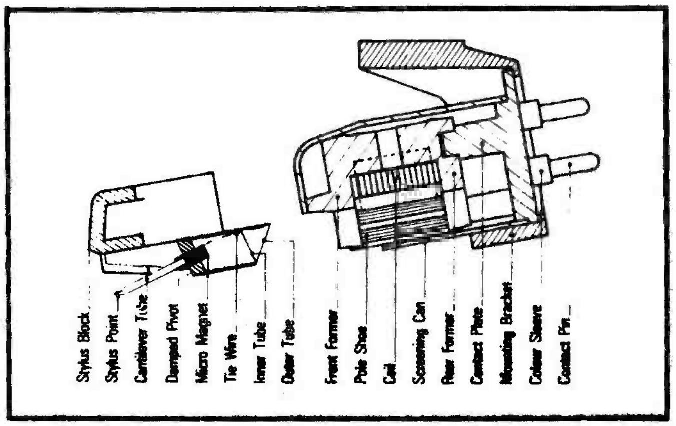


Fig. 1 Cross-sectional drawing of the Goldring G901IGC cartridge.

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!

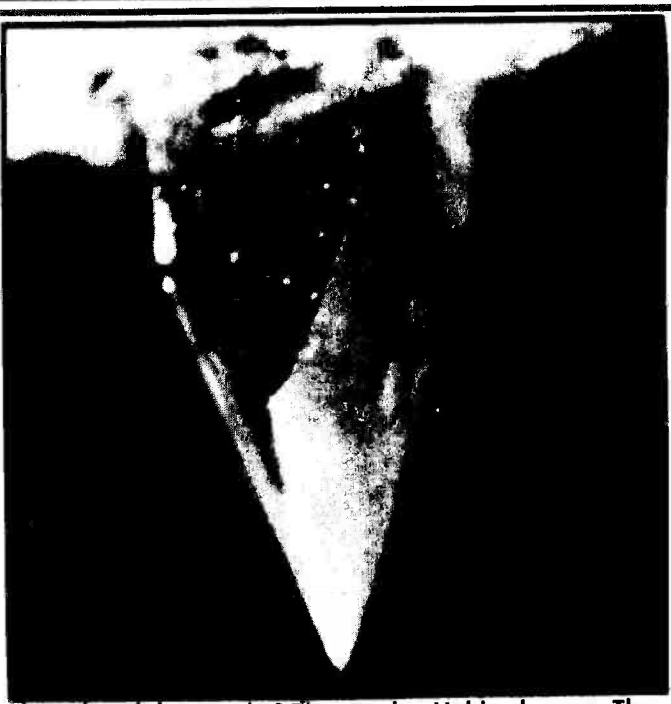
Back To The Plot

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 um and a major (contact) dimension of 85 um 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
FREQUENCY RESPONSE: (see graph)	20 Hz — 20 kHz ± 1.5 dB
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

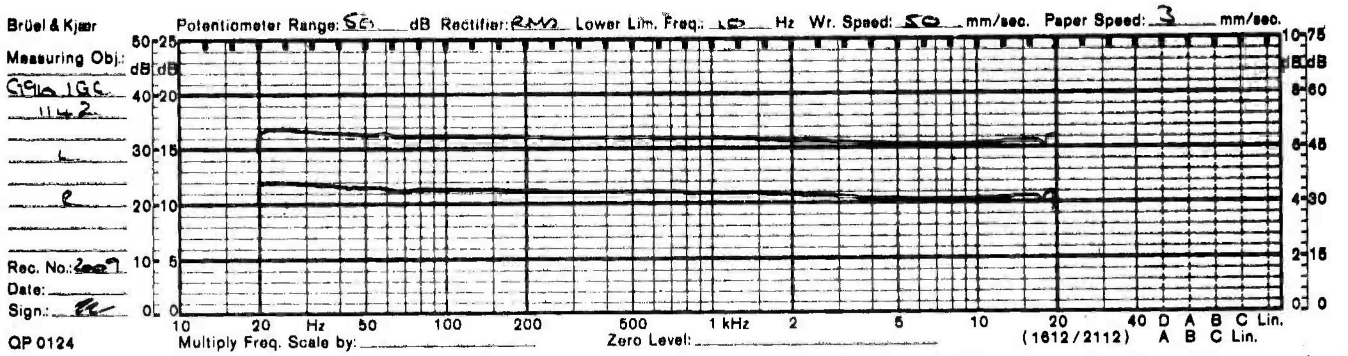


Fig. 2 (above) Frequency response plot of the G901IGC. Would that it contained a few deficiencies so that I could moan about them.

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 ± 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 beyong 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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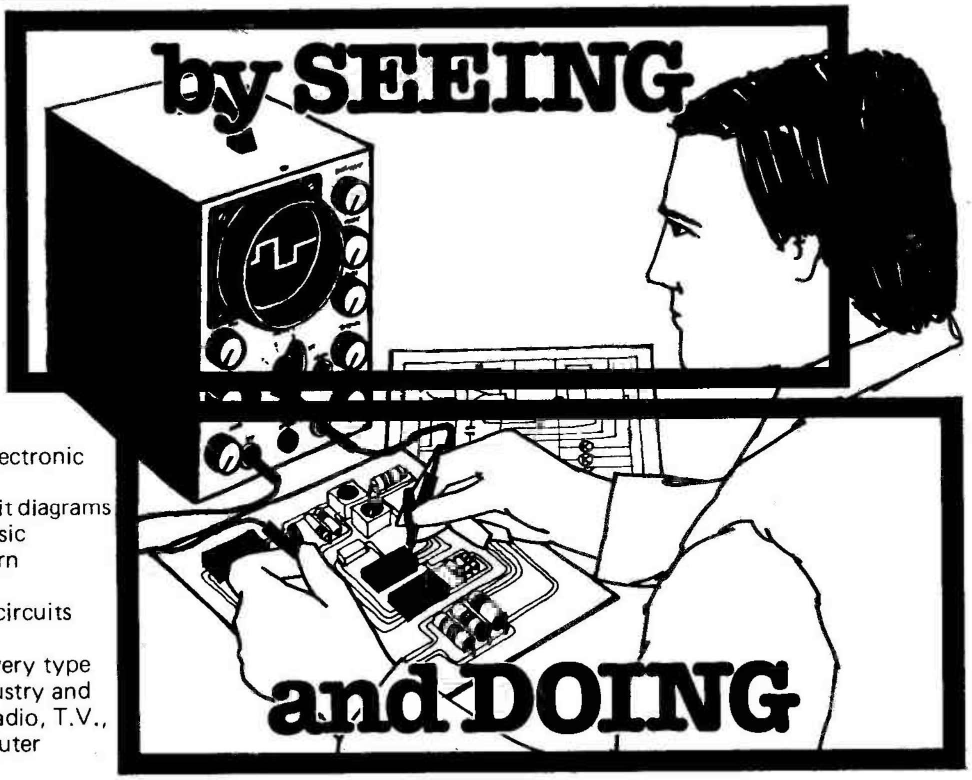

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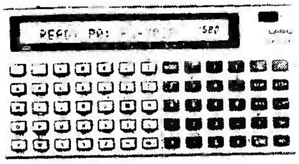

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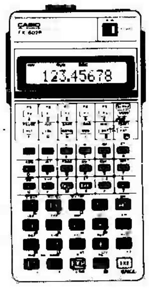

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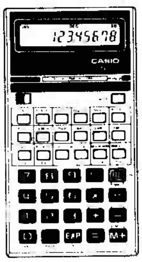

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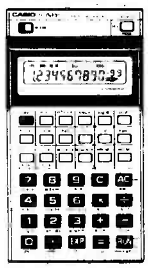

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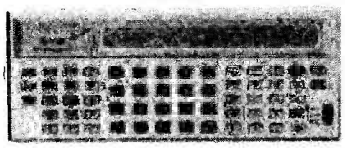

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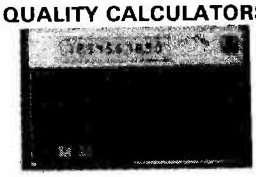

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	1x011	9+9	1 66	
	1x012	12+12	1 25	
	1x013	15+15	1 00	
	1x014	18+18	0 83	
	1x015	22+22	0 68	
	1x016	25+25	0 60	
	1x017	30+30	0 50	
50 VA 80×35mm 0 9Kg Regulation 13%	2x010	6+6	4 16	**£5.70** +p/p £1 30 +VAT £1 05 TOTAL £8 05
	2x011	9+9	2 77	
	2x012	12+12	2 08	
	2x013	15+15	1 66	
	2x014	18+18	1 38	
	2x015	22+22	1 13	
	2x016	25+25	1 00	
	2x017	30+30	0 83	
	2x028	110	0 45	
	2x029	220	0 22	
	2x030	240	0 20	
80 VA 90×30mm 1 Kg Regulation 12%	3x010	6+6	6.64	**£6.08** +p/p £1 67 +VAT £1 16 TOTAL £8 91
	3x011	9+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	
	3x028	110	0 72	
	3x029	220	0 36	
	3x030	240	0 33	
120 VA 90×40mm 1 2 Kg Regulation 11%	4x010	6+6	10 00	**£6.90** +p/p £1 67 +VAT £1 29 TOTAL £9 86
	4x011	9+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	
	4x018	35+35	1 71	
	4x028	110	1 09	
	4x029	220	0 54	
	4x030	240	0.50	
160 VA 110×40mm 1 8 Kg Regulation 8%	5x011	9+9	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	

TYPE	SERIES No	SECONDARY Volts	RMS Current	PRICE
225 VA 110×45mm 2 2 Kg Regulation 7%	6x012	12+12	9 38	**£9.20** +p/p £2 00 +VAT £1 68 TOTAL £12 88
	6x013	15+15	7.50	
	6x014	18+18	6.25	
	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 110×50mm 2 6 Kg 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 140×60mm 4 Kg Regulation 4%	8x016	25+25	10 00	**£13.53** +p/p £2 35 +VAT £2 38 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 140×75mm 5 Kg Regulation 4%	9x017	30+30	10.41	**£16.13** +p/p £2 50 +VAT £2 79 TOTAL £21 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	
	9x030	240	2 60	

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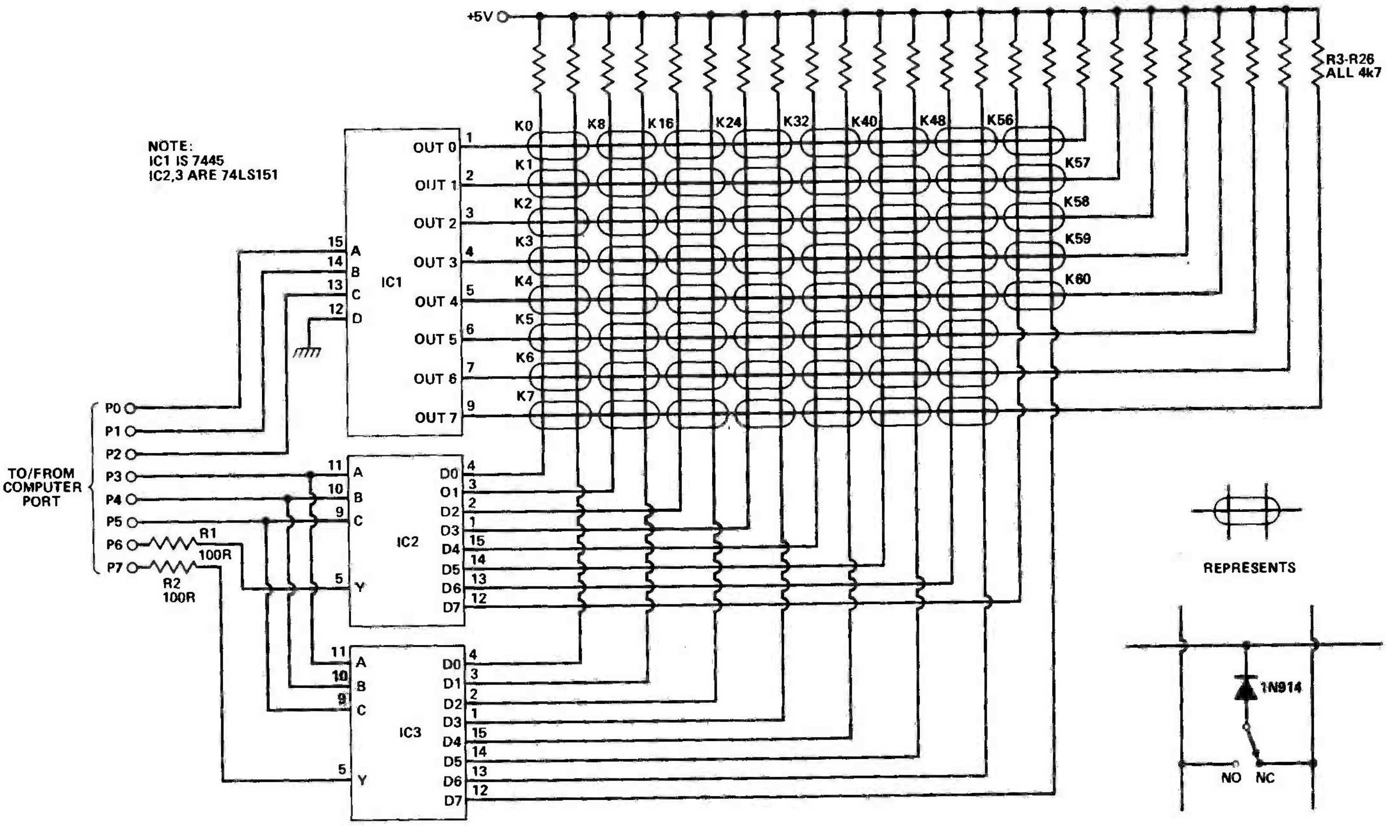
TECH TIPS



Computer/synth Keyboard Interface

Philip Jones, Wirral

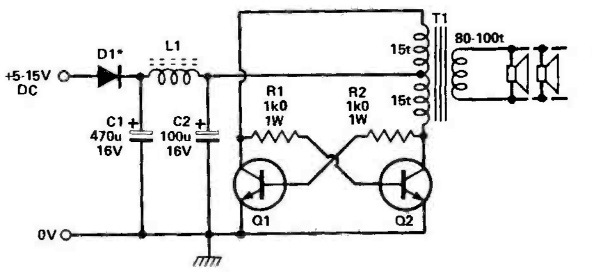
This circuit was produced to interface a 61-note music keyboard to a microcomputer for music synthesis applications. The facility for touch sensitivity is included by using changeover contacts for the keys and two multiplexer ICs (74LS151). Complete control from the computer is possible using one input/output 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



NOTE:
Q1,2 ARE TIP31, TIP41, BD201, MJ3055, ETC. WITH ADEQUATE HEATSINKS

T1 PRIMARY: 15t + 15t 25 SWG (BIFILAR)
SECONDARY: 80-100t 30 SWG
ON SIEMENS FERRITE CORE
B65631J0R26 OR MULLARD FX2243

L1 10-15 turns 19 SWG
ON SIEMENS B64290J46X026
OR MULLARD FX3830 TOROIDAL CORE

*D1 IS 1N4001 (REQUIRED ONLY IF POLARITY REVERSAL IS NEEDED)

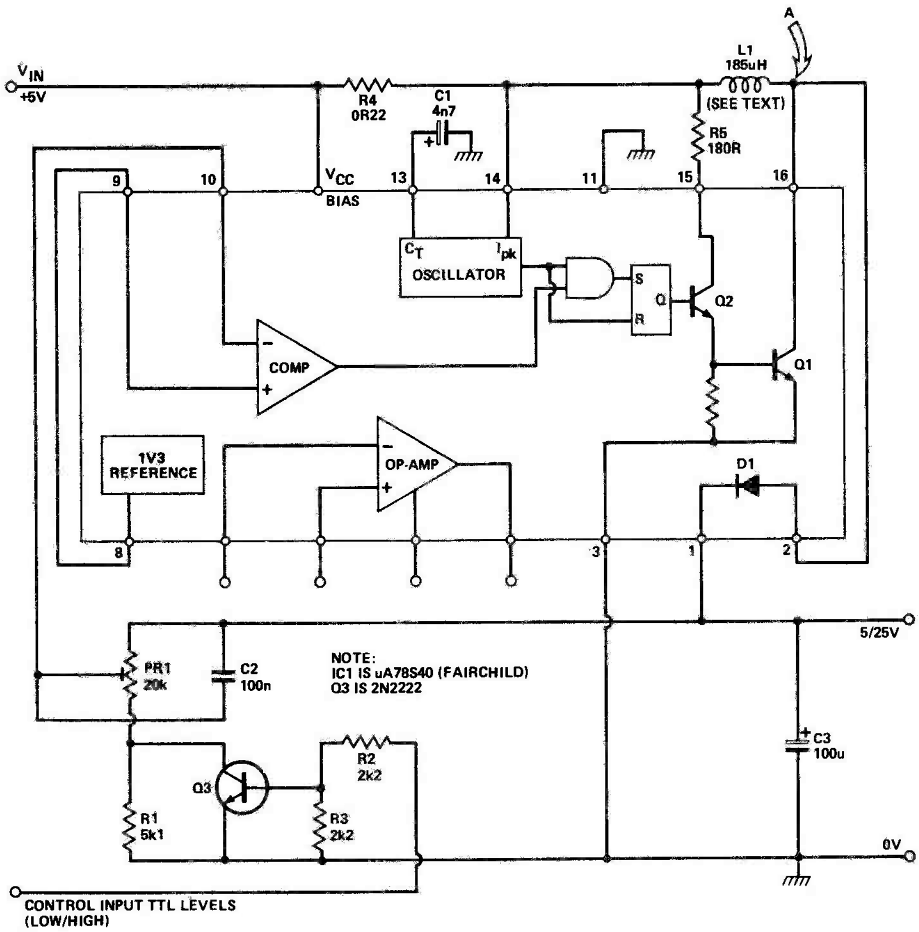
The circuit shown is a self-starting inverter where Q1 and Q2 are connected as a multivibrator with the transformer primary forming the collector loads. The 1k0 resistors provide the base drive.

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 25 V or 5 V (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 5 V V_{cc} input; this circuit will therefore eliminate the need for a transformer derived 25 V 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 5 V. When Q3 is turned on the feedback is reduced, so V_{OUT} will rise to +25 V. When off, feedback is increased and the output will fall to +5 V. 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 25 V 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 25 V for loads requiring up to 75 mA. The +5 V supply does exhibit 500 mV of switching ripple, but superimposed on a mean 5 V 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%.

Tech Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items. ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for at a competitive rate.

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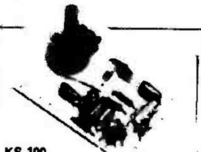

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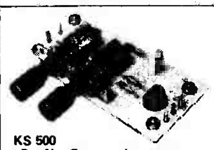

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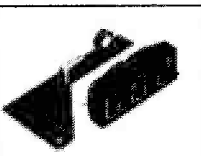

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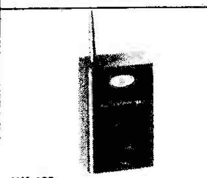

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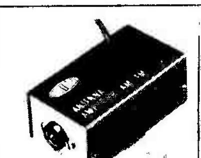

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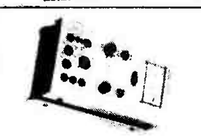
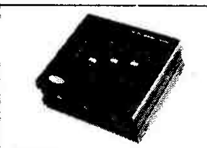


UK 562
Transistor and diode tester
£14.73 inc. V.A.T.



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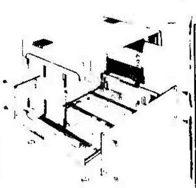

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	INCH	mm	INCH	mm	INCH	mm	VAT
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SIGNAL LINE TESTER

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 murmerings 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.

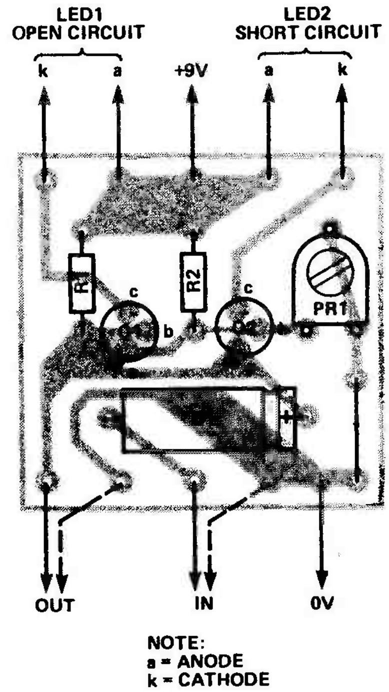

Fig. 1 Component overlay for the line checker. The line below PR1 may be replaced by a resistor — see text.

PARTS LIST

Resistors (all ¼W, 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 wil 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 1k0 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

HOW IT WORKS

The circuit diagram is shown in Fig. 1: we will consider the operation of the open-circuit indicator first. The emitter of Q1 is taken to the junction of R2 and PR1 which have values of 10k and 1k0 respectively, so the emitter is at a potential of one-tenth of the supply. The base of Q1 is connected to the junction of R1 (100k) and the load, which is nominally 10k; hence it too is at one-tenth of the supply voltage. Therefore there is no forward bias on Q1 as the base and emitter are at about the same potential, so no current passes through it and the LED in its collector circuit.

If the load now goes open circuit, the positive voltage on Q1 base rises since it is no longer tied down, so Q1 becomes forward biased, and current flows through LED1, illuminating it. Current limiting is provided by PR1 in the emitter circuit, which safeguards LED1.

The short circuit detector is built round Q2. The base of this transistor is taken to the R2-PR1 junction, and is at one-tenth of the supply; Q2 emitter is connected to the junction of R1 and the load, and so it too has base and emitter at the same potential and is cut off. Should the load become short circuited, the emitter voltage drops to zero which means there is a positive bias on the base. Therefore Q2 conducts and LED2 lights to indicate a short. Although there is no current-limiting resistor in series with LED2, the bias on the transistor can be adjusted by PR1 to give the correct current and desired illumination.

Note that neither fault condition affects the warning circuit of the other. If the load is short-circuited, Q1 base drops to 0 V while its emitter is still positive, so it is driven even further into cut-off. Similarly, if the load becomes open-circuit, the emitter voltage of Q2 rises above that of its base.

The capacitor C1 blocks DC from the sending equipment, should there be any, from upsetting the operation of the warning circuits and vice versa. It also prevents any DC path in the output of the sending device from shunting the load and rendering the open-circuit test ineffective.

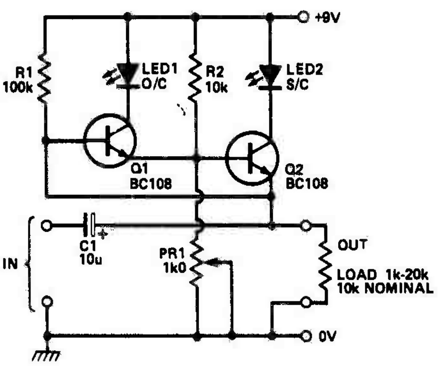

Fig. 2 Circuit diagram of the signal line tester.

there will be no limiting resistance for LED1 and it could be destroyed. If preferred, the value can be split between a 500R preset and 560R fixed resistor for the sake of safety. Once set, the preset should not require re-adjustment, and so can be sealed with a spot of paint.

Connect a 10k load resistor across the output socket. If one is already fitted across a switched jack socket, this will not be necessary. On applying the supply, both LEDs should remain off. Disconnect the load and LED1 should light up. Now short-circuit the output; LED1 should go out and LED2 illuminate. It will be found that one LED is brighter than the other due to differences in the h_{fe} of the transistors and tolerances of the resistors. Adjusting PR1 will produce equal brightness, so repeat the open-circuit and short-circuit tests and adjust PR1 each time until the desired illumination is achieved. Decreasing the value darkens LED2 and brightens LED1 and vice-versa.

Check that both LEDs are off with loads of 20k and 1k0. If LED1 glimmers at 20k increase the value of R1 to 120k or even more if required. This may be necessary if Q1 has an exceptionally high h_{fe}. **ETI**

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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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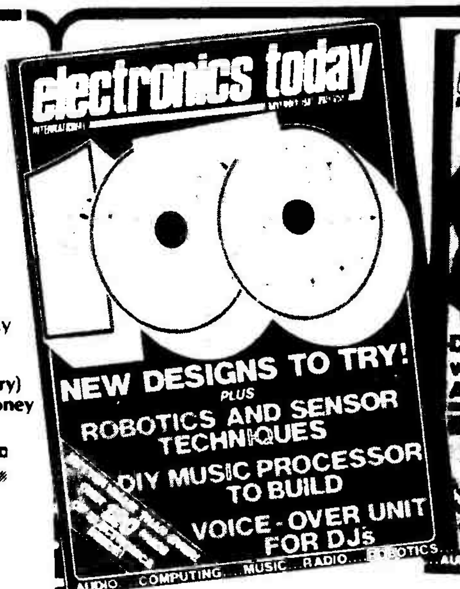

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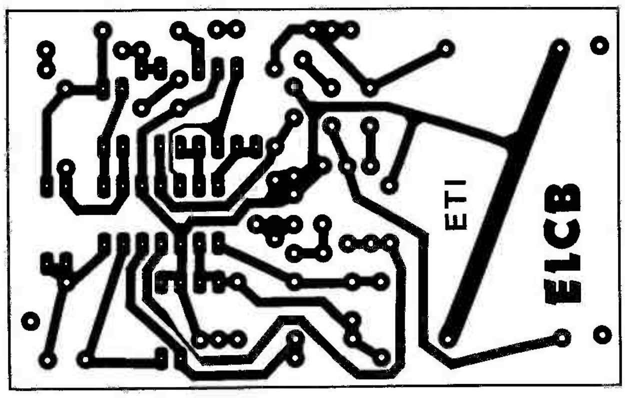

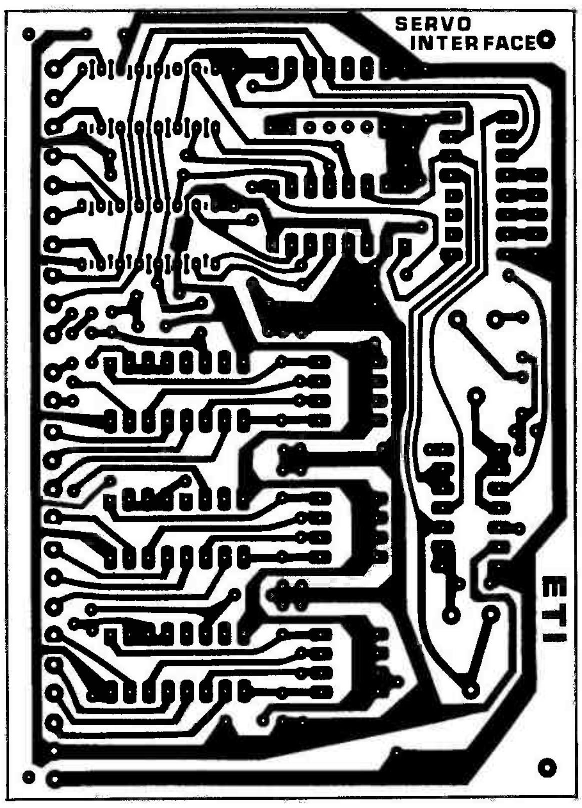

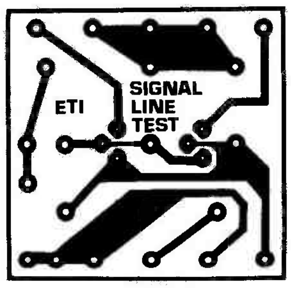

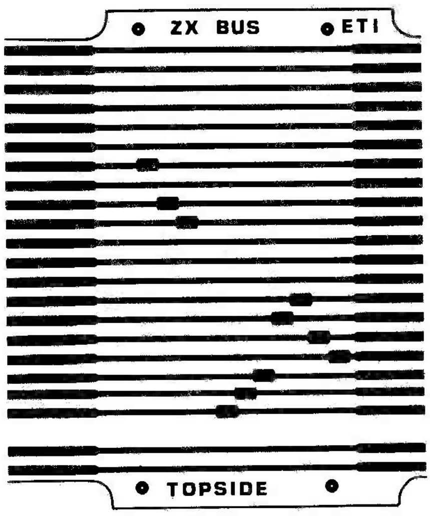

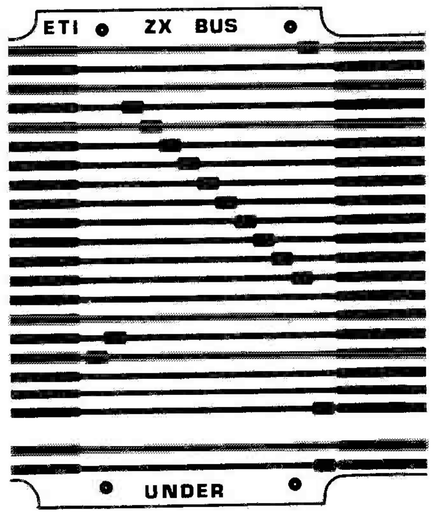

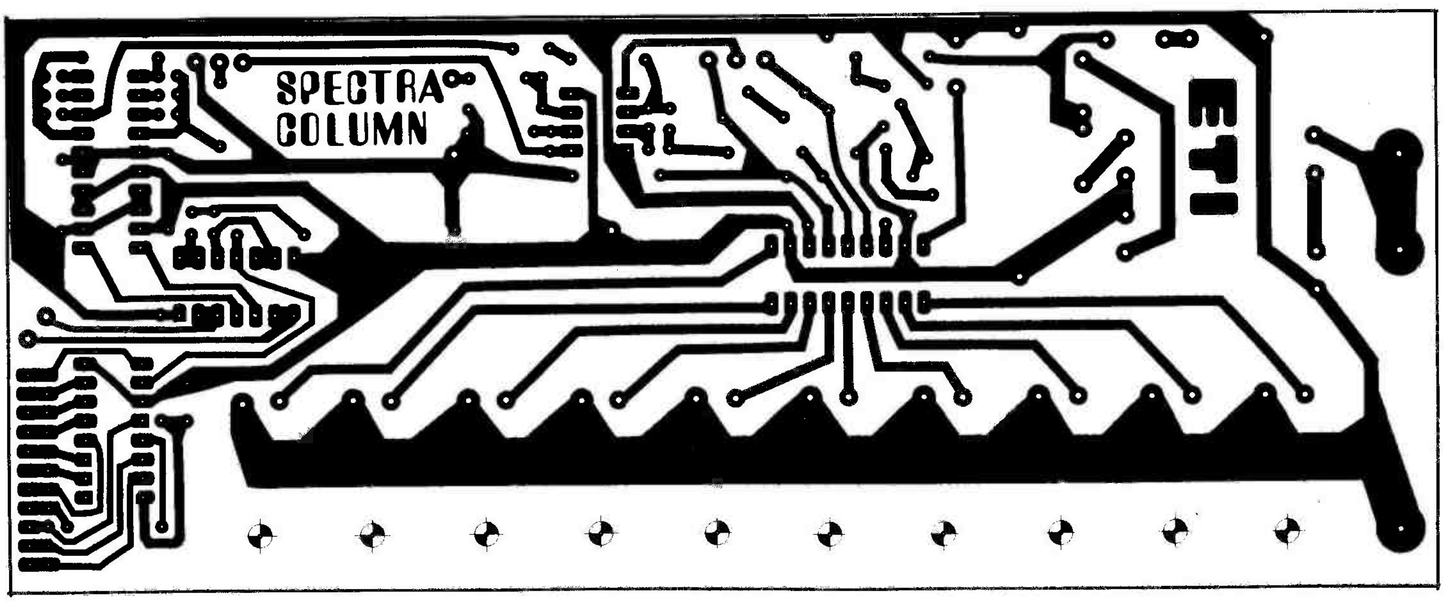

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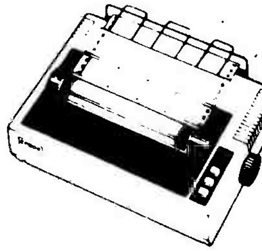

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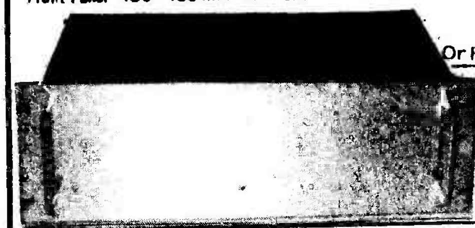

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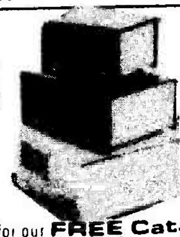

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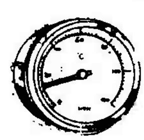

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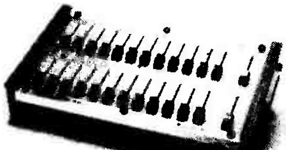

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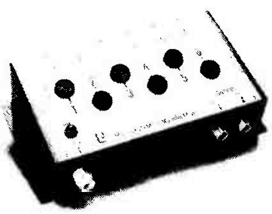

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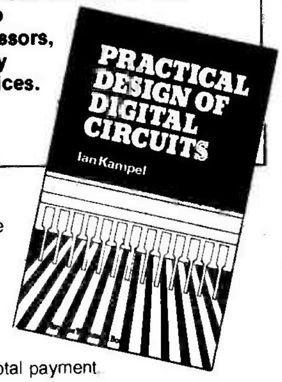

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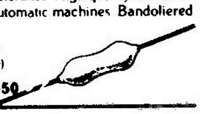

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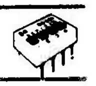

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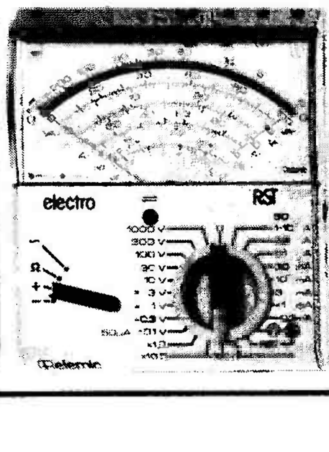

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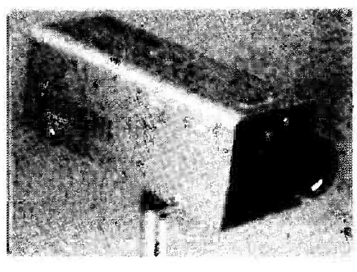

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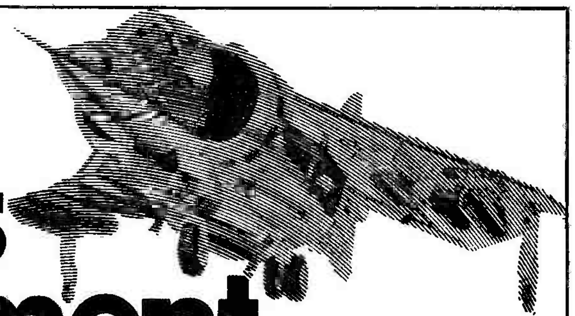

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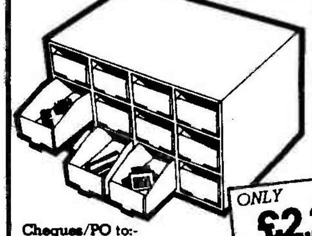

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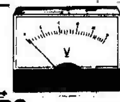

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Once again it's time to tread boldly into word-processor-land and sort out our year's offerings into alphabetical order. Everything we've done is listed (sometimes more than once under alternative names or alternative sections) with the exception of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

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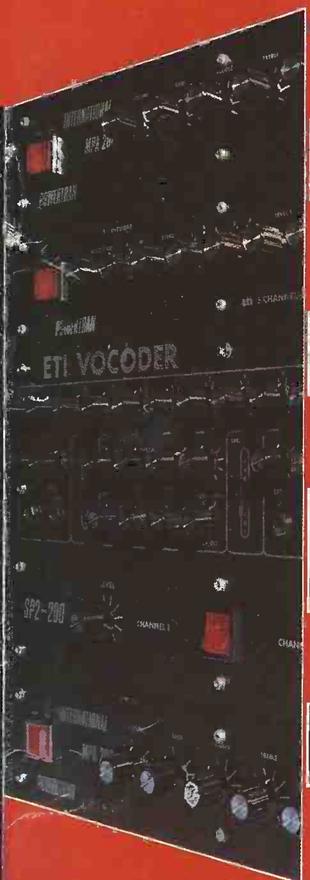

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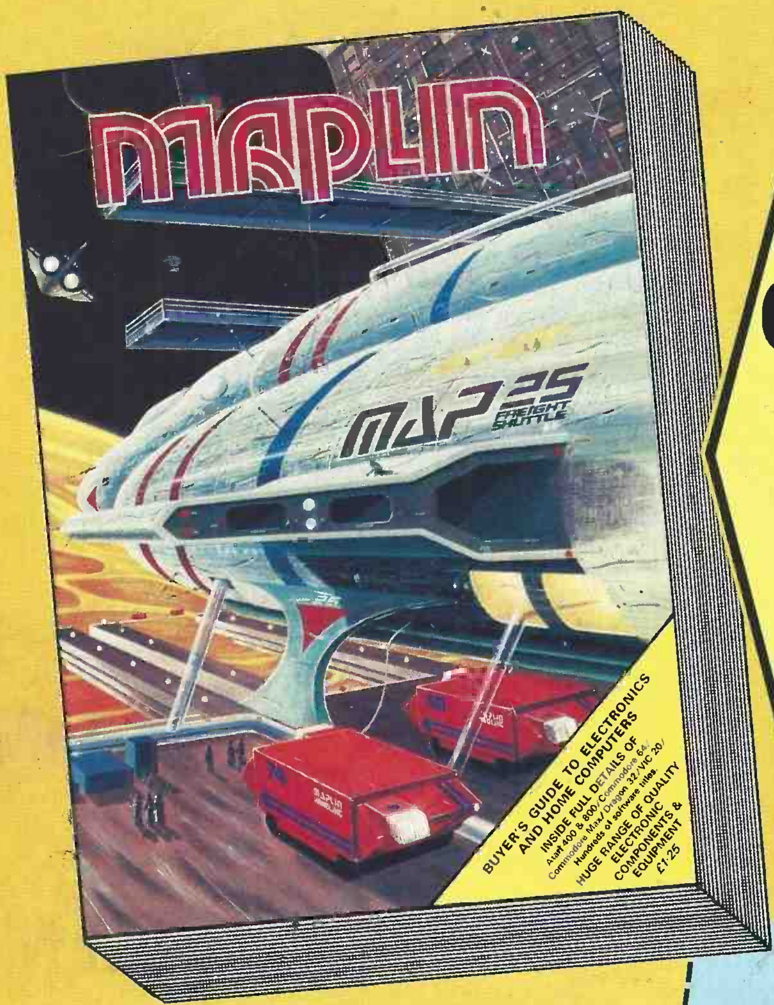

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