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electronics today

INTERNATIONAL
APRIL 1981 65p

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- VISUAL SOUND ANALYSER
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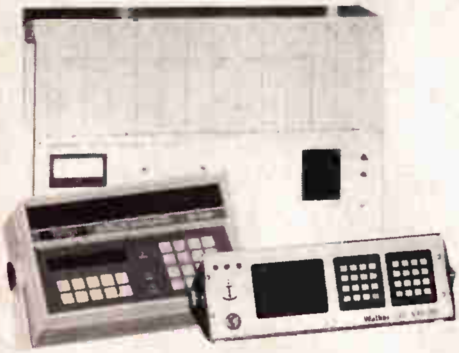
...NEWS. . . .PRO MICROPROCESSORS. . . .AUDIO. .

MANY MORE KITS ON PAGE 8

Our thanks to Music Bank, 6 Erskine Road, London NW3, who provided the facilities for our cover photograph

Double dose of drumming p.75



All at sea p.28

Interplanetary pix p.71

electronics today INTERNATIONAL

APRIL 1981 VOL 10 NO 4

FEATURES

PROJECTS

INFORMATION

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Why the Sinclair ZX80 is Britain's best-selling

Built: £99.95

Including VAT, post and packing, free course in computing, free mains adaptor.

Kit: £79.95

Including VAT, post and packing, free course in computing.

This is the ZX80. A really powerful, full-facility computer, matching or surpassing other personal computers at several times the price. 'Personal Computer World' gave it 5 stars for 'excellent value'. Benchmark tests say it's faster than all previous personal computers.

Programmed in BASIC – the world's most popular language – the ZX80 is suitable for beginners and experts alike. And response from enthusiasts has been tremendous – over 20,000 ZX80s have been sold so far!

Powerful ROM and BASIC interpreter

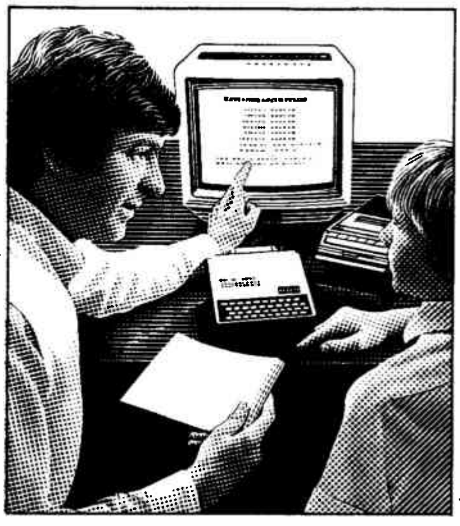
The 4K BASIC ROM offers remarkable programming advantages:

* Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.
* Unique syntax check. A cursor identifies errors immediately.
* Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison).
* Up to 26 single dimension arrays.
* FOR/NEXT loops nested up to 26.
* Variable names of any length.
* BASIC language also handles full Boolean arithmetic, condition expressions, etc.
* Randomise function, useful for games and secret codes, as well as more serious applications.
* Timer under program control.
* PEEK and POKE enable entry of machine code instructions.
* High-resolution graphics.
* Lines of unlimited length.

Unique RAM

The ZX80's 1K-BYTE RAM is the equivalent of up to 4K BYTES in a conventional computer – typically storing 100 lines of BASIC.

No other personal computer offers this unique combination of high capability and low price.



The ZX80 as a family learning aid. Children of 10 years and upwards are quick to understand the principles of computing – and enjoy their personal computer.

The Sinclair teach-yourself BASIC manual

If the specifications of the Sinclair ZX80 mean little to you – don't worry. They're all explained in the specially-written 128-page book (free with every ZX80). The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming – from first principles to complex programs.

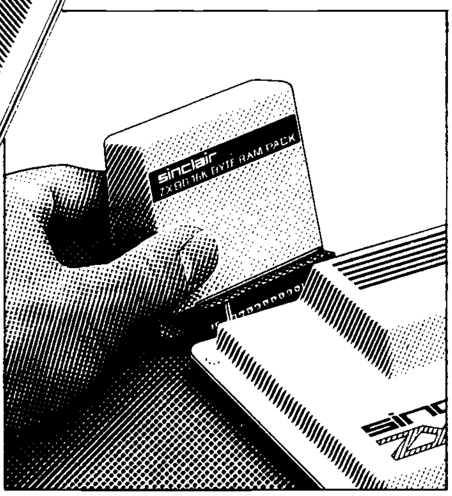
Kit or built – it's up to you

In kit form, the ZX80 is pleasantly easy to assemble, using a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9V DC nominal unregulated. If not, see the coupon.

Both kit and built versions come complet with all necessary leads to connect to your TV (colour or black and white) and cassette recorder. Plug in and you're ready to go. (Bui versions come with mains adaptor.)

personal computer.

Now available for the ZX80... New 16K-BYTE RAM pack



Massive add-on memory. Only £49.95.
The new 16K-BYTE RAM pack is a complete module designed to provide you – and your Sinclair ZX80 – with massive add-on memory. You can use it for those really long and complex programs – or as a personal database. (Yet it can cost as little as half the price of competitive add-on memory for other computers.)

For example, you could write an interactive or 'conversational' program to show people what your ZX80 can do. With 16K-BYTES of RAM, they could be talking to your computer for hours!

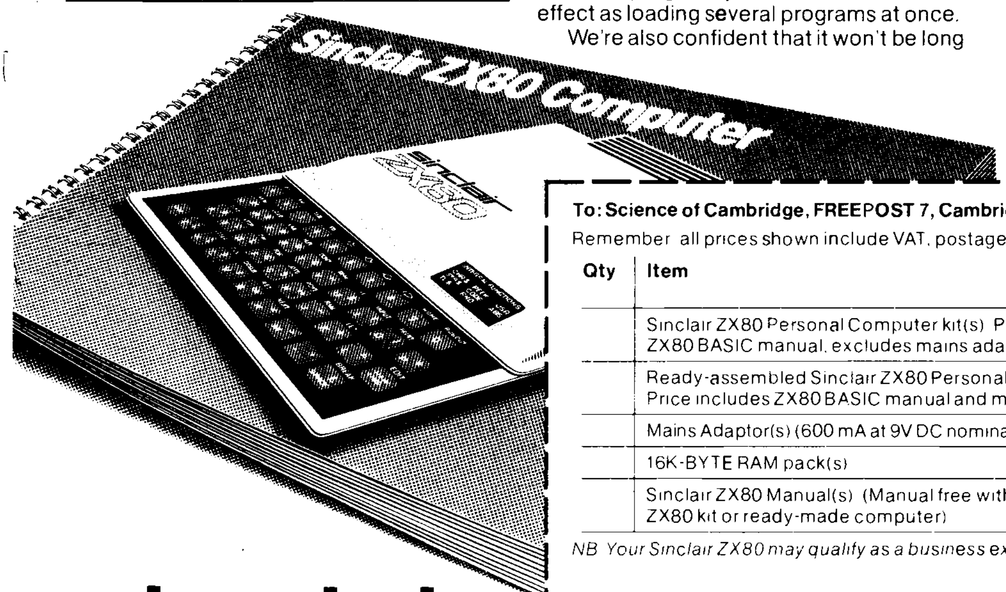
Or you can store a mass of data – perhaps in a fairly simple program – such as a name and address list, or a telephone directory.

And by linking a number of separate programs together into one giant, but modular, program, you can achieve the same effect as loading several programs at once.

We're also confident that it won't be long before you can buy cassette-based software using the full 16K-BYTE RAM. So keep an eye on the personal computer magazines – and brush up your chess perhaps!

The RAM pack simply plugs into the existing expansion port on the rear of the ZX80. No wires, no soldering. It's a matter of seconds and you don't need another power supply. You can only add one RAM pack to your ZX80 – but with 16K-BYTES who could want more!

How to order
Demand for the ZX80 exceeds all other personal computers put together! So use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We'll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt – and we have no doubt that you will be.



To: Science of Cambridge, FREEPOST 7, Cambridge CB2 1YY.
Remember all prices shown include VAT, postage and packing. No hidden extras. Please send me:

Qty	Item	Code	Item price £	Total £
	Sinclair ZX80 Personal Computer kit(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	02	79.95	
	Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual and mains adaptor.	01	99.95	
	Mains Adaptor(s) (600 mA at 9V DC nominal unregulated).	03	8.95	
	16K-BYTE RAM pack(s).	18	49.95	
	Sinclair ZX80 Manual(s). (Manual free with every ZX80 kit or ready-made computer.)	06	5.00	

NB. Your Sinclair ZX80 may qualify as a business expense. **TOTAL: £**

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SPST on/off	**54p**
SPDT c/over	**60p**
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SPDT biased both ways	**105**
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DPDT centre off	**88p**
DPDT biased both ways	**145p**
DPDT 3 positions on/on/on	**185p**
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SLIDE 250V:

DPDT 1A	**14p**
DPDT 1A c/off	**15p**
DPDT ½A	**13p**
4 pole 2-way	**24p**

PUSH BUTTON 6A
with 10mm Button

SPDT	**99p**
DPDT	**145p**
SPDT	**99p**
DPDT	**145p**
Mini Non Lock Push to Make	**15p**
Red, Blue, Grn., Push to Break	**25p**

OIL SWITCHES
SPST 4 way **85p**, 6 way **95p;** 8 way **115p;** 10 way **145p.**

ROTARY (Adjustable Stop) SWITCHES
1 pole/2 to 12 way, 2 pole/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way **45p**
ROTARY: Mains DP 250V 4A on/off **56p**
ROTARY: Make your own multiway switch. Shafting Assembly Has adjustable stop. Accommodates up to 6 wafers **90p**
WAFERS: (Break before Make) 1 pole/12 way, **2p**/6 way, **3p**/4 way, **4p**/3 way, **8p**/2 way **68p**
Mains DP Switch 250V/2A to fit **45p**
Spacers **4p;** Screen **8p**

'D' CONNECTORS (Cannon type)

	Plugs	Sockets	Covers
			Ptc
9way	**95p**	**125p**	
15way	**135p**	**195p**	**150p**
25way	**198p**	**284p**	**170p**
37way	**290p**	**398p**	**185p**

CRYSTALS

100KHz	**323**
200KHz	**370**
455KHz	**383**
1MHz	**323**
1.008M	**395**
1.28MHz	**392**
1.6MHz	**323**
1.8MHz	**323**
1.8432MHz	**362**
2MHz	**305**
2.4576MHz	**382**
3.2768M	**323**
3.57954M	**195**
4.000MHz	**290**
4.032MHz	**323**
4.19430M	**270**
4.433619M	**135**
5.0MHz	**355**
5.185M	**323**
5.24288M	**425**
6.0MHz	**323**
6.144MHz	**295**
6.5536M	**200**
6.5536MHz	**290**
7MHz	**290**
7.168MHz	**290**
7.680M	**323**
8.0MHz	**392**
8.08333M	**382**
8.867237M	**362**
9.375M	**323**
10.0MHz	**323**
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14.31818M	**362**
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18.432M	**323**
20.0MHz	**323**
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48.0MHz	**323**
100.00MHz	**323**
116.0MHz	**300**

Parts available for ETI Projects

TRANSFORMERS (Mains Prim 220-240V)

6-0-6V 9-0-9V, 12-0-12V 100mA **98p**
3VA: 0-6V 0-6V (PCB mounting) **175p**
6VA: 6V-.5A 6V-.5A, 9V-.4A 9V-.4A, 12V-.3A 12V-.3A, 15V-.25A 15V-.25A **220p**
12V: 4.5V-1.3A 4.5V-1.3A, 6V-1.2A 6V-1.2A; 12V-.5A 12V-.5A, 15V-.4A ⅛⅝V-.4A, 20V-.3A 20V-.3A **250p** (30p p&p)
24VA: 6V-1.5A 6C-1.5A 9V-1.3A 9V-1.3A, 12V-1A 12V-1A, 15V-.8A 15V-.8A, 20V-.6A 20V-.6A **320p** (55p p&p).
50VA: 6V-4A 6V-4A, 9V-2.5A 9V-2.5A, 12V-2A 12V-2A, 15V-1.5A 15V-1.5A, 20V-1.2A 20V-1.2A, 25V-1A 25V-1A, 30V-.8A 30V-.8A **365p** (60p p&p).
100VA: 12V-4A 12V-4A 15V-3A 15V-3A, 20V-2.5A 20V-2.5A; 30V-1.5A 30V-1.5A, 40V-1.25A 40V-1.25A, 50V-1A 50V-1A **820p** (74p p&p) (NB p&p charge to be added above our normal postal charge.)

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5¼x4x2½"	**120**
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6x4x3"	**148**
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7x5x3"	**180**
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PANEL METERS

FSD
60x46x35mm
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"
445p each

4¼x3¼x1½"
0-50µA
0-100µA
0-500µA
595p each

VOLTAGE REGULATORS

1A	TO3	+ ve		−ve	
5V	7805	**145p**		7905	**220p**
12V	7812	**145p**		7912	**220p**
15V	7815	**145p**			—
18V	7818	**145p**			—
1A	TO220	Plastic Casing			
5V	7805	**60p**		7905	**65p**
12V	7812	**60p**		7912	**65p**
15V	7815	**60p**		7915	**85p**
18V	7818	**60p**		7918	**85p**
24V	7824	**60p**			
100mA	TO92 Plastic Casing				
5V	78L05	**30p**		79L05	**65p**
6V	78L62	**30p**			—
8V	78L82	**30p**			—
12V	78L12	**30p**		79L12	**65p**
15V	78L15	**30p**		79L15	**65p**

LM300H	**170p**	LM723	**38p**
LM305H	**140p**	TAA550	**50p**
LM309K	**135p**	TBA625B	**95p**
LM317K	**350p**	ZDA1412	**150p**
LM317H	**240p**	78H05 + 5V·5A	
LM323K	**550p**		**595p**
LM325N	**240p**	78HG +5V to +25V	
LM326N	**240p**	5A	**650p**
LM327	**270p**	79HG	**850p**

OPTO

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TIL209 Red	**13**
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2" Flashing Red	**48**
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TIL78 Detector	**75**
BARGRAPH Red 10 segments	**225**
LS400	**255**
OCP71	**120**
ORP12	**63**
ORP61	**85**
2N5777	**45**

ISOLATORS

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TIL111 2·4	**90**

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TIL322 5" CC	**115**
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FND500	**115**
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6" Green CA	**215**
3 ± 1 Red CA	**150**
3 ± 1 Green CA	**150**
OVM176	**1885**
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LCD 4 Digits	**750**
LCD 6 Digits	**850**

LS245	**350**	LS373	**150**	4016	**35**	4054	**130**	4175	**120**	4522	**150**
LS247	**136**	LS374	**150**	4017	**70**	4055	**130**	4194	**115**	4526	**98**
LS248	**135**	LS375	**150**	4018	**76**	4056	**135**	4408	**790**	4527	**125**
LS249	**136**	LS377	**199**	4019	**42**	4057	**2850**	4409	**790**	4528	**100**
LS251	**130**	LS378	**140**	4020	**85**	4059	**575**	4410	**750**	4529	**150**
LS253	**96**	LS379	**215**	4021	**90**	4060	**110**	4411	**950**	4530	**90**
LS257	**96**	LS384	**250**	4022	**85**	4061	**1225**	4412F	**1250**	4531	**130**
LS258	**120**	LS385	**420**	4023	**24**	4062	**995**	4412V	**1520**	4532	**120**
LS259	**160**	LS386	**85**	4024	**60**	4063	**120**	4415F	**480**	4534	**510**
LS261	**450**	LS390	**140**	4025	**24**	4066	**46**	4415V	**850**	4536	**310**
LS266	**75**	LS393	**140**	4026	**170**	4067	**430**	4419	**280**	4538	**145**
LS273	**180**	LS395	**210**	4027	**45**	4068	**26**	4422	**570**	4539	**120**
LS275	**320**	LS396	**199**	4028	**92**	4069	**22**	4432	**1050**	4541	**150**
LS279	**88**	LS398	**275**	4029	**98**	4070	**25**	4435	**850**	4543	**150**
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LS283	**90**	LS445	**140**	4031	**185**	4072	**25**	4450	**350**	4553	**399**
LS290	**130**	LS447	**195**	4032	**125**	4073	**25**	4451	**350**	4554	**192**
LS293	**130**	LS490	**245**	4033	**175**	4075	**23**	4452		4555	**85**
LS295	**215**	LS668	**105**	4034	**213**	4076	**85**	4490F	**350**	4556	**60**
LS298	**215**	LS669	**105**	4035	**95**	4077	**30**	4490V	**750**	4557	**425**
LS299	**420**	LS670	**270**	4036	**275**	4078	**28**	4501	**28**	4558	**174**
LS300	**175**	LS673	**750**	4037	**115**	4081	**26**	4502	**105**	4559	**450**
LS302	**175**	LS674	**850**	4038	**110**	4082	**25**	4503	**65**	4560	**199**
LS320	**270**	**CMOS**		4039	**299**	4085	**90**	4506	**75**	4561	**104**
LS323	**450**	4000	**14**	4040	**85**	4086	**90**	4507	**48**	4562	**525**
LS324	**200**	4001	**14**	4041	**80**	4089	**150**	4508	**280**	4566	**195**
LS325	**320**	4002	**15**	4042	**70**	4093	**55**	4510	**85**	4568	**299**
LS326	**330**	4006	**86**	4043	**80**	4094	**210**	4511	**98**	4569	**195**
LS327	**315**	4007	**19**	4044	**80**	4095	**95**	4512	**84**	4572	**36**
LS346	**185**	4008	**76**	4045	**175**	4096	**95**	4513	**225**	4580	**495**
LS347	**150**	4009	**46**	4046	**96**	4097	**340**	4514	**220**	4581	**320**
LS348	**190**	4010	**50**	4047	**98**	4098	**115**	4515	**250**	4582	**135**
LS352	**185**	4011	**18**	4048	**65**	4099	**150**	4516	**90**	4583	**105**
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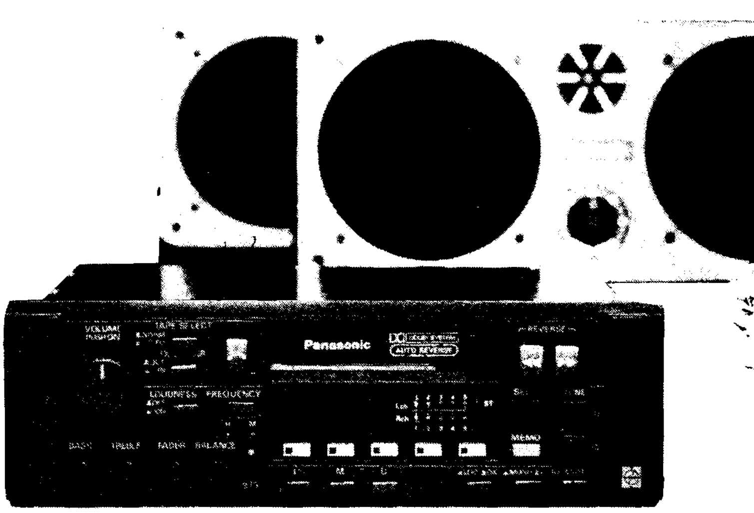


OOPS
Digital Test Meter

Some constructors of the DTM (September '80) have reported problems with the DVM module blowing. This can be prevented by putting a 10M resistor in series with the IN HI pin of the module.

On page 83 the overlay for the resistance measurement board (bottom overlay) shows the common of R43, R44, R45 and C15 connected to IC7 pin 4. In fact IC7 pin 4 should go only to the −6 V takeoff point and C7 −ve. Cut the PCB track just above R45 (page 80 Fig.1 shows the correct wiring).

Vocoder

Two of the ICs in the Vocoder (September '80) are listed incorrectly. In the circuit diagram and Parts List for the internal excitation board, IC5 is a 4030 and IC6 is a 4006.

Breadboard 80

In our report on Breadboard 80 (in the February News Digest), our reporter, no doubt overcome by the occasion, said that our celebrity guest was Brian Rix. In fact Mr Rix, a radio amateur, was at the show as a guest of Practical Wireless, to whom we offer our apologies.

Panasonic Car-Fi

Panasonic has introduced what it believes to be the first full hi-fi stereo car radio/cassette that will fit into a standard DIN size dashboard aperture. The CQ 973 combines microprocessor electronics with full hi-fi specifications and according to Panasonic it is the most advanced in-car system available.

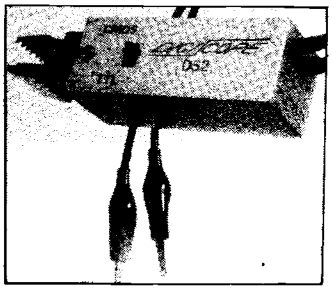
For those of you who can afford the £395.95 price tag, the CQ 973 offers digital frequency readout, three waveband stereo radio, (LW/MW/FM), electronic preset tuning, auto-seek tuning, an auto-reverse cassette player with a Dolby Noise Reduction system, and an output of 100 W. The radio functions are all push-button controlled, with a total of 15 preset stations (five on each band); as an additional safety feature the driver can also keep his hands on the steering wheel and tune the radio by footswitch. The bright green digital frequency readout also functions as a clock, and at night all the major controls are illuminated.

The unit is fitted with normal/metal tape selection and both the fast forward and rewind buttons can be locked in. Separate bass, treble and loudness controls are provided. For further information on the CQ 973 and the rest of Panasonic's in-car entertainment range, contact any of Panasonic's authorised dealers.

Take It Anywhere

New from JVC is the CX 610GB, a 6" VHF/UHF portable colour TV/monitor. This compact unit can be taken anywhere; it is capable of PAL and SECAM TV reception so you can receive programmes in any country that has one of the following TV systems — PAL B, G, or I system and SECAM B, G, D, K, or KI system (both CCIR continental and OIRT standards). The CX 610GB's colour system automatically switches to the broadcast system being used and the corresponding sound IF frequency can then be selected. The set has a newly developed JVC precision in-line picture tube, giving excellent colour pictures, and its highly sensitive swivel antenna ensures good quality reception wherever you are. The flexibility of this unit is further enhanced by a four-way power supply — from the household mains, ordinary batteries, its own rechargeable battery pack or from a 12 V DC car or boat battery.

The CX 610GB can also function as an on-location video monitor when used in conjunction with a colour video camera and portable video recorder. You can even record off-the-air television broadcasts out-of-doors by connecting the CX 610GB to a portable video recorder. The recommended retail price is £259 (including VAT), and further information is available from JVC (UK) Ltd, Eldonwell Trading Estate, Staples Corner, 6-8 Priestley Way, London NW2 7AF.



Logic Monitor

If you're in the business of developing or trouble-shooting digital circuits then you'll be interested in the Digiscope DS2 Logic Monitor. The device simply clips over any 14 or 16 pin DIL logic IC during operation, and indicates the state of each pin, either 0 or 1. Each pin has its state shown simultaneously on a 16-LED display, enabling circuit action and faults to be traced with ease. The DS2 is powered from either the circuit supply or an external source and draws negligible current from the IC under test, so circuit operation is unaffected. The input threshold is adjustable to suit either TTL or CMOS ICs. The monitor can also be used to check free packages; power is applied to the supply pins and since the DS2 pulls all the inputs high, operation can be checked by grounding the appropriate inputs and observing the effect. The DS2 is housed in a tough aluminium case and is suitable for use in industrial environments; the case is only 1" wide so several ICs may be checked side-by-side simultaneously. There is a range of accessories available including plugs and an extension lead for remote monitoring. The Digiscope DS2 costs £27.40 and further information is available from the manufacturers, J.E. Sinclare & Co., 82 Plumstead Common Road, London SE18 3RE.

Micro Talk

General Instrument Microelectronics have announced the introduction of a new speech synthesis chip, the SP0256. It's a 28 lead LSI device, designed to generate up to 256 discrete sequences of human speech or other complex sounds stored in its built-in 16K ROM. External expansion can increase the SP0256's repertoire to almost 3825 sequences. Commonly used sounds can be stored once and called from memory when necessary, reducing data storage requirements. Applications envisaged include warning systems, radar, test gear and security systems.

TRANSCENDENT 2000

SINGLE BOARD SYNTHESIZER

Designed by consultant Tim Orr (formerly synthesizer designer for EMS Ltd.) and featured as a constructional article in ETI, this live performance synthesizer is a 3 octave instrument transposable 2 octaves up or down giving sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.

The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal film), and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready-built units selling for many times the price.

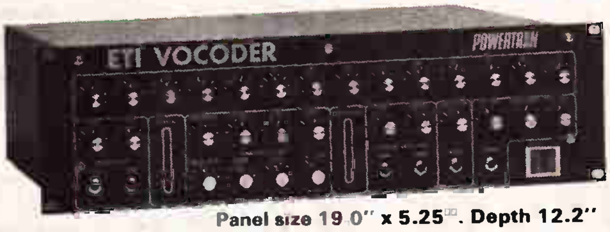
Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more elaborate than a multi-meter and a pair of ears!

COMPLETE KIT ONLY
£168.50 + VAT!

Cabinet size 24.6" × 15.7" × 4.8" (rear) 3.4" (front)

COMING SHORTLY!

1024 NOTE COMPOSER/SEQUENCER — LESS THAN £100



Panel size 19.0" x 5.25". Depth 12.2"

ETI VOCODER

COMPLETE KIT ONLY
£195 + VAT!

Kit includes FREE foot control and test oscillator!

Featured as a construction article in **Electronics Today International** this design enables a vocoder of great versatility and high intelligibility to be built for an amazingly low price.
14 channels are used to achieve its high intelligibility, each channel having its own level control. There are two input amplifiers, one for speech either from microphone or a high level source e.g. mixer or cassette deck and one for external excitation (the substitution signal) from either high or low level sources. Each amplifier has its own lever control and a rather special type of tone control giving varying degrees of bass boost with treble cut or treble boost with bass cut. The level of the speech and excitation signals are monitored by LED PPM meters with 10 lights — 7 green and 3 red which indicate the level at 3dB steps. There are three internal sources of excitation — a noise generator and two pulse generators of variable frequency and pulse width. Any of the internal sources and the external source can be mixed together. There is a voiced/unvoiced detector which substitutes noise for the excitation signal at the points in speech where the vocal chord derived sounds of the speaker are substituted for by the unvoiced sounds of sibilants, etc. There is a slew rate control which smooths out the changes in spectral balance and amplitude enabling a change of the speech into singing or chanting and other special effects. A foot switch is provided to permit a complete freeze in spectral balance and amplitude whenever required. An LED on this indicates when the freeze is in operation.
An output mixer allows mixing of the speech, external excitation and vocoder output. The majority of the components fit into the large analysis/synthesis board with the rest on 8 much smaller boards with the controls and sockets mounted on them for ease of construction. Connectors are used for the small amount of wiring between the boards.
The kit includes fully finished metalwork, professional quality components (all resistors 2% metal oxide) nuts, bolts, etc. — even a 13A plug!

TRANSCENDENT DPX

MULTI-VOICE SYNTHESIZER

Another superb design by synthesizer expert Tim Orr published in Electronics Today International

COMPLETE KIT ONLY
£299 + VAT!

Cabinet size 36.3" × 15.0" × 5.0" (rear) 3.3" (front)

The Transcendent DPX is a really versatile 5 octave keyboard instrument. These are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound—fully polyphonic, i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano as a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass as the lower end (the keyboard is electronically split after the first two octaves) or vice-versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrator comes in only after waiting a short time after the note is struck for even more realistic string sounds.
To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects.
As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing, etc., etc.).
Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.
The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug!

POWERTRAN

MANY MORE KITS ON PAGE 107. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER

All projects on this page can be purchased as separate packs, e.g. PCBs, components sets, hardware sets, etc. See our free catalogue for full details and prices.

Hobby Electronics '81
BRISTOL EXHIBITION CENTRE

Hobby Electronics BRISTOL EXHIBITION CENTRE '81

Hobby Electronics BRISTOL EXHIBITION CENTRE '81

COMPUTERS ● AUDIO ● RADIO ● MUSIC ● LOGIC ● COMPONENTS ● CB

HOBBY ELECTRONICS GOES WEST

London has more than its fair share of electronics shows, but we know that electronics enthusiasts are by no means limited to the capital. For that reason the first annual Hobby Electronics Show is to be held in Bristol — centre of the South-West.

What's to see there?

- major electronics component suppliers
- special exhibition offers
- Wales & West schools' electronic project competition (*has your school submitted an entry yet? Available from Hobby Electronics 81)

TICKETS — at the door — **ADULT** : £1.00. **CHILD, STUDENT, OAP** : 50p.

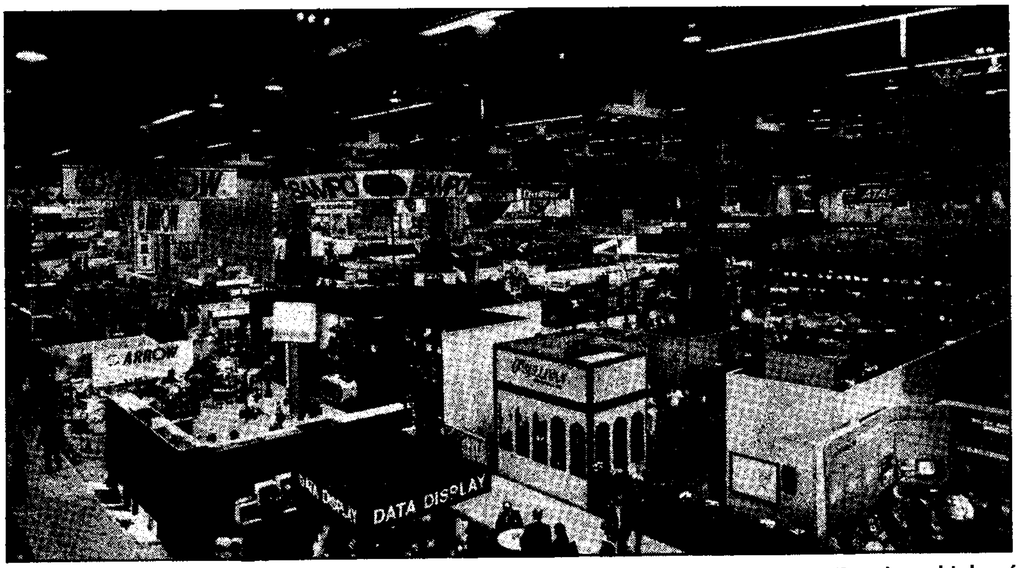
GAMES ● KITS ● TEST GEAR ● MAGAZINES ● SPECIAL OFFERS ● BOOKS

OPEN DAYS :

Friday May 29th : 10am — 7pm ● Saturday May 30th : 10am — 6pm ● Sunday May 31st : 10am — 4pm

bby BRISTOL EXHIBITION CENTRE '81 tronics

Order your tickets now from :
Exhibition Manager,
Hobby Electronics 81,
145 Charing Cross Road,
London WC2H 0EE.



Vegas

The Winter Consumer Electronic Show keeps breaking its own records, and this year's event will be no exception. The Show organisers said that more than 850 exhibitors are showing off their new products at the Las Vegas Convention Centre, up from 757 at last year's Winter Show.

By the end of the year, it seems improbable that anyone will not have heard of the Video Disc. The long wait for the disc to become a functioning reality is over, and by next Winter's CES, close to 25 manufacturers will have a system on the market. The most carefully orchestrated and the most expensive promotion, advertising, and distribution programmes ever seen for an electronic product will forcefeed the video disc message to the American consumers in 1981.

Much of the attention is still focused on the competition between the Philips-made optical laser disc format and the RCA-patented CED Disc system. Matshushita's VHD system, which will be a later entry into the field, can be expected to buck the other two, benefitting from the publicity about discs created by the optical — CED dogfight.

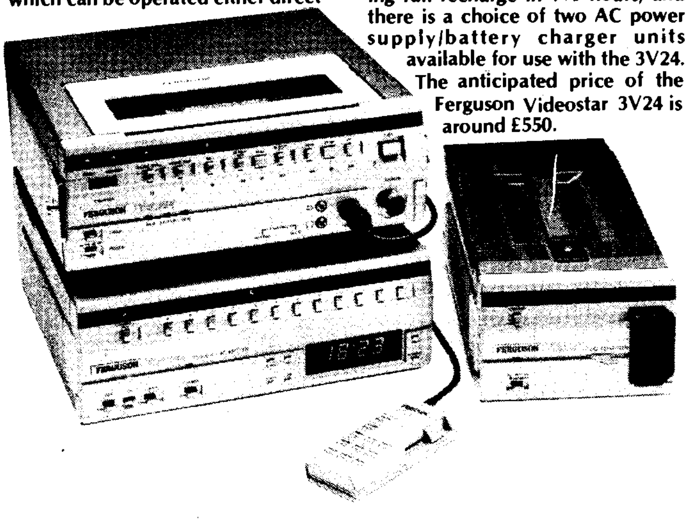
Another Atari first is their new remote control console which combines sleek, futuristic styling and advanced technology and simply makes the game more enjoyable. Two quick-action remote controllers allow the players to move around the room freely without clumsy controller wires interfering with game action. Now the players can select, play and reset games on this new system without ever having to get up. Fingertip touch controls and LED signals are built into the hand-held remote controllers for game select and game reset options and the combination joystick and pedal controllers respond quickly and easily to the players' touch. Activision also showed some new cartridges they have lined up which are compatible with the Atari system. One is Centrecourt Tennis, which offers everything from lightning-quick serves to breathtaking back-hand cross-court returns. Charging players can rush the net or lay back and play the baseline. Laserblast casts you as the commander of a fleet of spacecraft; you come upon some very unfriendly alien types — just get them before they get you but remember the bad guys don't miss very often.

Finally, Studer/Revox enter the cassette equipment market with their model No. B710, utilising the same professionalism inherent in the company's other audio products. It is aimed to achieve the same high level of acceptance and respect by consumers that has been accorded to previous Studer/Revox audio equipment. Two peak reading LED bar displays are used for level indication and feature a resolution of 1 dB from −10 to +6 dB, with 2 dB intervals between −20 and −10 dB. A 0 dB indication represents "Dolby level". Stylistically, the B710 matches the other components in the Revox line.

Gerald Chevin

Versatile Video

Supplies of the new Ferguson Videostar VHS Portable video cassette recorder, model 3V24, are soon to become available. The 3V24 is expected to be the most lightweight recorder on the market, weighing in at 5.2 kg. The 3V24 has a microprocessor-assisted, fully electronic logic control cassette deck which can be operated either directly or by the full remote control unit supplied. The recorder incorporates a new Edit Start Control system for minimising picture break-up between recordings, as well as a picture scan facility which operates at 10 times normal speed, both forward and reverse. Other facilities include still frame, single frame advance and variable slow motion. A new quick-change power pack is supplied giving full recharge in 1½ hours, and there is a choice of two AC power supply/battery charger units available for use with the 3V24. The anticipated price of the Ferguson Videostar 3V24 is around £550.



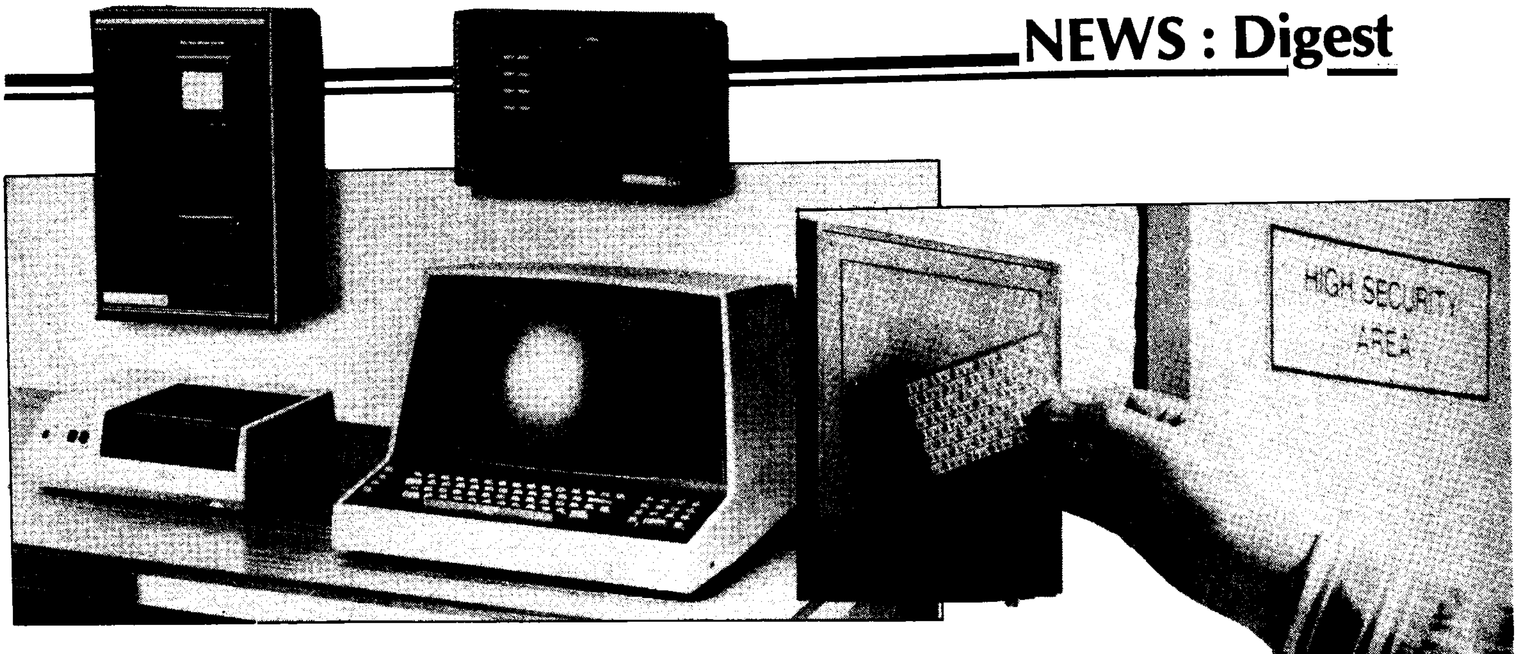
Telly Type

Delpa Systems have just announced their new Video telex which is capable of overcoming many of the inherent problems of ordinary telex machines. The Video telex uses a VDU and so the typing of messages takes half the normal time. The machine offers full correction and editing facilities, including the correction of spelling mistakes and the deletion of lines or paragraphs. It also provides full tabulation which means more attractive layouts, particularly useful in reports and orders. On existing machines where punch tapes are used, error correcting is extremely awkward and any incoming calls will interrupt the process, but the Video telex does not punch the message until it is 100% correct. The machine can either be used in the telex room or by other staff throughout the office building. Each station costs around £900 and further details can be obtained from Delpa Systems (UK) Ltd, Data Transfer Division, 56 Chiswick High Road, London W4 1SZ.

IMPORTANT NOTICE

Readers have recently confused Electronics Today Limited as being associated with the ownership of our magazine, Electronics Today International. Our magazine is owned by Modmags Limited, part of the Argus Press Holdings Limited Group of Companies.

Electronics Today Limited has advertised in our magazine, as "Metac", but so as to prevent any further confusion we wish to make it clear that Electronics Today Limited is not owned or managed by any member of the Argus Press Holdings Limited Group of Companies.



Hidden Security

A new system from STC Electronic Security Systems (STC-ESS) protects itself while it is protecting the customer. The ITT Access Control System, now marketed by STC has no visible mechanism to vandalise or attack at the point of entry. It operates by proximity. A hidden sensor reads a credit-card-size command key and transmits signals to a unit which controls and records access. Conventional keys, key holes or card slots are not used. The command key can even be used while it is still inside a wallet, pocket or bag or is being used as a lapel badge.

The system is modularly expandable and can be integrated into existing or planned security and environmental systems requiring control of multiple access locations. More information on Access Control Systems and other STC security products is available by contacting STC-ESS, 313 Ballards Lane, London N12.

Wire Cutting

If you've ever had an electrical fault in your Rolls, you're only too well aware of the jungle of wires that lurk beneath your bonnet, the colour coding cleverly hidden under years of crud. Ripault of Enfield in collaboration with Liverpool University's Dept. of Electrical Engineering and Electronics have addressed themselves to the sticky problem of cutting down the wiring harness to something a little more manageable.

The prototype has already been installed in a Maxi. It uses 10 m of twin core cable instead of 100 m of 130 separate leads used in the conventional Leyland harness. The wire links a number of electronic control boxes, one core carrying power and the other digital control signals for the black boxes. Not only does this method cut down enormously the amount and complexity of the vehicle's wiring, but it also eliminates the use of high current electromechanical relays which are subject to contact wear.

The system is designed to meet a BL specification. Amongst the requirements are that the system should operate under the hostile environment of the engine compartment. That means surviving a temperature range of -40°C to +120°C.

Benefits of the new system include low power consumption, quick and convenient fault diagnosis and easier servicing. A security system could also be built-in.

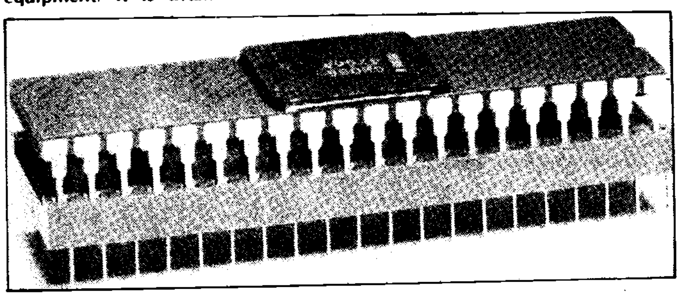
Teach Yourself Video

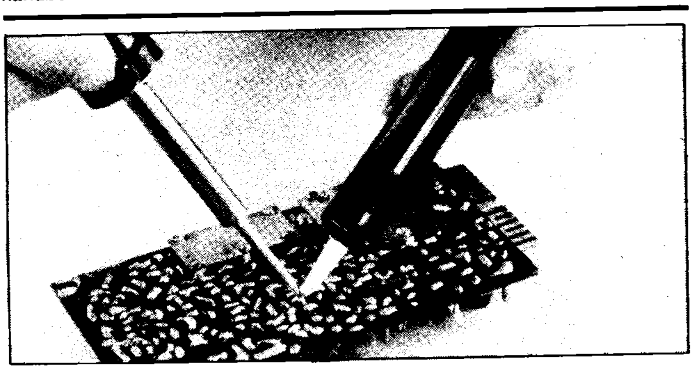
Have you invested in a video recorder, but haven't yet discovered its full potential? If the sole function of your recorder is to commit 'Crossroads' to tape, a new publication from 'those awfully nice Sony people' might widen your horizons. Their 48 page full colour handbook 'How To Video' is on sale at their 134 Regent Street showroom in London for 60p (also by post for 90p).

Video recorders are very complex electronic devices, but are nevertheless simple to operate. 'How To Video' uses simple, non-technical language and ample illustrations to explain what your recorder is capable of, how to make home movies, the use of sound and lighting and even the creation of professional style, special effects and titling.

IC Survival

Winslow Component Systems has introduced a new range of IC sockets designed to be virtually indestructable. The heart of the socket is a new contact featuring an inverted leaf design. This double-sided inverted leaf allows for a certain degree of careless handling when inserting an IC, which also facilitates the use of automatic insertion equipment. It is available in two versions — the W3200 series, which has tin plated contacts, for the lower cost consumer type applications and the W3300, aimed at the industrial and professional market incorporating tin and gold plated contacts which are totally insulated from surface tracks on double sided PCBs. The W3300 is also 100% anti-wicking. Both versions come in the complete range of contact configurations from 8-40 pins, they are only 0.15" high and are moulded in UL approved glass reinforced polyester.





Suck It And See

New from OK Machine & Tool (UK) Ltd is the DSP-1 desolder pump. OK claim that it features industrial performance at an economy price. For about £6.00 you can arm your toolkit with this all-metal device, with an easy-to-replace Teflon tip — self-cleaning on each stroke.

The DSP-1 desolder pump is supplied by OK Machine & Tool (UK) Ltd, Dutton Lane, Eastleigh, Hants SO5 4AA.

April Fair

Keep April 14th to 16th of 1981 free in your diary for the gathering of the clans in the Polytechnic of North London Theatre when the Association of London Computer Clubs hold their second London Computer Fair. For only 75p you can spend a day in North London in the company of everyone who is anyone in personal computing. In addition to retail stands you can visit seminars, workshops and club stands. There's even a bring and buy sale. If you're within reach of a tube station, you're half way there. The venue, the Polytechnic of North London, is opposite Holloway Road tube station.

● ORDER BY POST OR TELEPHONE WITH BARCLAYCARD/ACCESS
● ELECTRONIC TEST EQUIPMENT SPECIALISTS
● CALL IN AND SEE FOR YOURSELF

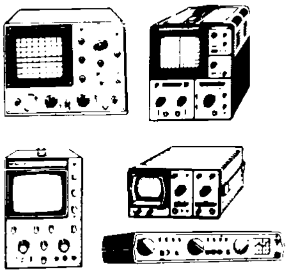
AUDIO ELECTRONICS

● ALL MODELS ON DISPLAY
● RETAIL – MAIL ORDER – EXPORT – INDUSTRIAL
● OPEN SIX DAYS A WEEK

ALL PRICES INCLUDE VAT

SCOPES

A range of Scopes in stock from 5mHZ Single Trace to 50mHZ Dualtrace. Mains and Battery/Mains Portables. Many on demonstration.



SINGLE TRACE (UK c/p etc £2.50)

Hm 307-3 10mHZ, 5mV, 6 x 7 cm display plus component test **£158.78**
CO1303D 5mHZ, 10mHZ, 7 x 7cm display **£109.25**
SC110 10mHZ battery portable, 10mV 3.2 x 2.6cm display (Optional case **£8.86**. Nicads **£8.83**. Mains unit **£4**) **£158.95**
***LBO512A** 10mHZ 10mV, 5" display **£195.00**
CS1559A 10mHZ 10mV, 5" display **£190.50**
***V151** 15mHZ 1mV 5" display **£241.50**

OPTIONAL PROBES (ALL MODELS)

XI **£6.50**, X10 **£8.50**, X100 **£12.95**, X1-X10 **£10.95**

***PRICE INCLUDES FREE PROBE(S)**

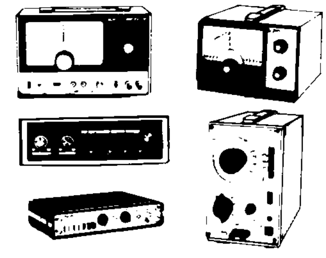
DUAL TRACE (UK c/p etc £3.50)

CS1562A 10mHZ, 10mV 5" display **£287.00**
CS1575 5mHZ 1mV 5" display **£284.00**
Hm 312-8 20mHZ, 5mV 8 x 10cm display **£253.00**
CS1566A 20mHZ, 5mV, 5" display **£339.00**
***LBO 3085** 70mHZ, 2mV, 5 x 6 3cm display. Battery/mains. Portable built-in Nicads **£482.00**
HM412-4 20mHZ, 5mV, 8 x 10cm display plus Sweep Delay **£399.50**
CS1577A 35mHZ, 2mV, 5" display **£478.00**
CS1830 30mHZ, 2mV, 5" display plus sweep delay and delay line — new model **£589.00**
Hm512-8 50mHZ, 5mV, 10 x 8cm display. Delay Sweep **£867.00**
***LBO514** 10mHZ, 1mV, (5mV) 5" display **£294.00**
***V152** 15mHZ, 1mV, 5" display **£328.00**
***V302** 30mHZ, 1mV, 5" display **£447.35**
***V550** 50mHZ, 1mV, 10 x 8cm Delay sweep + 3 channel display **£799.25**

HAMEG ● TRIO ● LEADER ● SINCLAIR ● HITACHI

GENERATORS

(UK c/p **£1.75**)



TRIO ● LEADER ● CSC SINCLAIR ● LEVELL

RF

SG402 100 KHZ-30mHZ with AM modulation **£68.00**
LSG16 100KHZ-100mHZ (300mHZ on Harmonics) **£83.25**
SG2030 250KHZ-100mHZ low cost range **£46.95**
ARF 300 18HZ-200mHZ low cost range audio and RF **£76.95**

PULSE

2001 1HZ-100KHZ (function) **£89.70**
TG105 5HZ-5mHZ **£92.50**
4001 0.5HZ-5mHZ **£109.25**
TT100 (function 10KHz) **£90.85**

AUDIO (All sine/square)

AG202A 20HZ— 200KHZ **£69.00**
LAG26 20HZ— 200KHZ **£73.60**
AG203 10HZ— 1mHZ sine/sq **£126.75**
LAG120A 10HZ— 1mHZ **£146.00**

LOGIC PROBES/MONITORS

Logic probes indicating high/low, etc., states that scopes can miss. All circuit powered for all ICs.

LP3 50 mHZ logic probe **£55.95**
LP1 10 mHZ logic probe **£35.50**
LP2 1½ mHZ logic probe **£19.95**
LM1 Logic monitor **£33.00**
LDP 50 MHz logic probe with case **£51.00**
Also in stock range of Protoboard kits and breadboards.

'PRO' MULTIMETERS

M1200 100K/Volt 30 ranges plus AC/DC 15 amp **£67.00**
K1400 20K/Volt 23 range large scale **£79.95**
M1500 20K/Volt 42 range plus AC/DC 10 amp **£53.50**
(UK c/p **£1.20**)
K200 38 range FET 10m ohm input 20Hz to 30MHz multimeter **£95.00**
(UK c/p **£1.50**)

SWR/FS AND POWER METERS

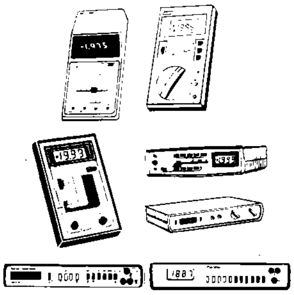
Range in stock covering up to 150mHZ and up to 1K watt power PL259 sockets. Also 250 UHZ Grid Dipmeter.

SWR9 SWR/S 3-150mHZ **£9.50**
SWR50 SWR/Power meter. 3½-150mHZ 0-1000 watts **£13.95**
110 SWR/Power 1½-144mHZ 0/10/100 watts **£11.50**
171 As 110 Twin meter plus F/S £14.50
Plus large range of BNC/PL259/etc leads / plugs / adaptors / connectors always in stock.
176 SWR/Power/FS 1½-144mHZ 5-50 watt **£16.60**
KDM6 Grid Dip 1½-250mHZ **£38.50**

DIGITAL MULTIMETERS

KAISE ● SINCLAIR ● LASCAR ● THURLBY

A range of LED and LCD Bench and Hand DMM's battery operated with optional Mains Adaptors some with optional Nicads. All supplied with batteries and leads.



HAND HELD (UK post etc 85p)

TM352 3½ Digit LCD plus 10 ADC and Hfe checker **£54.95**
TM354 3½ Digit LCD 2A AC/DC **£45.94**
ME502 3½ Digit LED plus 10A DC and Hfe checker **£43.95**
LM2001 3½ Digit LCD 2 amp AC/DC 0.1 % **£51.70**
6200 3½ Digit LCD 0.2A AC/DC. Auto range **£45.95**
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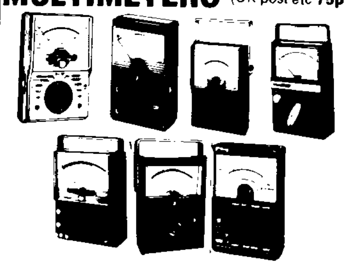

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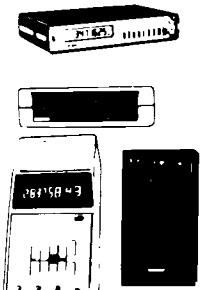

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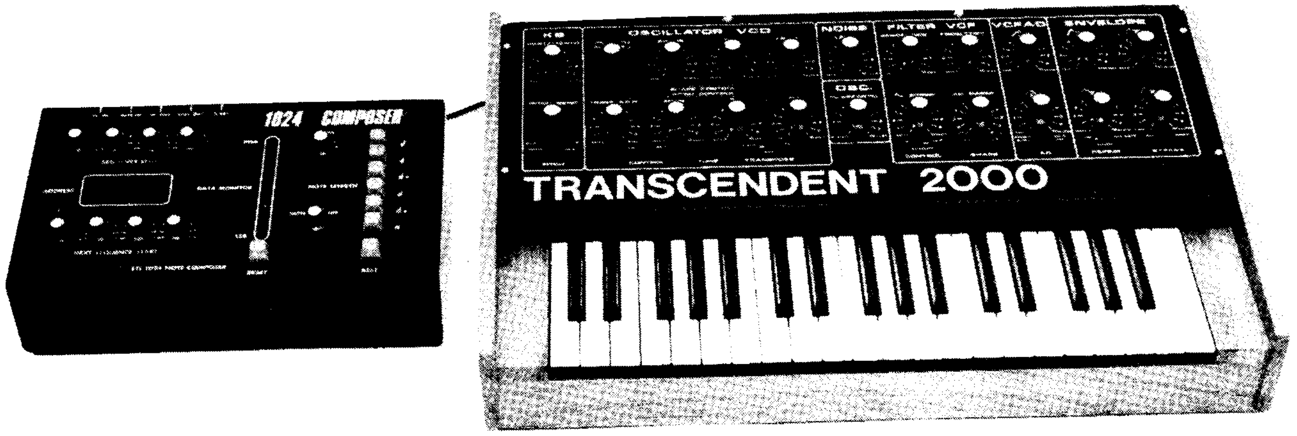

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IR REMOTE CONTROL

As promised last month, we present a five-channel infra-red remote control system which will interface with last month's Noiseless Power Switch. The unit has three latching channels (ie push-on, push-off), two non-latching channels, and a range of up to 30 feet. Full constructional details of both the transmitter and receiver will be given.

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TOUCH DIMMER

This project makes light work of lamp dimming. Based on the S566B IC, it provides touch control of brightness and a memory that turns the light on at a pre-determined level. The big difference with this design is that it can be used with the IR remote control and still retain all the normal functions. The remote control unit can operate two of these dimmers.

POWER SWITCH

For those of you who don't need the low noise and high current capability of the Noiseless Power Switch, we're publishing a cheap power switch that will handle a current of 5 A and interface with the IR remote control. Up to three of these switches can be controlled by the IR transmitter.

SONIC HOLOGRAPHY

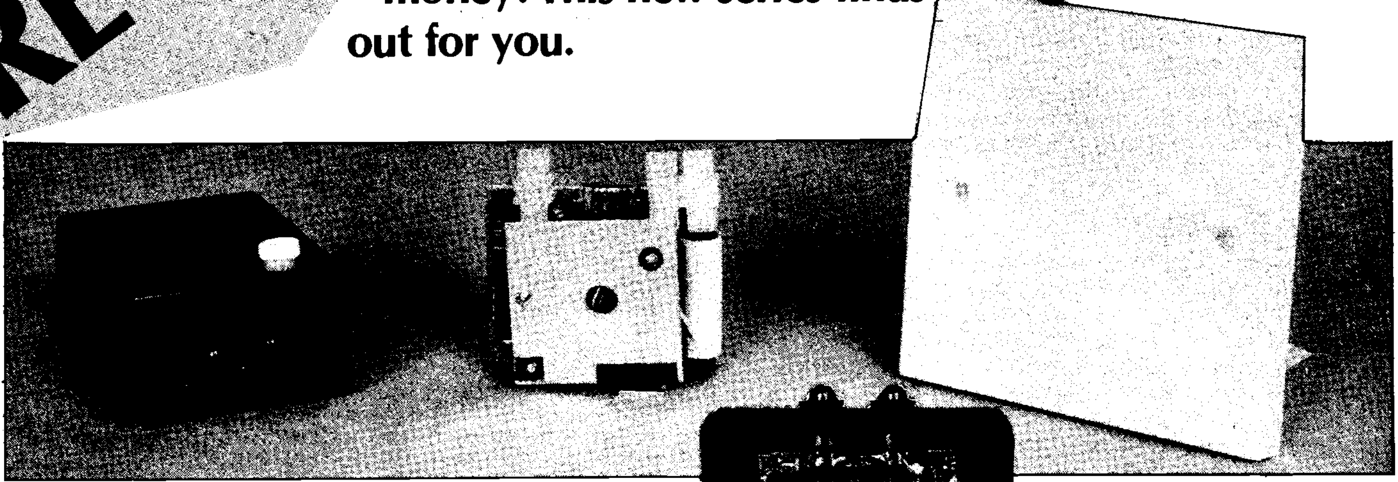
Surround-sound in your living room! No, your eyes don't deceive you — the speakers are in front of you. No, your ears don't deceive you — sounds to the left of you, to the right, behind and above you. Find out more in next month's ETI.

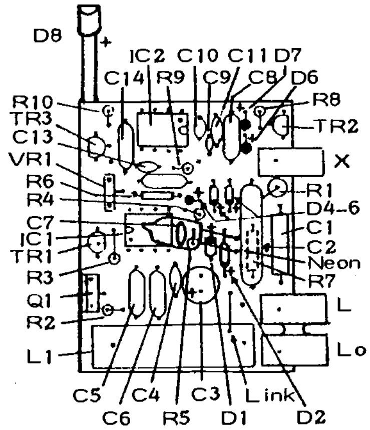
Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

LOOK OUT FOR THE MAY ISSUE ON SALE APRIL 3rd

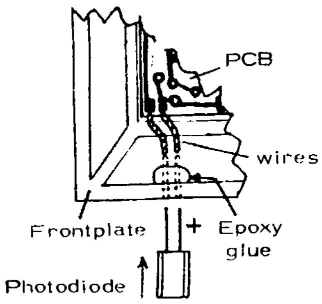
KIT REVIEW

There are many adverts about for build-it-yourself electronic kits — everything from door chimes to hi-fi. But do they represent value for money? This new series finds out for you.





How to connect photodiode D8 to P.C.B.



Above left: the assembled transmitter. Note the shaky PCB fittings. Above and right: examples from the well-explained notes. Diagrams are basic, but well thought out. Instructions are generally adequate for the constructor with a little experience.

This is the first in a new series of articles, designed to look in detail at some of the DIY kits available on the market, particularly those which yield a useful item for the home or car when completed.

We will be paying close attention to ease of construction — which includes a consideration of the clarity of the instruction leaflets provided. Anyone reading this who produces a kit which they feel might be suitable, is asked to ring the editor at our office number and we'll take if from there.

Taking A Dim View!

For our first month we're having a look at TK Electronic's remote controlled light dimmer, which sells for around £20. The kit comprises two separate units, a touch operated light switch and an IR (infra-red) control box. The dimmer can be constructed initially with straightforward touch operation, and the IR option added later.

The dimmer itself uses the 566 IC, which allows for a neat little circuit with 'memory' capability. Turn on the light by touching the plate and it will assume the level of brightness you last set it at. Holding a finger on the plate will cause the level to cycle between maximum and minimum brightness.

To add the IR facility an external photodiode is fitted to the mounting plate (see photo). This then produces full operation from the hand-held unit. The latter is little more than a multivibrator and two IR LEDs. A neat little black plastic box is provided, predrilled, for mounting the controls.

Constructive Thinking

The instructions provided with the kit are well explained, but could be better presented. A separate sheet is included with details of different types of electronic components and some helpful hints on soldering.

These serve as a general construction guide, the detailed building notes for a specific project being pretty sparse. This, together with the very high component density found on the PCB, makes me think that an absolute beginner would find the dimmer a difficult task. As this is a mains circuit, best make a start in electronics elsewhere.

Having said that, anyone who has built a few magazine projects would find the kit *relatively* simple to put together, although care will still be needed in soldering up the PCB, however experienced you may be!

Assembly of the hand controller is very simple indeed, as there are only some eight components involved! The push button is PCB mounted, as are the LEDs. One point about the controller that I did not like was the fact that the LED leads are used to secure the PCB into the box. This means that every time the push button is operated, the leads are stressed unnecessarily. Also the box is a fraction too narrow to admit a PP3 with a battery clip fitted. Thus, it has to be laid along the case which means in turn that it is effectively jammed against the PCB — again putting stress upon the LED leads!

Built And Working

Assembly took about two hours, including the time required to sort out the components initially. No "sillies" manifested themselves from the instructions and the kit was complete as supplied.

Once built the unit functioned first time and the notes provided on installation and use were clear and concise. Take some care with the choice of wiring box you use for mounting the kit, though, as it is fairly deep and will protrude some 35 mm behind the front plate when fitted.

In use the dimmer functioned perfectly at all times, with the photodiode having a good wide acceptance angle. Range is about 30 ft — more than most living rooms I would have thought.

Conclusions

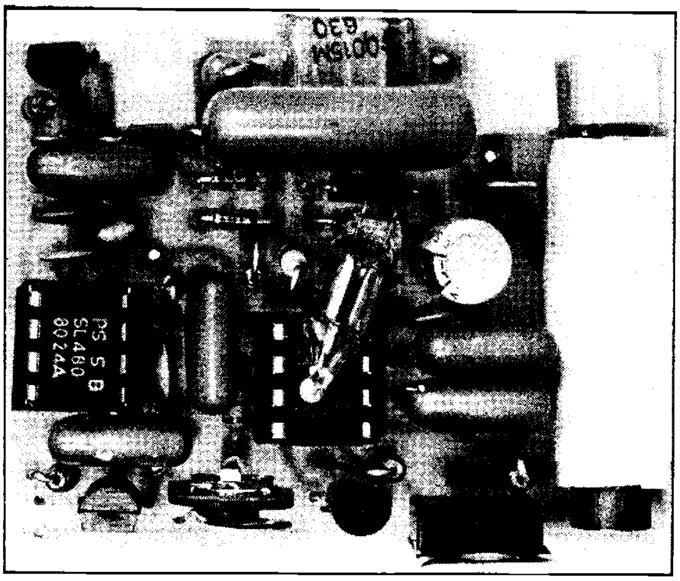
Overall a good design. The circuit is neat and well thought out and the PCB design quite a feat of miniaturisation! However, this does tend to mean that the kit is best suited to someone with some previous constructional experience.

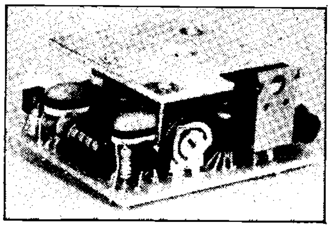
The unit represents reasonable value for money and can be confidently recommended.

RON HARRIS

BUYLINES

TDR300K Touch Dimmer Kit £14.30 + VAT (+ 40p P&P per order), MK6 Infra-red Transmitter £4.20 + VAT. TK Electronics, 11 Boston Road, London W7 3SJ. Tel: 01-579 9794.





Above: the main PCB assembled — note the bulb fitting. This is to ensure that it lines up with the hole in the touch plate, shown fitted (right photo). The board is somewhat crowded in places and care needs to be exercised when soldering.

ETI

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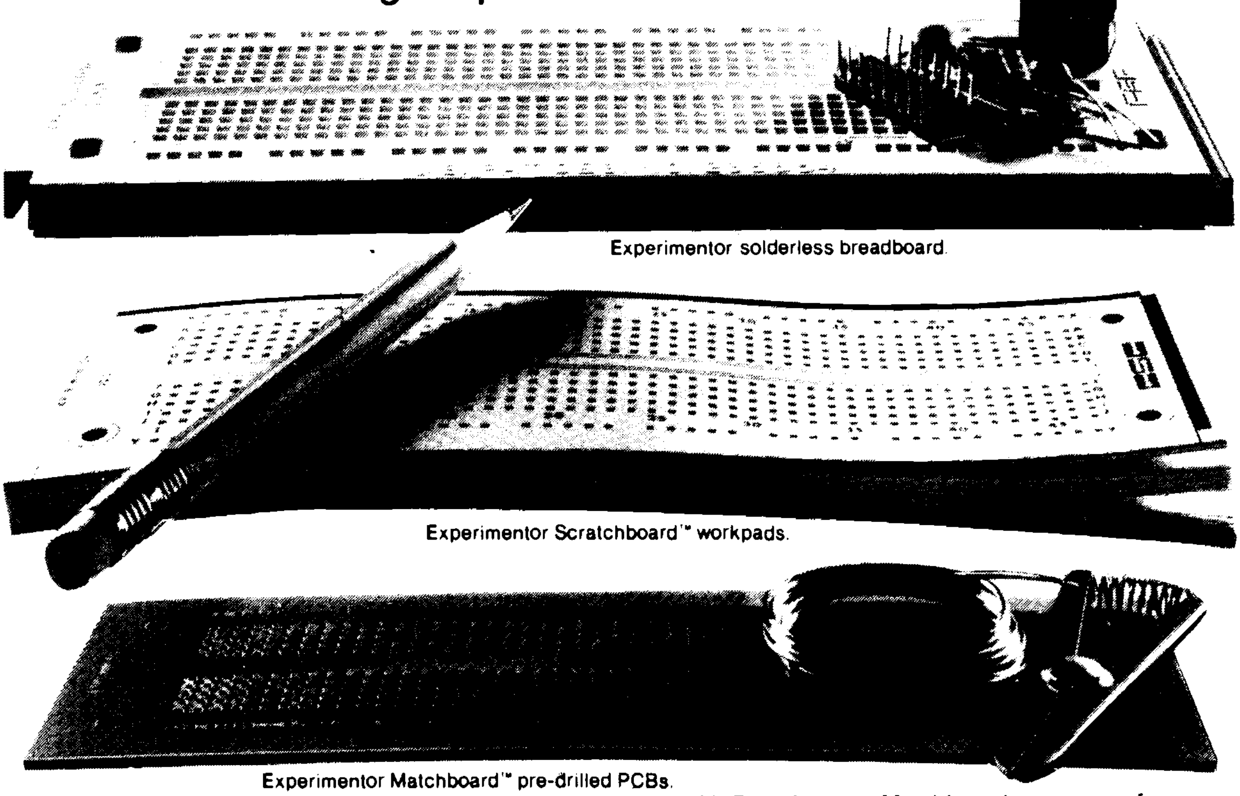

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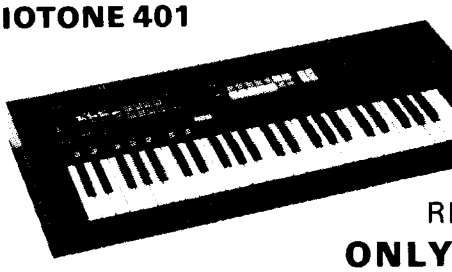

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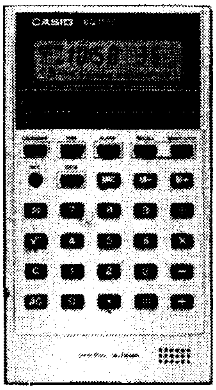

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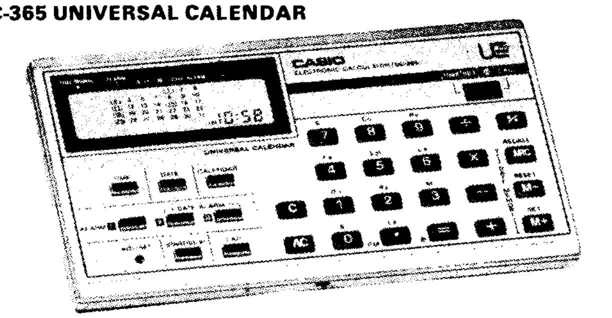

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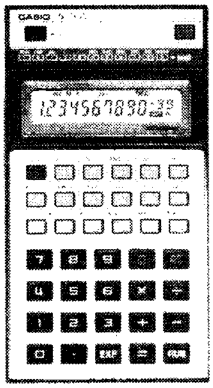

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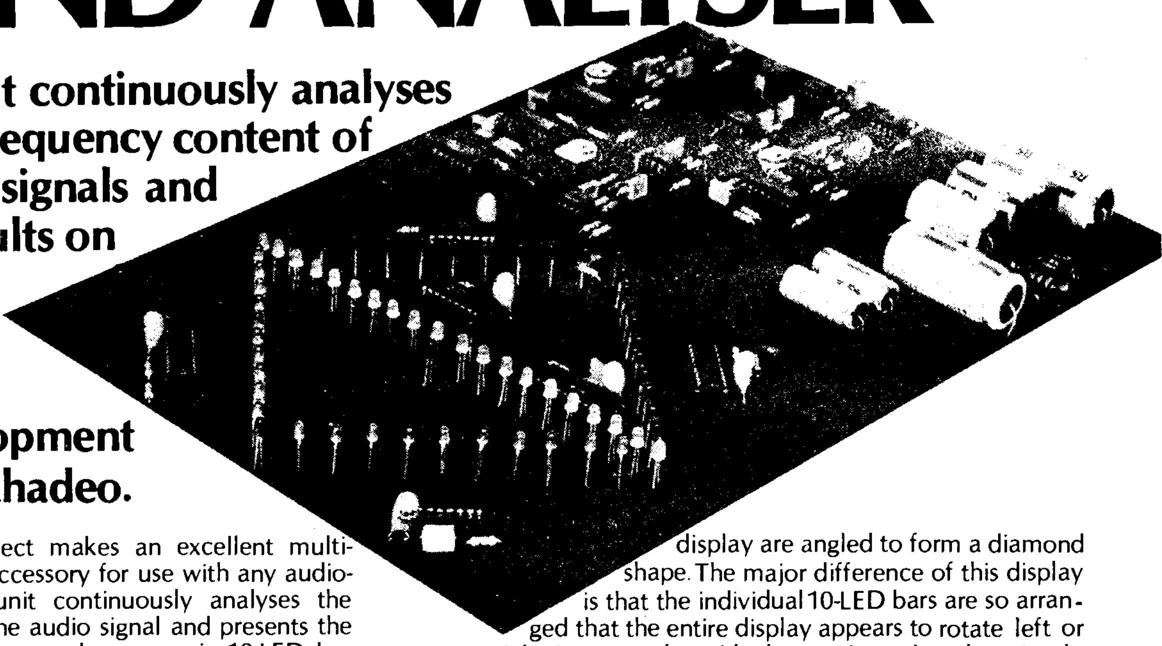
VISUAL COMPLEX SOUND ANALYSER

This unusual unit continuously analyses the amplitude/frequency content of complex audio signals and presents the results on a multi- colour 60-LED display. Design by Ray Marston. Development by Steve Ramsahadeo.



This very unusual project makes an excellent multi-colour visual display accessory for use with any audio-output system. The unit continuously analyses the complex sound content of the audio signal and presents the results of the analysis, in three colours, on six 10-LED bar displays arranged as a diamond with a diagonal. Naturally, in the presence of music, etc., the displays bounce and sway in sympathy with the analysed contents of the audio signal and present an attractive moving display.

The Visual Complex Sound Analyser display unit is mains powered and receives its audio input signal from the output (speaker) of the system under test. The audio signal is actually analysed in the form of three overlapping audio bands, having nominal 3 dB points of 20 Hz — 120 Hz (red display), 250 Hz — 2 kHz (yellow display), and 2 kHz — 7 kHz (green display). The upper three 10-LED bars each move in 3 dB steps and display the instantaneous signal amplitudes of the three audio bands. The lower three 10-LED bars move in linear steps and display the instantaneous dominant frequencies of the three bands.

The Display

This is a project where the skilled constructor might like to experiment with alternative display-pattern layouts. Our development prototype unit was originally built up on Veroboard and had a display in which the six 10-LED bars were arranged as three parallel 20-LED lines, each representing a specific colour-coded frequency band, with the upper half of the display showing amplitude and the lower half showing instantaneous dominant frequencies. On this unit, the central 'reference' bar (four LEDs) of the display represents zero amplitude/frequency, so that each of the three display lines appears to expand and contract from its central point.

On the final PCB version of the unit we've changed the display to the form shown in the photographs. Here, the display is again in the form of three 20-LED lines, each representing a specific colour-coded frequency band, with the upper half of the display showing amplitudes and the lower half showing dominant frequencies, but in this case the two outer lines of the display are angled to form a diamond shape. The major difference of this display is that the individual 10-LED bars are so arranged that the entire display appears to rotate left or right in sympathy with the music, rather than simply expand or contract. Thus, on the low-frequency (red) band the two 10-LED bars expand downwards with increasing amplitude/frequency, whereas on the high-frequency (green) band the two 10-LED bars expand upwards under the same condition; the central (yellow) band expands in a downwards direction. If you've got any better ideas, feel free to do your own thing.

Construction

The entire circuit, with the exception of mains transformer T1 and pot RV1, is built up on a single large (12 x 8 inches) PCB. On our prototype we've coated the entire top surface of the PCB with navy-blue flock paper, to enhance the visual appeal of the unit: if you wish to do the same, proceed as follows.

(1). The PCB uses a fairly large number of bridging links on the top side of the PCB, as well as several long links on the underside; these underside links are facilitated by Veropins (marked on the overlay as A, B, C, etc) pushed through the board from the top side. The underside links are completed by joining A to A, B to B, etc. To start the construction, drill all holes to accommodate the wire links and the Veropins, then insert the links and pins from the component (upper) side of the PCB and solder into place.

(2). Now coat the entire upper surface of the PCB and the lower side of the flock paper with cow gum, allow ten minutes to set and then press the paper evenly into place and trim the outer edges.

(3). Next, drill all remaining holes in the PCB and then proceed with the construction in the normal way, taking extra care to observe the polarities of all semiconductor devices (particularly IC17 and IC18) and electrolytic capacitors. Take special care to check the functioning/polarity of all LEDs before soldering them into place and note that the LEDs *must* be of the colours shown in the circuit diagram. Don't forget to connect the (several) links on the underside of the PCB.

When the construction is complete, double-check all wiring, connect the unit to RV1 and T1 and then switch on. Initially, only the central 4-LED 'bar' should illuminate. Now connect the unit to an audio (music) source and check that the unit is functioning by adjusting RV1 to give a display that behaves in the manner already described.

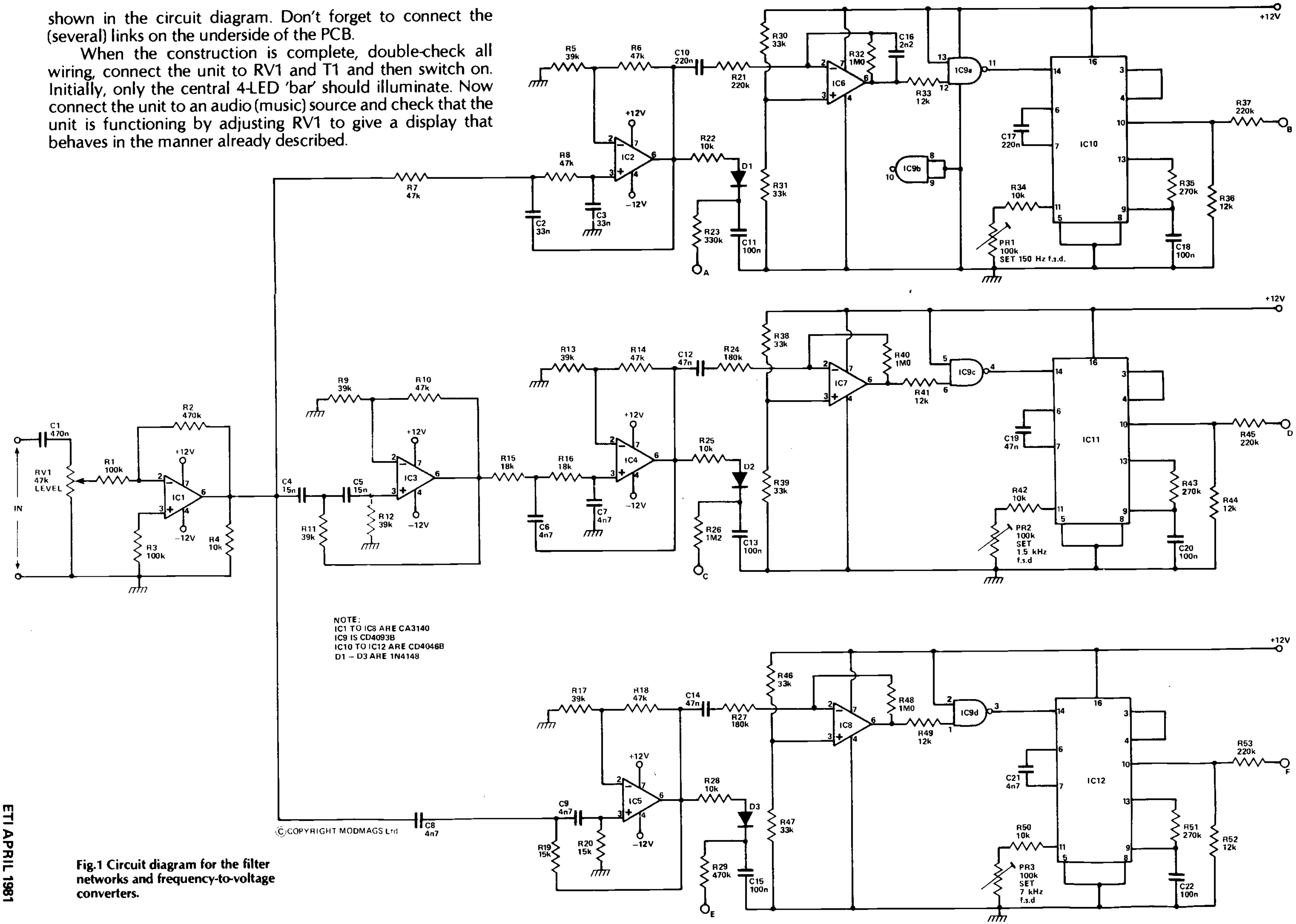


Fig.1 Circuit diagram for the filter networks and frequency-to-voltage converters.

HOW IT WORKS

The audio input signal is fed, after a simple 'level control' (RV1-IC1), to a multiple filter network, which divides the complex input signal into three distinct (but overlapping) bands. The lowest band has an upper 3 dB cut-off frequency of 120 Hz and operates in the low-pass mode (IC2). The middle band operates in the band-pass mode (using high-pass filter IC3 and low-pass filter IC4) and has lower and upper cut-off points of 250 Hz and 2 kHz respectively. The upper band operates in the high-pass mode (IC5) and has a lower cut-off point of 2 kHz.

The output of each filter is peak-detected and filtered by a rapid-charge slow-discharge network (R22-D1-C11-R23-R56, etc) and passes to the input of a 10-LED 'amplitude indication' display. These displays are based on LM3915 dot/bar drivers and give a log display in 10 3 dB steps: they are set, via pins 6-7, to read full scale at 1.2 V. The outputs of the rectifier networks are fed to the inputs of the LM3915 drivers via fixed potential divider networks (R23-R56, R26-R60, and R29-R64), the values of which have been calculated to compensate for differences in the gains of the three sets of filters.

Note that in the LM3915 circuits the ICs are powered from a 12 V supply, but the LED chains are driven from a 24 V supply. The ICs are wired to operate in the 'dot' mode (via pins 9 and 11), but the 10 LEDs in each chain are wired in series; consequently, the LEDs produce a 'bar' display with the LEDs that are on passing a common current. Thus, the LED current consumption is constant, irrespective of whether one or 10 LEDs are turned on.

The low-frequency level indicator (IC13) uses red LEDs, the mid-band indicator (IC15) uses yellow LEDs and the upper indicator (IC17) uses green LEDs. To give an equal brightness to all three colours, the LED drive current of each LM3915 is weighted by the resistor connected to pins 6-7. The red LEDs pass approximately 8 mA, the yellow pass 18 mA and the green pass 25 mA.

The output of each of the three audio filters is also fed to a frequency-to-voltage converter network, and the instantaneous frequency is subsequently displayed on another line of 10 LEDs by LM3914 linear drivers. These drivers are again operated in the dot mode with a bar display and are current-weighted.

Each frequency-to-voltage converter operates as follows. The output of each audio filter is amplified (by IC6, etc) and converted to a square wave by one of the IC9 Schmitt gates. The resulting square wave signal is fed to the input of a phase-locked loop (PLL) circuit (IC10, etc) and compared with an externally set reference frequency (set by C17-R34-PR2, etc). The PLL incorporates a phase comparator and a voltage-controlled oscillator (VCO). The output of the comparator is coupled to the input of the VCO via a simple filter network (R35-C18) and the VCO input voltage is made available, via an internal buffer, at pin 10. As the PLL tries to track the rapidly-shifting input signal, it generates a signal at pin 10 that is proportional to the instantaneous frequency of the input signal (0 V at zero frequency, 12 V at the reference frequency, etc). The output signal of each PLL circuit is fed to the input of its respective LM3914 display driver via a simple potential divider network (R37-R57, etc).

The total of six 10-LED displays are arranged in three pairs, each of a different colour and each displaying the instantaneous amplitude (upper LEDs) and frequency (lower LEDs) of a specified audio band. A bar of four red LEDs is mounted horizontally across the centre of the display, to enable the amplitude and frequency areas of each band to be readily distinguished.

The complete unit uses +24 V, +12 V and −12 V supply rails, each regulated by an IC.

The unit incorporates only three preset controls (PR1, PR2, PR3), which are used to set the full-scale reading of each frequency display (150 Hz, 1.5 kHz and 7 kHz). Figure 5 shows a simple circuit which can be used to generate suitable reference signals when initially calibrating the unit. The circuit is a basic astable, with its frequency determined by the C1-R2-R3-R4 values; the circuit can be easily built on a spare piece of Veroboard.

Fig.2 Block diagram of the complete circuit.

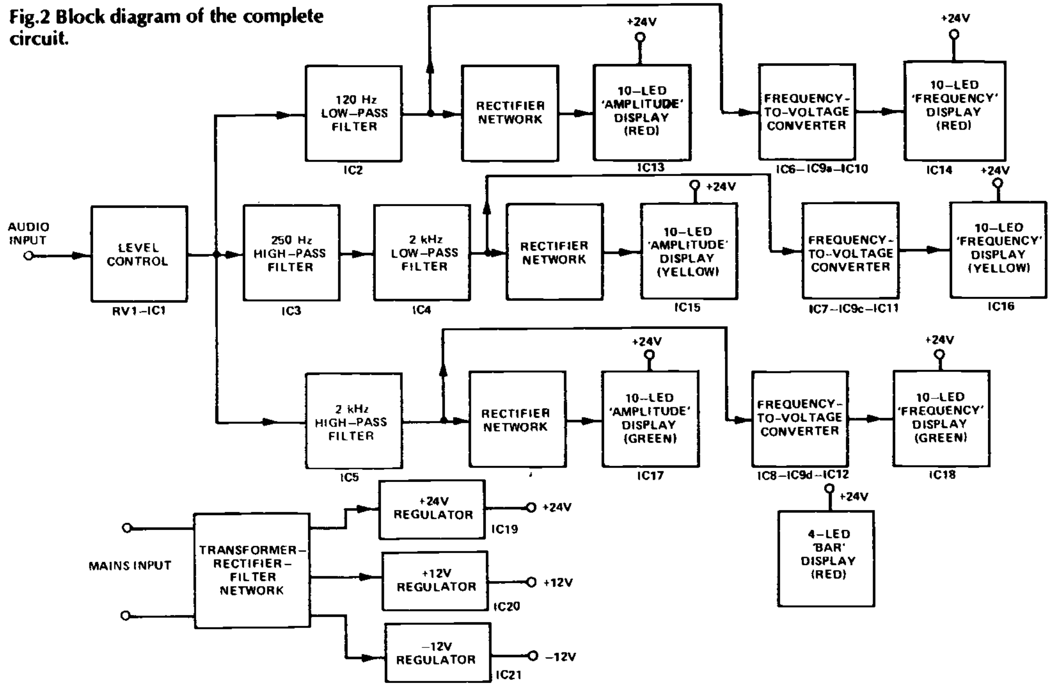
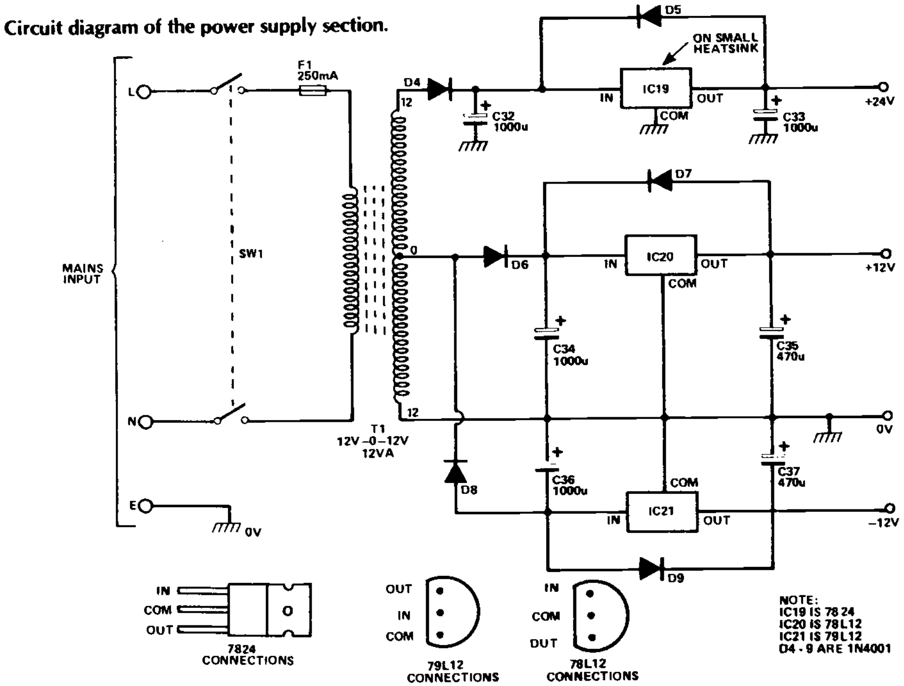


Fig.3 Circuit diagram of the power supply section.



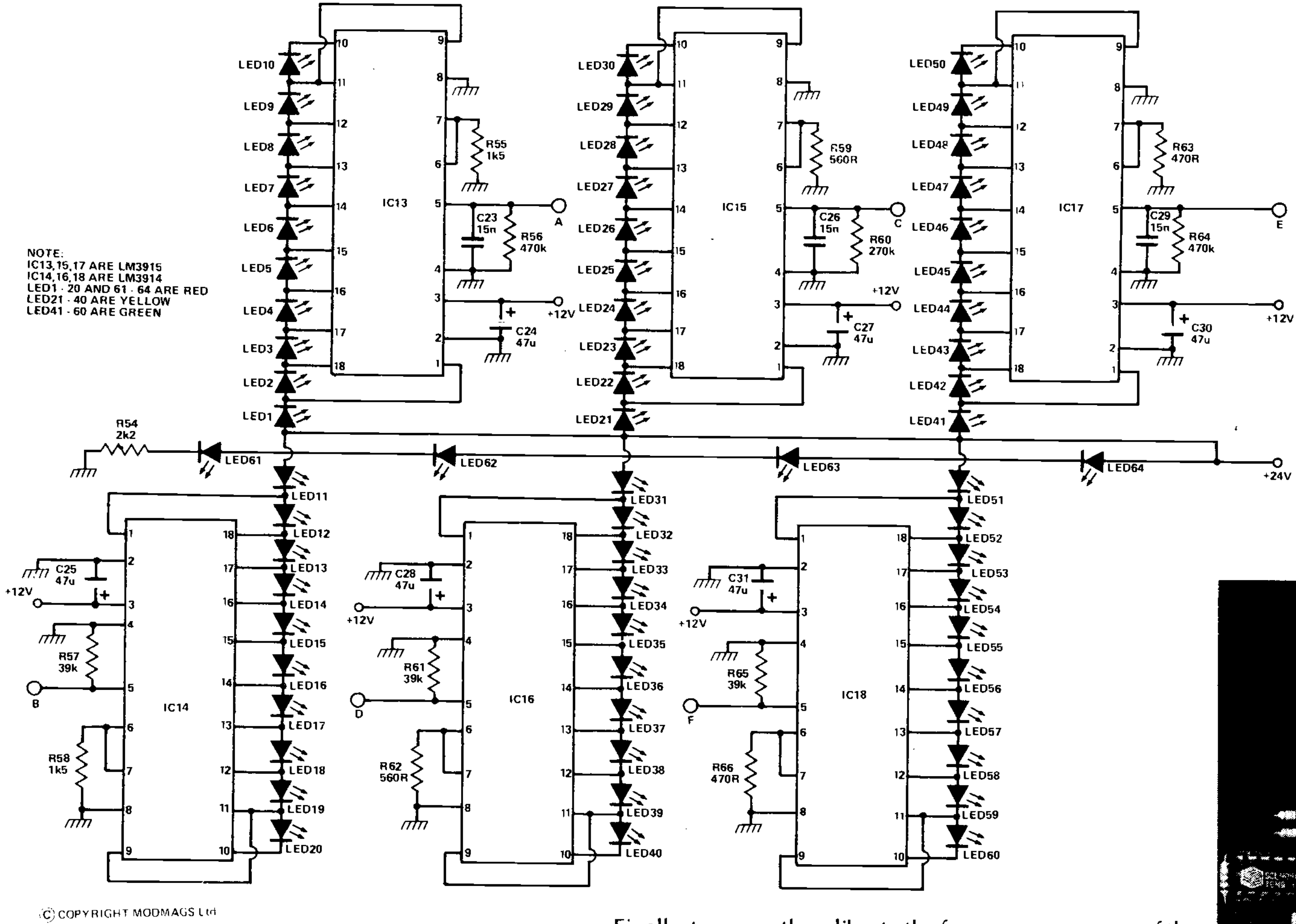
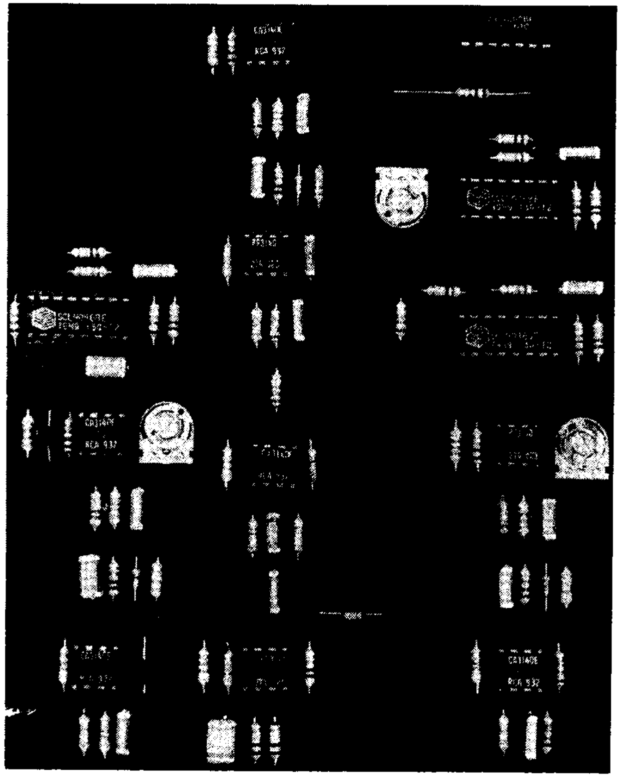
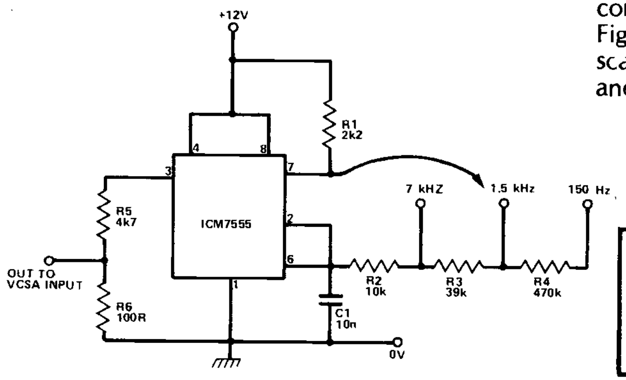


Fig.4 Circuit diagram of the display circuitry. The three sections at the top display the amplitude, and those below display the dominant frequency, in each of the three bands.

Close-up of the filter circuitry (below).





Finally, to correctly calibrate the frequency response of the completed unit, build the simple calibration oscillator (see Fig. 5) on a piece of Veroboard and then use it to set up the full-scale frequency levels of the three frequency bars with PR1, PR2 and PR3.

Fig.5 (left) This simple circuit will generate the three frequencies required to calibrate the frequency display.

BUYLINES

All components used in the V.C.S.A. are easily available. In case of difficulty the LM3914 and LM3915 can be purchased from advertisers in this issue. Should you decide to enhance the appearance of your PCB with flock paper then Paperchase Products Ltd., 213 Tottenham Court Road, London W1P 9AF offer a selection of colours.

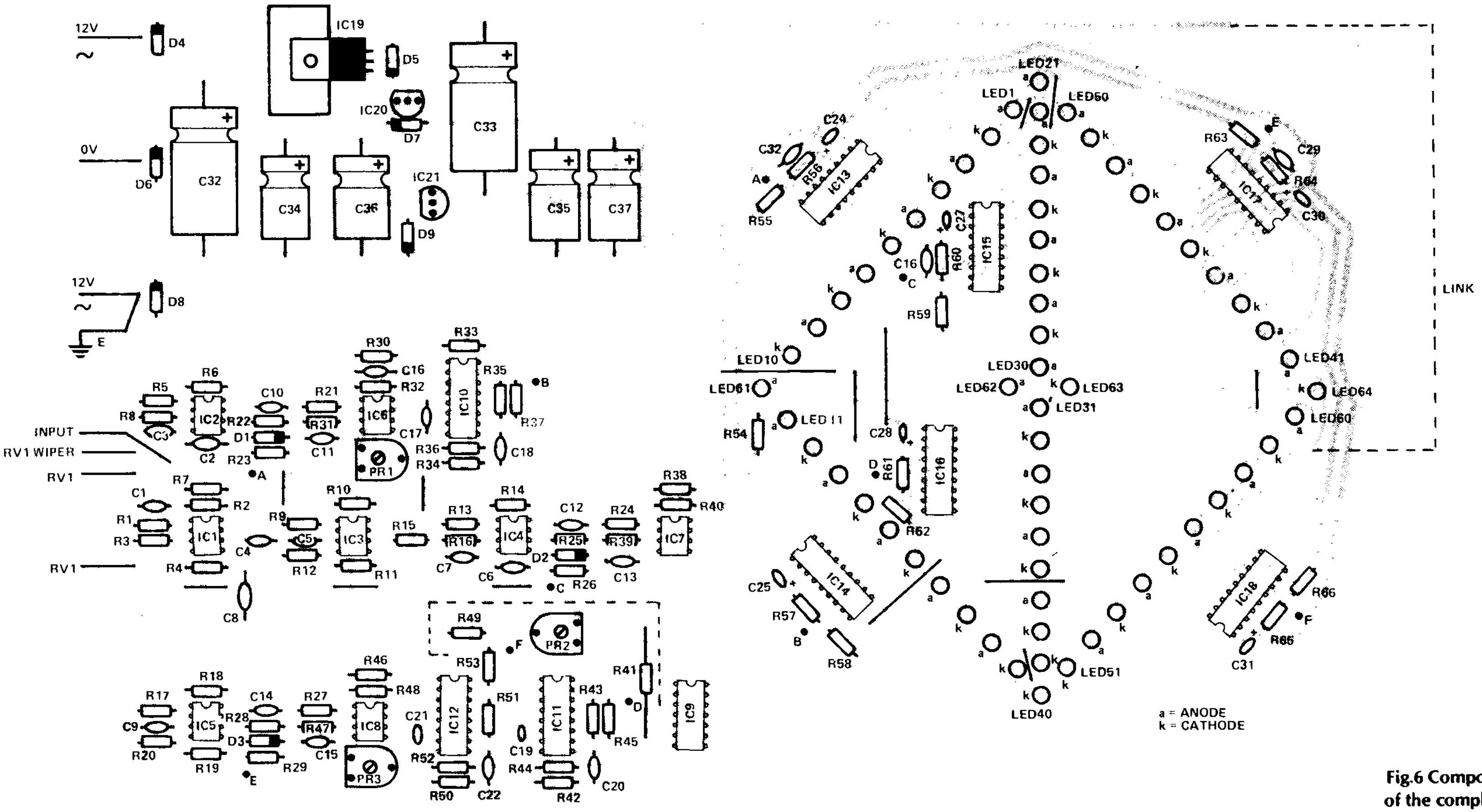


Fig.6 Component overlay of the complete VCSA.

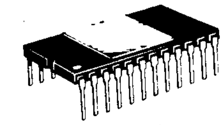
PARTS LIST

Resistors (All ¼W 10%)	
R1, 3	100k
R2, 29, 56, 64	470k
R4, 22, 25, 28, 34, 42, 50	10k
R5, 9, 11, 12, 13, 17, 57, 61, 65	39k
R6, 7, 8, 10, 14, 18	47k
R15, 16	18k
R19, 20	15k
R21, 37, 45, 53	220k
R23	330k
R24, 27	180k
R26	1M2
R30, 31, 38, 39, 46, 47	33k
R32, 40, 48	1M0
R33, 36, 41, 44, 49, 52	12k
R35, 43, 51, 60	270k
R54	2k2
R55, 58	1k5
R59, 62	560R
R63, 66	470R

Potentiometers	
RV1	47k linear
PR1, 2, 3	100k minature horizontal preset
Capacitors	
C1	470n polycarbonate
C2	33n ceramic
C3	33n polycarbonate
C4, 5, 23, 26, 29	15n polycarbonate
C6, 7, 8, 9, 21	4n7 polycarbonate
C10, 17	220n polycarbonate
C11, 13, 15, 18, 20, 22	100n polycarbonate
C12, 14	47n polycarbonate
C16	2n2 ceramic
C19	47n ceramic
C24, 25, 27, 28, 30, 31	47u 16 V tantalum
C32, 33	1000u 63 V electrolytic
C34, 36	1000u 25 V electrolytic
C35, 37	470u 16 V electrolytic

Semiconductors	
IC1-8	CA3140
IC9	4093B
IC10, 11, 12	4046B
IC13, 15, 17	LM3915
IC14, 16, 18	LM3914
IC19	7824
IC20	78L12
IC21	79L12
D1-3	1N4148
D4-9	1N4001
LED1-20, 61-64	0.125" Red
LED21-40	0.125" Yellow
LED41-60	0.125" Green
Miscellaneous	
T1	12-0-12, 12 VA
SW1	DPDT miniature toggle
F1	250 mA fuse and holder

MICROS



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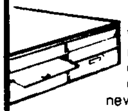

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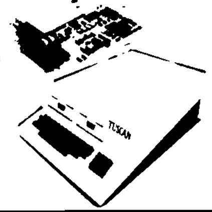

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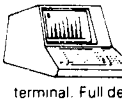

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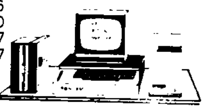

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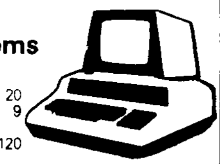

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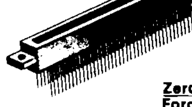

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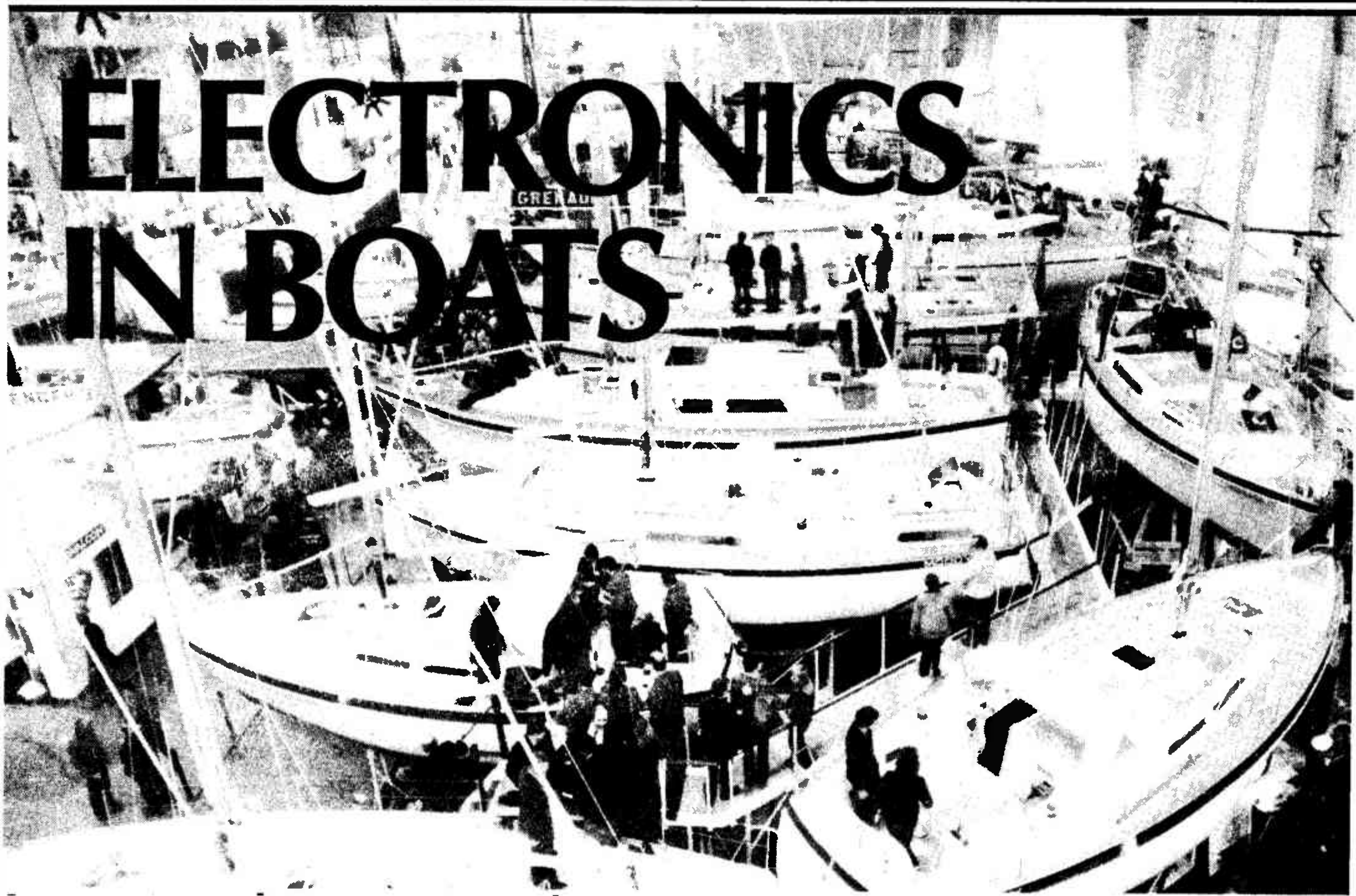
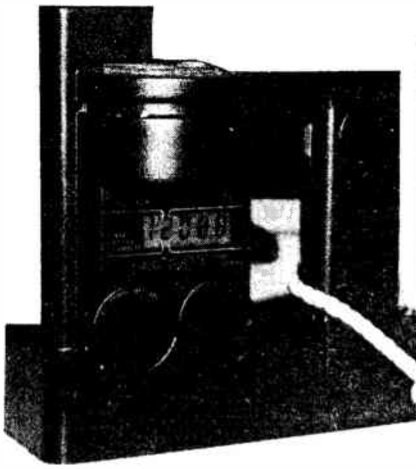
ELECTRONICS IN BOATS



January saw the return to Earl's Court of the International Boat Show. Tina Boylan, (ETI's very own Tiller Girl) and Peter Green went along to see what part electronics plays in boating.

The 27th London International Boat Show brought a brief glimpse of the sunny Caribbean to a frost-bitten and land-locked crowd this January at Earl's Court. It was filled to the gunwales with land-lubbers and sea-goers alike, for the show is not merely aimed at the enthusiast or those of us with money to burn. There are plenty of attractions; gadgets to puzzle over and pleasure craft of every conceivable shape and size fill the huge halls as far as the eye (no offence, Nelson) can see. The whole experience is geared towards sun-baked fantasies and the epitome of luxury.

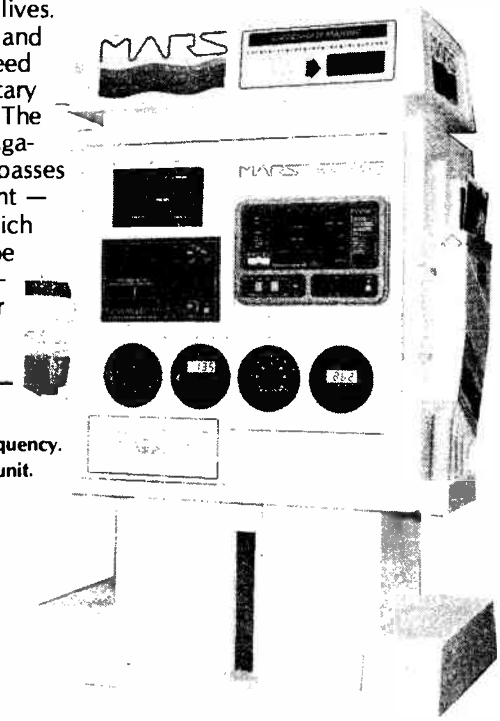
As you leave the lower halls, however, you find stands with some of the more down-to-earth(?) elements of boating on offer. Waterproof gear, life jackets and a million different types of rope. Proving that there's a lot more to boats than basking in the sun!



Messing About In Boats

Practically a whole floor was given to what interests ETI most — electronic devices. Electronics now plays an extremely important part in sailing the seven seas; the aid it gives to navigation and safety is immeasurable. For although men have successfully managed to sail over quite long distances for thousands of years with little more than the stars to guide them, electronics enables them to navigate far more accurately and has saved hundreds of lives.

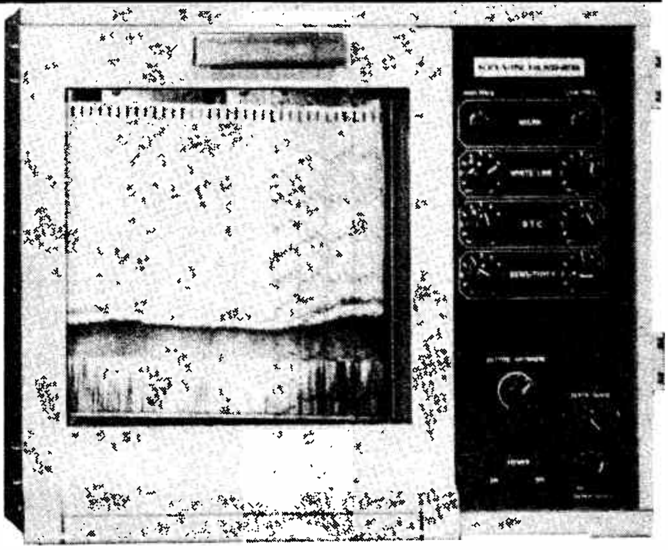
Direction finding and measurement of speed are the most rudimentary necessities for sailing. The earliest form of navigation used charts, compasses and the first instrument — the log (literally!), which was a log tied to a rope knotted at equal intervals and dropped over the stern of the boat, the rope being paid



Far left: A small radio direction finder with digital readout of the selected frequency.

Left: A satellite navigation unit.

Right: A demonstration console for various navigational aids.



Above: A depth sounder with pen recorder.
Bottom: Another satellite navigation console.

out for a known length of time and the knots counted. Calculations would then be made using these three ingredients. The result was always an approximation, as time keeping was not very accurate. In order to solve this problem, during the 17th century the British Admiralty offered a prize of ten thousand pounds for the development of an accurate chronometer. This huge sum was clearly an indication of the importance of such a device. In 1762 horologist John Harrison collected the prize for his design which kept an accuracy of better than two minutes over a six week period — a considerable achievement for the time(groan)!

Today electronic time keeping and calculation are accepted as being both accurate and simple. But electronics in navigation has come a long way from this simple level. Any mechanical instrument can be used in conjunction with electronics and in the case of navigation it is used in three main ways.

Which Way Now?

The first simple method is mainly an offshore aid and is called Radio Direction Finding (RDF). To use this system you must know your approximate position and from your (still indispensable) charts, you then choose three or more transmitting aircraft or marine radio beacons which are in the vicinity of your approximate position. The simplest RDF receivers are operated by manually turning a loop of ferrite antenna until the chosen beacon is heard at minimum strength. Beacon direction is then read off a calibrated scale. A separate sensing antenna must be incorporated to tell whether the beacon is in front of the boat or behind it. Some of the hand-held RDFs, of which there were many at the show, have a built-in compass. Using this it is possible to obtain a fix quickly and the skipper is able to use this on deck, therefore avoiding interference from rigging etc. Headphones are provided on many models for aural identification of very weak signals. When you have read off the bearing of each beacon you plot them on the chart and where the lines cross — X marks the spot, your position has been found! The bearings taken from these fixed stations give a resultant bearing which is usually accurate to within 2°.

The second method of navigation is an essential for any water-going vessel and is the aforementioned log, only somewhat changed in design! The log indicates speed and nautical mileage using a sensor. The simplest form of this is a small impellor monitoring water flow which is mounted through the hull, or over the stern of small boats. As it rotates it pulses a reed or similar switch to provide a suitable signal for subsequent analogue or digital processing and display. This type of sensor is unfortunately liable to clogging by seaweed or flotsam or may be inaccurate due to protrusions from the hull of the boat.

A way round this is to use one of two other electronic systems which have no moving parts. The first of these transmits ultrasonic pulses through the hull into the water and then listens for reflections caused by bubbles or other moving particles under the boat. The frequency of the received signal will differ from the transmitted one because of the Doppler shift and this is proportional to the speed of the water flow. The instrument displays the frequency difference as units of speed. Incorporated circuitry compensates for variations in the speed of sound in water at different temperatures and salinities.

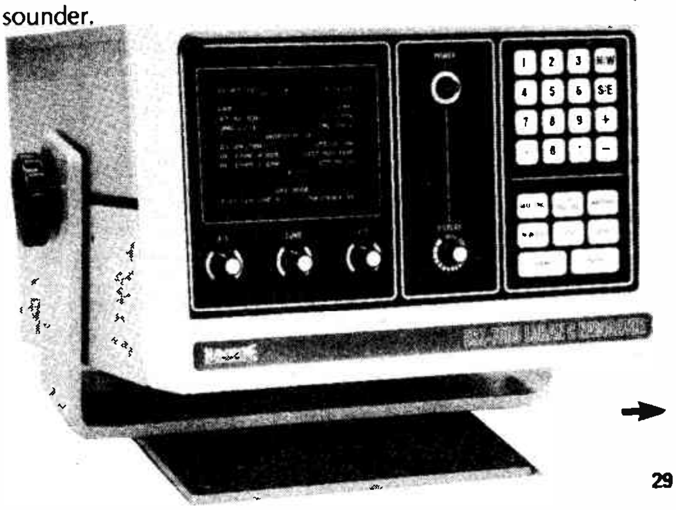
The second and more common device is a hull-mounted electromagnet which creates a magnetic field at right-angles to the motion of the boat, with the lines of flux passing vertically through the hull. Since seawater is conductive, a voltage is induced in the water proportional to the velocity at which the water cuts through the field. There are two small metal studs which protrude through the hull and pick up the voltage — and that's all there is to it! With the log to calculate speed and mileage and bearings taken from a compass, this method can be used for dead reckoning navigation out at sea.

Seeing Stars

Satellite navigation is the last and most accurate means of position finding at present. This method is used mostly in large boats and ships as it can be rather expensive to install. As each satellite orbits the earth it transmits a signal on 150 and 400 MHz every two minutes. These signals give its exact orbital parameters, which are frequently updated with information based on observations made by land-based dedicated tracking stations. The satellites can provide information 19 or 20 times in every 24 hours, and, although their passes are not evenly spaced the worst delays are not normally longer than 2½ to 3 hours. Using the most sophisticated type of on-board dual frequency receivers, a positional accuracy of a few metres can be achieved anywhere in the world. Current satellite navigation receivers often incorporate extra features which are capable of predicting the next satellite pass, and have the ability to perform dead reckoning navigation *between* passes as well as ringing an alarm when the predicted destination is reached.

Sounds Fishy

So now your direction is pretty clear, but there is more information which must be found because you *really* need to know what's around you as well, and particularly what's under you. The open sea is not a swimming pool with a constant depth everywhere, and rivers are not like canals; they have sandbanks and shallows. So next on the list of electronic aids is a depth sounder.



These work by transmitting an impulse and measuring how long it takes to return. Ultrasonic energy is used for this; all types of depth sounder use this principle and only vary in the type of display, output power and frequency.

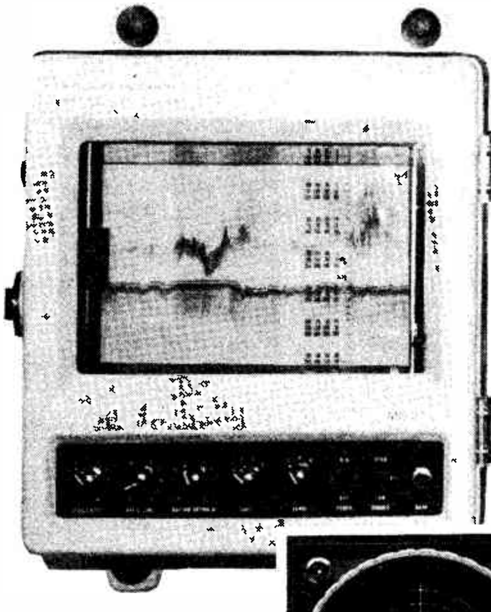
The display is usually an LED type, and when the acoustic pulse is sent out an LED flashes at the zero mark. When the echo returns another LED flashes on the dial at an angle proportional to the time since the transmit pulse was sent, thus indicating the depth of water below the hull. Apart from indicating the distance of the sea bed, the depth sounder will also pick up the position of shoals of fish, making it a useful aid for fishermen. Many depth sounders incorporate a pen recorder which enables them to return to a particularly good area where shoals have been found before. The depth sounder also makes landing less hazardous in bad weather conditions.

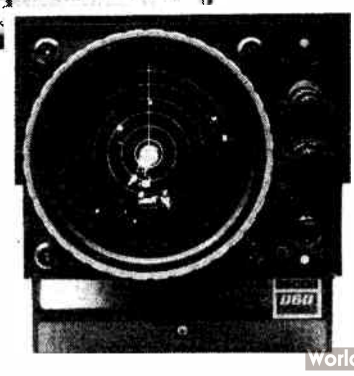
So now you know exactly where you're going. Great. But with the waterways of the world crowded with many different types of vessel, it's rather important that you know where *they're* going to, otherwise — oops! A collision, and that happens all too frequently!

On The Rebound

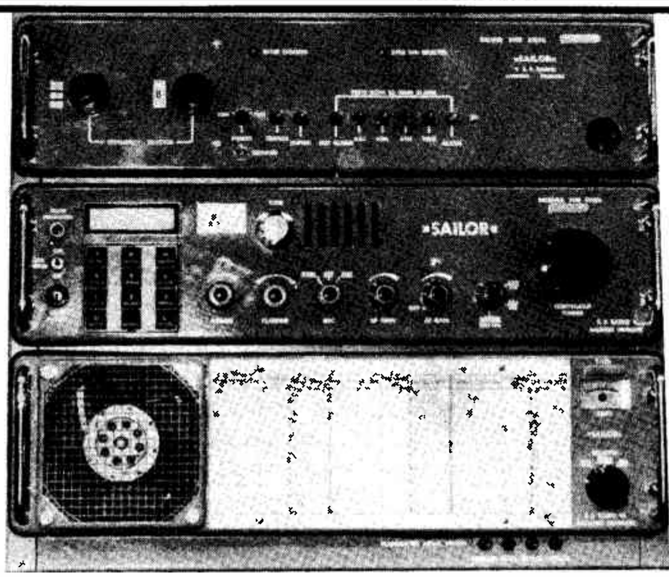
As far as hitting other vessels at sea goes, radar is the most effective safeguard available, even for the smallest craft. Radar not only enables you to see other vessels, but can also be used as a navigational aid because coastlines are also visible on it. Most radar sets consist of two main units — a console containing the display circuitry and controls, and a transceiver/scanner unit containing the RF electronics and the rotary antenna. Efficient radar does depend largely upon the height of elevation of the antenna since radar waves are transmitted on a line-of-sight principle. In bad weather this can mean that high waves will deflect the radar signal from a small boat making readings inaccurate. A small boat can also be easily mistaken for a wave by a radar operator on a large vessel, and this point brings us neatly to an associated safety device which is used with radar.

A small boat, particularly if it is built of fibreglass or wood, does not reflect radar waves as well as a large vessel or one made of steel or aluminium, which leaves it little hope of being spotted on radar. Luckily there is a device which greatly improves the visibility of a small boat and can be easily fitted.





Above: another depth recorder.
Right: small radar screen.



Above and left: Two reasons for choosing a small VHF radio telephone. These HF units are fairly bulky and would only suit large craft travelling far out to sea.

The metal radar reflector is masthead mounted and its shape and material make it an effective reflector of radar beams, giving a clear indication of the presence of a small boat on a radar monitor. These do have to be carefully fitted or they can be practically useless.

Steering A Straight Course

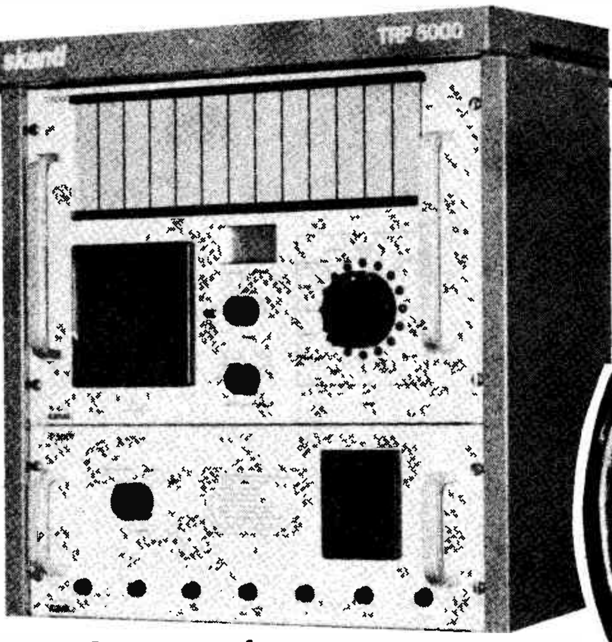
Electronics can also be used for steering your course once it is chosen. An 'autopilot' can be used for either power boats or sailing boats. Basically an autopilot is a straightforward servomechanism; the actual heading is compared to the desired course and the error signal is used to drive a servomotor, thus correcting the rudder. A disadvantage with this system is that the swell of waves can affect the autopilot and cause it to continually try to correct the movements of the rudder, however insignificant they may be, so many autopilots have a built-in override mechanism which can be adjusted to compensate for varying sea conditions.

On a sailing boat, steering is far more dependent on wind direction, so an autopilot of the type used in power boats would be next to useless; it would keep a heading regardless of wind change leaving the sails set wrongly, which, at best, would cause the boat to lose speed and at worst could put it into a dangerous situation. So most sailboat autopilots keep the boat on the right heading relative to the wind; these units offer a choice of compass or wind vane to generate the control signal.

Come In Number 44

Even boats equipped with all of the safety features so far mentioned can find themselves running into trouble and in need of communication with rescue services. Or maybe you want to contact someone you wish to speak to (you're half-way across the North Sea when you realise that it's Aunt Maud's birthday and you forgot to send a card . . .).

British Telecom International, the new telecommunications branch of the Post Office, now operates 12 coastal radio stations in Britain; 11 of these are for medium/short range use, one is for long range. In addition, there is a continually growing network of remotely controlled VHF stations. The coastal stations will deal with any type of message, from ship-to-shore social calls to distress signals — the latter naturally receiving priority at all times — and also broadcast routine weather reports, gale warnings and details of navigational hazards.



handset and a small helical aerial. In an emergency the set can be removed from its installation and used as a walkie-talkie; an obvious advantage if your cockpit is on fire, you've lost your mast and the main aerial with it, or you're sitting in a small rubber dinghy about 20 fathoms above the remains of your yacht! However, in this mode your range will be reduced still further, especially at sea level.

Left: This VHF radio telephone features more facilities than the basic models but is still quite compact.

The Art of RT

The VHF radio telephone solves many of the problems that prevent small boat owners from fitting HF equipment and as such is an invaluable aid to safety for pleasure boats. HF radios are generally large and draw a lot of power, sometimes necessitating extra batteries. They are more complex, more prone to interference, more expensive and more difficult to install (aerials are generally loaded whips which require a ground plane). A typical VHF unit, though, is only slightly bigger than a car radio/cassette player and is just as easy to install. Mounting brackets for vertical or horizontal fitting are usually provided, and some types have a mounting flange that allows flush installation in a bulkhead, car dashboard style. After that you simply fit a mast-top aerial, plug into the boat's 12 V supply and you're ready to go.

Models generally offer similar facilities and these are limited to the essentials — on/off switch, volume, squelch and channel selector switch. The VHF frequencies allocated are from 156 MHz to 162 MHz and generally the transceivers will have a selection of a dozen channels in this range. Some models use a frequency synthesiser, so you can only transmit on the frequencies pre-selected by the manufacturer. Others have individual crystals fitted for each channel, and by changing crystals you can pick any set of frequencies that are convenient. *All* radio telephones should be capable of transmitting on channel 16 — this is the VHF international distress frequency.

Output power ranges from about 10 W to 25 W and often a control is provided to reduce the power output when speaking to a station at close quarters. This may either be in the form of a high/low switch or a continuously variable pot, and prevents unnecessary interference to more distant users.

Simply Simplex

Although there are some duplex channels in the VHF band (ie you may transmit and receive simultaneously, as with a telephone), only simplex transceivers were in evidence at the Show. These require the use of a press-to-talk button on the microphone, a feature well-known to those "good buddies" who have the *other* sort of radio fitted in their cars!

The qualification "in-shore and coastal" is due to the one disadvantage of VHF compared to HF: lack of range. VHF frequencies are not subject to 'skip' via the ionosphere and while this provides immunity from unwanted signals, it does mean that only line-of-sight communication is possible. Even with a mast-top aerial, range is limited to about 20 nautical miles.

A few VHF radio telephones have an optional version which allows completely portable use: the set has a battery pack (rechargeable from the ship's 12 V supply), a telephone handset and a small helical aerial.

Hand-Held Help

For absolute assurance that an accident at sea will not be compounded by your inability to summon help, a portable distress radio telephone is essential. These units are complete, self-contained HF radio telephones, pre-tuned to one frequency only, the international maritime distress frequency (2182 kHz). Unlike the VHF band, this frequency is not subject to line-of-sight restrictions and is insensitive to aerial height. Typical 'worst-case' transmitting ranges exceed 40 miles; under favourable conditions this can be greatly extended.

A typical distress radio telephone is shock-resistant, waterproof and self-buoyant (radio overboard?!). The controls are kept to an absolute minimum and are designed to be easy to operate even with numbed fingers. Instructions are clearly and concisely printed on the case for the benefit of untrained people. To use the unit, the earth-wire with its lead sinker is thrown into the sea, the telescopic aerial extended fully, and the alarm button pressed for abut 20-30 S. This causes a two-tone signal to be transmitted which overrides all other traffic on the 2182 kHz frequency and automatically activates the watch-keeping receivers used by coastguards, rescue services, merchant ships and trawlers. Once you've attracted everyone's attention you can make speech contact with your rescuers.

These units may also be used for 'urgency' calls (without using the alarm button), for direct contact with coastguards and commercial ships in order to obtain medical, meteorological or navigational advice, or to report any less serious damage to your vessel such as engine failure.

It should be pointed out that, especially in the case of VHF sets, there is little point in fitting a radio telephone unless *everyone* who is aboard the boat has been told where the set is and how to use it. Help is going to be a long time coming if the only man who can use the radio is the one who has just suffered a heart attack, or food poisoning, or been washed irretrievably overboard. For similar reasons, try to get a VHF set with duplex operation. Then anyone unfamiliar with radio procedure is unable to cause, at least, confusion and at worst, fatal delay, by forgetting to press the push-to-talk button.

Be Prepared

So that more or less sums up the wide range of electronic gadgets you will need for your boat, whatever size it may be. Of course, there are still many developments being made in nautical electronics because, unfortunately accidents *do* still happen. One thing visiting the Boat Show can teach you is how important having the right equipment is, and, if you visit next year's Show you too may become hooked on boats for life! **ETI**

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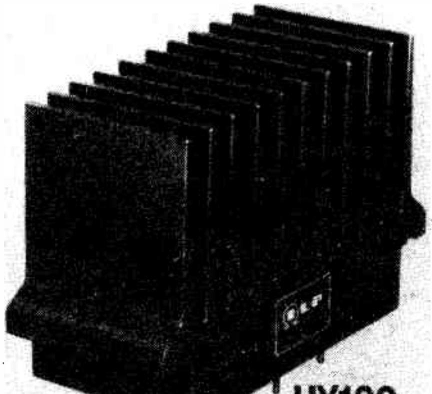
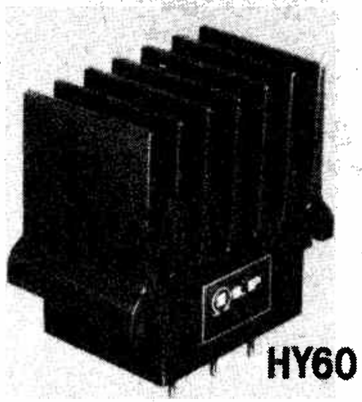


HY120



HY60

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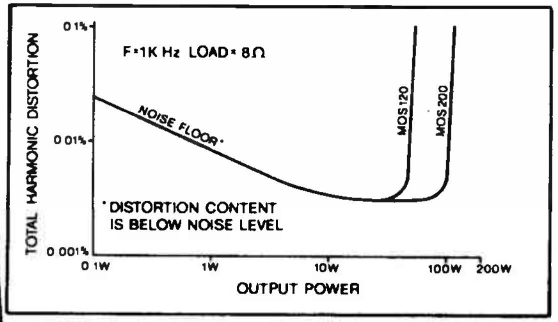
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£25.88 + £3.88
MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

I.L.P POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE



Load impedance both models 4Ω - ∞ Input sensitivity both models 500mV

Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB

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(Standard O-P Transistors)

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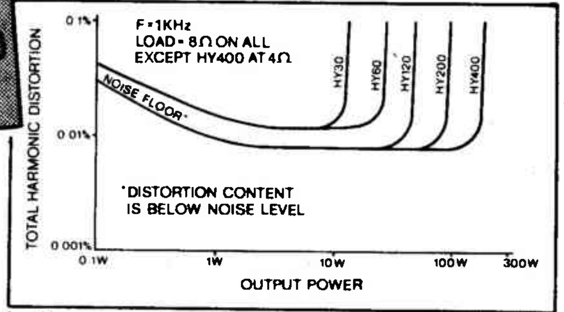
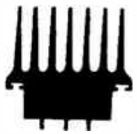
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.29 + £1.09
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£8.33 + £1.25
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£17.48 + £2.62
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£21.21 + £3.18
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£31.83 + £4.77



Load impedance all models 4Ω - ∞ Input sensitivity all models 500mV

Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz – 3dB



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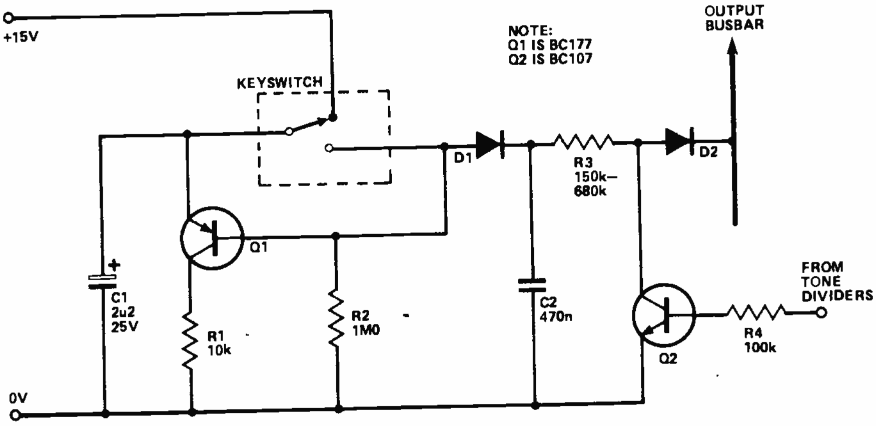


Touch-Sensitive Piano Keying

J. Cozens, York

The circuit is operated by a single-pole change-over key switch. When the key is in the fully released position C1 is held charged from the 15 V rail. Q1 is turned on by the bias current supplied by R2. When the key is depressed C1 is disconnected from the 15 V rail and starts to discharge through Q1 and R1. When the key is fully depressed Q1 is turned off and the remaining voltage on C1 then charges up C2 via D1. Both capacitors then discharge via R3. The envelope produced by this decaying voltage is chopped by Q2, driven directly from the tone dividers. Upon the release of the key, C1 is disconnected from the chopper circuit and C2 discharges rapidly via R3, simulating the action of the dampers. D1 is included to prevent C2 discharging through R2 when the key is released and D2 prevents interaction with other keying circuits.

As the voltage remaining on C1 at the completion of a keystroke depends on the key velocity, a degree of touch-sensitivity is obtained with this circuit.

Tuning Fork Mods.

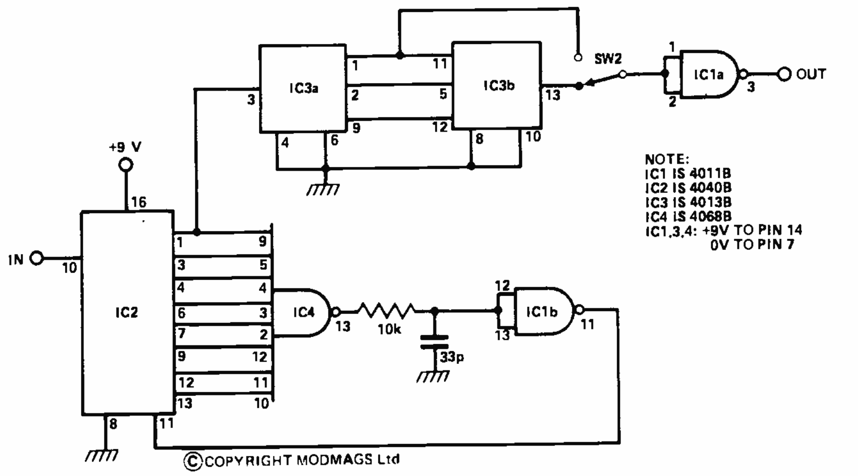
M.L. Duncan, Greenford.

With a few slight modifications to the ETI Tuning Fork it is possible to use the very cheap and plentiful TV colour crystal tuned to 4.43361875 MHz.

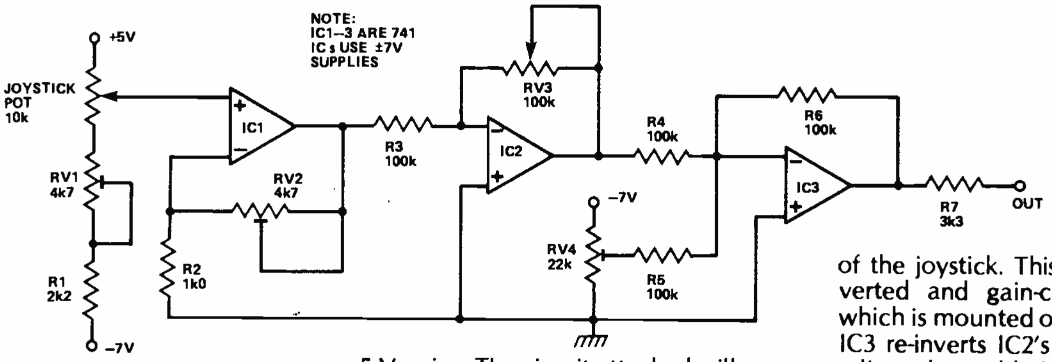
The oscillator circuit output is divided by 2519 giving a frequency of 1760 accurate to one part in 250,000. The division is done by a 4040 in place of the 4020 and the switching giving an alternate 'A' at 445 Hz is eliminated.

A 4013 dual flip-flop is added before the output buffer to give further division by two and four. These outputs are switched before the buffer to give a choice of 'A's at 880 and 440 Hz respectively. The extra cost of the 4013 is offset by eliminating one of the 4011s.

The diagram shows the altered parts of the circuit. The oscillator is retained, using the changed crystal, as is the output circuit from R4 onwards.



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. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.



Joystick Control

M. Swale, Cardiff

Having recently built the ETI 4600 synthesiser, I found, to my dismay, that most joystick pots only vary by about 30° at maximum deflection. Consequently, the original circuit for the joystick control, which assumes complete rotation of the joystick pot, will not give the required 5 V swing. The circuit attached will convert a small DC voltage change provided by the joystick into 0-5 V at the output.

Circuit function and setting up is as follows:- RV1 is adjusted so that there is 0 V at the joystick pot wiper. (Note that RV1 and R1 may need to be on the + 5 V side of the joystick pot, depending on the actual pots used in the joystick).

RV2 is then adjusted to give ±2V5 swing at IC1 output with full deflection of the joystick. This voltage is then inverted and gain-controlled by RV3, which is mounted on the joystick plate. IC3 re-inverts IC2's output and RV4 is adjusted to add 2V5 to the output of IC3. The output then becomes a 0-5 V swing, with 2V5 at the centre point.

This control voltage swing is ideal for use in the 4600 synthesiser since 2V5 into the keyboard modulation input gives no variation in pitch, ie the keyboard pitch can be shifted up and down by an amount dependent on RV3. The power for the circuit can be taken directly from the 4600 PSU.

Improved Speaker Overload Indicator

J. Harrold, Bristol

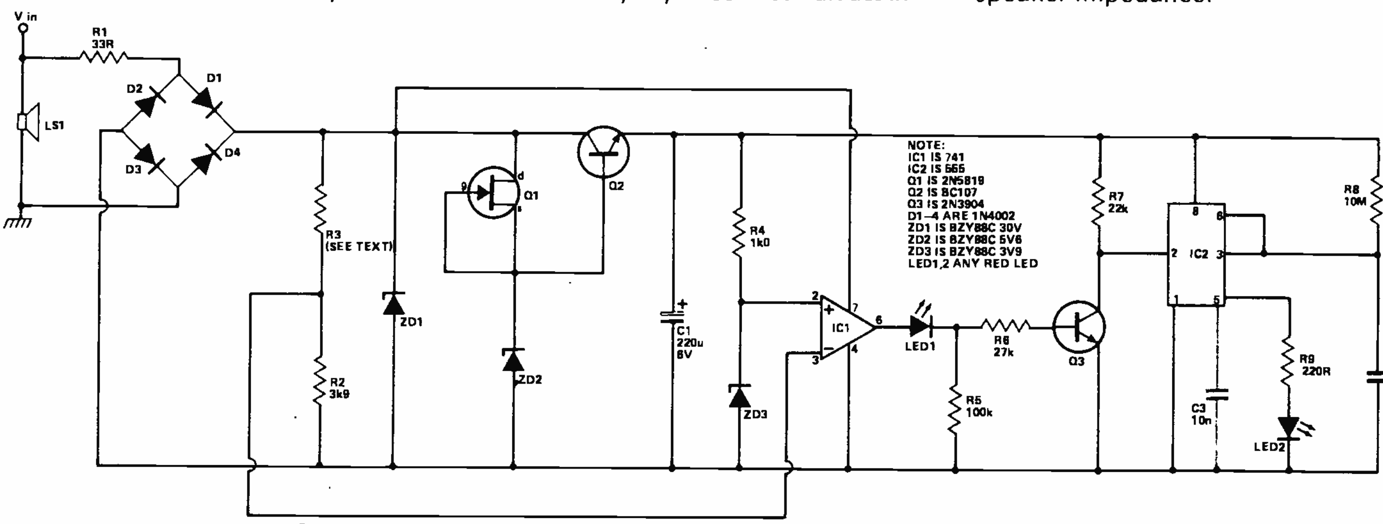
This circuit is based on a design by J. P. Macaulay, which appeared in Electronics Digest Vol. 1. This one offers an improvement in performance, which is low cost and does not introduce an external DC power supply.

Peaks in music can be very short and may be too fast (or dim) to be seen clearly on a LED if held for their duration only. This circuit uses a monostable to hold a LED on for a set time after triggering by a peak in music.

The voltage at the speaker output terminals is rectified and then passed to potential divider R2, R3. ZD1 provides 'last ditch' protection for Q1 and IC1 (this method is not suitable if indication of overloads of greater than 50 W is required). Q1 is used as a voltage variable resistor and with ZD2, series pass transistor Q2 and C1, provides a regulated supply. This supply improves the stability of the 3V9 reference potential at the inverting input of IC1 and also provides a stable supply for IC2 and its timing components R8, C2. C1 cannot be placed between 0 V and the collector of Q2 as this would have an adverse filtering effect on high frequency signals. When the voltage across R2 is less than 3V9, the output from comparator IC1 is low ($\simeq$1V5) and this voltage is dropped across forward biased red LED 1 (or alternatively any three silicon diodes in series). Q3 is off and the trigger (pin 2) of IC2 is high. When the voltage across R2 exceeds 3V9, IC1 output goes high and Q3 is turned on, lowering the voltage at IC2 pin 2, triggering the monostable and lighting LED 2 for a period dependent on R8, C2 (about 100 mS with given values). C2 must be a low leakage type (not ceramic). Decoupling of the control voltage (pin 5) by C3 was not necessary in the prototype. R1 protects the amplifier from possible bridge failure. Q1 may be replaced by a fixed resistor appropriate to the input voltage with slight degradation of performance. The value of R3 is given by:

$$R3 = (\sqrt{2PR} - 3.9) \text{ kilohms},$$

where P is the power output and R is the speaker impedance.



'Zener-less' Battery Eliminator

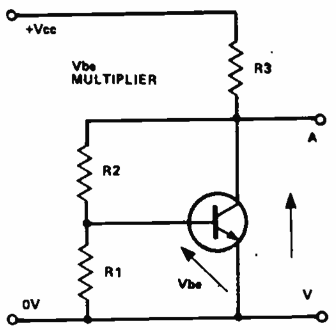
P.J. Hunt, Wimborne

Designed as a variable-voltage battery eliminator, this circuit provides a stabilised output without Zener diodes as the reference source. Instead, a V_{be}-multiplier is employed, so that the output voltage may be continuously varied by PR1 over the range 6-10 V.

The V_{be}-multiplier is shown schematically in the inset. Provided that V_{cc} is high enough, the potential across R1 will be about 600 mV for a silicon transistor. The current through R1 can thus be adjusted so that the base current of the transistor may be ignored for practical purposes. In this case, the current through R1 will equal the current through R2. The potential at point A is thus given by:

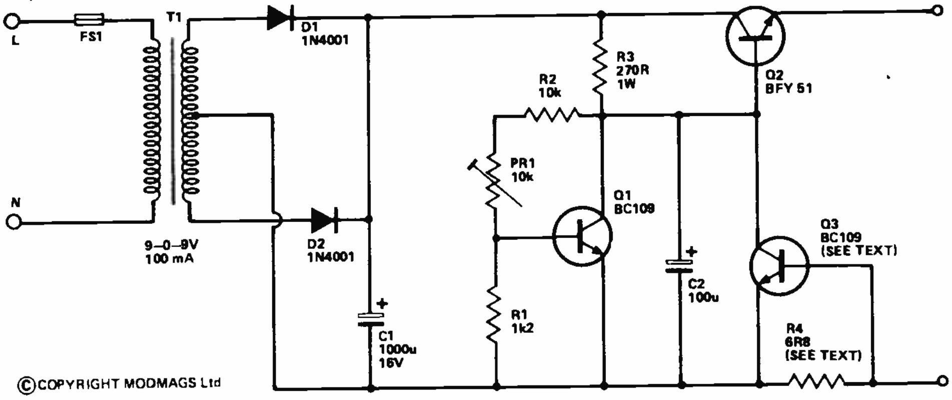
$$V = V_{be} \times \frac{(R1 + R2)}{R1}$$

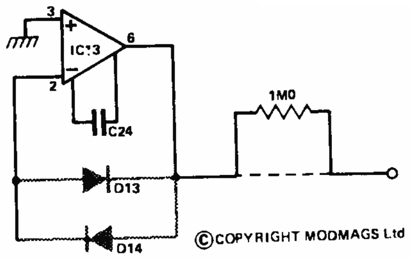
— hence the name V_{be}-multiplier.



R3 limits the current through the parallel combination of the transistor and R1/R2. Suppose as an example that V_{cc} tries to rise. The potential divider formed by the three resistors will try to raise the voltage across R1. This will tend to increase the collector current and thus increase the potential drop across R3, leading to a stabilising effect at point A. This is a case of voltage-derived series feedback.

In the practical circuit, R3 also provides base current for the series transistor Q2. Q3 and R4 form a current limiter. If the output current exceeds approximately 100 mA, Q3 starts to turn on, reducing the output voltage. If desired, Q3 and R4 may be omitted, in which case R3 may be de-rated to ½ W. The whole unit fits easily inside a PP9 battery case.



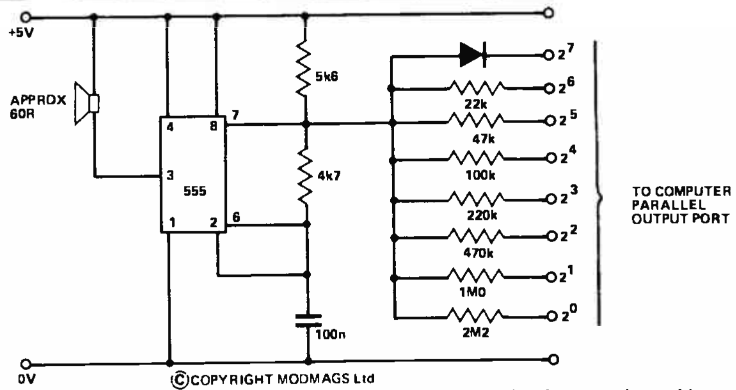


Transcendent Pulse Wave Improvement

J.F. Jordan, Cambridge

The pulse wave on the original Transcendent 2000 suffers from a slow falling edge, making LFO modulation of pulse width less effective for chorus sounds and removing the characteristic hollow tone of the square wave.

This problem can be solved by removing D13 and D14 and inserting a 1M0 resistor across a break in the track from the output of IC13 to SW4. The comparator then operates in open loop mode giving much improved waveform edges.



Cheap Micro Music Box

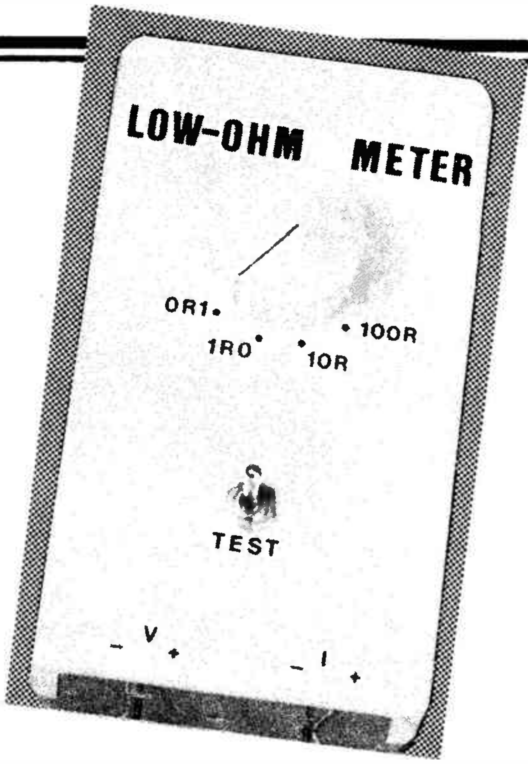
T.M. Tobin, Birmingham

This circuit may be connected to the output port of any micro to generate musical notes over a range of about 1½ octaves. On/off control is provided by the most significant bit and the resistors provide seven bit resolution. Alternative on/off control methods can be used to give eight bit resolution, eg by using the handshake lines, if available.

If the diode is replaced by a resistor, say 10k, it will be found that below a certain output value the voltage at pin 7 is insufficient to charge the capacitor. Thus the sound can be switched off.

The resolution is sufficient to enable values to be found corresponding to tones and semitones throughout the frequency range. Current consumption depends largely on the loudspeaker impedance and is generally low enough for power to be taken directly from the computer. Most constructors will have all the parts required which in any case will cost less than £1.

LOW-OHM METER

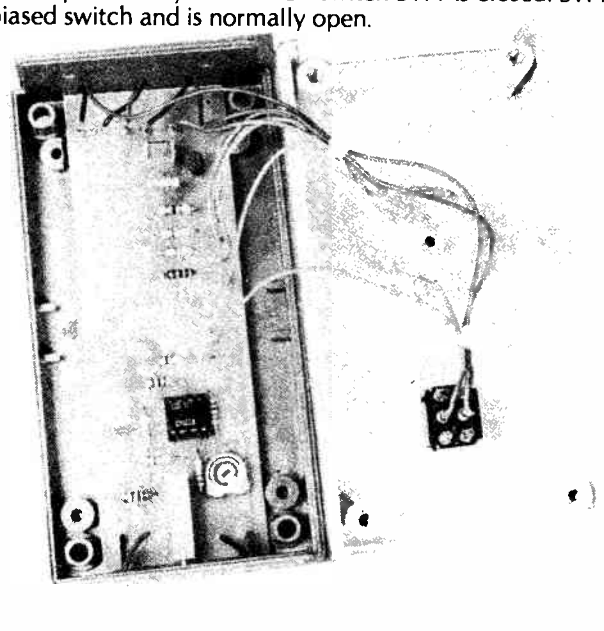


Measure resistances from a hundred ohms down to a few milliohms with this accurate four-range meter. It can be built as a self-contained unit or as an adaptor for use with an existing multimeter. Design and development by Ray Marston.

Ever wanted to measure the resistance of a transformer winding or a suspect solder joint, but found that your trusty multimeter wasn't sensitive enough to do the job? If so, our Low-Ohm Meter will solve your problems. It accurately measures resistances from a hundred ohms down to a few milliohms, in four decade ranges, using a precision four-terminal measuring technique that eliminates the effect of connecting leads, etc, from the readings.

Our Low-Ohm Meter contains two fully independent (and independently powered) circuits, these being a multi-range constant-current generator and a DC millivoltmeter with a full-scale sensitivity of 10 mV. The generator is used to apply a fixed test current to the resistor that is being measured, and the voltmeter is used to measure the resultant voltage that is developed directly across the resistor, indicating the true value of the resistor and ignoring the effects of the test leads. This four terminal measurement technique is widely used in precision calibration laboratories.

The Low-Ohm Meter indicates 100 milliohms (0R1) on its most sensitive range, using a test current of 100 mA. Supply battery B1 must be capable of supplying this current without excessive voltage drop; a PP9 type is recommended. The unit consumes power only when TEST switch SW1 is closed. SW1 is a biased switch and is normally open.



Construction

The Low-Ohm Meter can be built as either a self-contained unit, with built-in supply batteries and moving coil meter, or as an adaptor unit for use with an existing multimeter. In this latter instance, use a meter set to its 1 V DC range.

Start the construction by assembling the components on the PCB, as shown on the overlay. If your meter or multimeter has a sensitivity of 100 uA (10k/V) or better, give R9 a value of 10k. If the sensitivity is 1 mA (1k0/V) or better, reduce the R9 value to twice the ohms-per-volt value of the meter.

When assembling the components, note that PR2 is a multi-turn 3/4 inch cermet trimmer and that its adjuster spindle overhangs the edge of the PCB; we'll refer to this end of the PCB as the 'front'. Solder four flexible leads to the indicated points at the front of the PCB. Solder Veropins to the other terminal points. Now test-fit the PCB in your chosen case. Drill a small hole in the front of the case, in line with PR2, to accept PR2's spindle and facilitate external 'set zero' adjustments. Drill two additional holes in the case front, to allow passage of the two pairs of 'I' and 'V' leads. You might consider taking the 'I' leads to a pair of quick-connection terminals (push-button loudspeaker type), for easy insertion of the resistor under test. Now drill the top of the case to accept SW1 and SW2 and fit these components into place. Finally, fix the PCB into the case and complete the interwiring to the switches.

Test And Use

When construction is complete, connect the two 9 V batteries to the unit, noting that B1 must be capable of supplying 100 mA, and connect the 'M' terminals to a 1 V DC meter or multimeter. Now short the two 'V' terminals together, close the test switch, and adjust PR2 to obtain a zero reading on the meter.

Next, turn SW1 to the 100R range and connect a 100R resistor (5% or better) accross the 'I' terminals. Now connect the 'V' terminals across the test resistor (on the resistor side of the 'I' leads), with like polarities to like (+ to +, etc), close the test switch, and adjust PR1 to obtain a full scale reading on the meter. The unit is now calibrated and ready for use.

The PCB is mounted so that the cermet preset can be adjusted through a hole in the case.

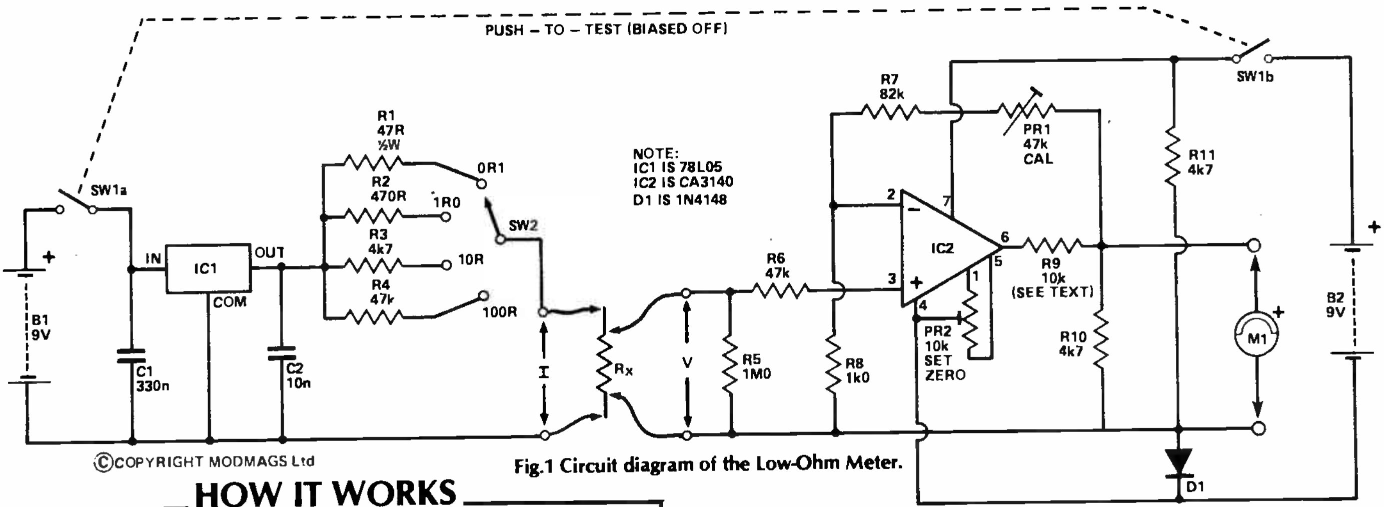


Fig.1 Circuit diagram of the Low-Ohm Meter.

HOW IT WORKS

The constant generator circuit is very simple. IC1 is a 5 V regulator and the output test current (I) is determined by resistor R1 to R4. On each range, the value of the test resistor (Rx) is very low relative to the current-limiting resistor, and the full scale test voltage (10 mV) is very small relative to the 5 volts of the regulator. Consequently, on each range, the test current is virtually independent of the effects of lead resistances, etc: on the most sensitive (100 milliohms) range (I = 100 mA), one ohm of lead resistance will introduce a maximum full-scale error of 2%. A similar lead resistance will introduce an error of only .002% on the 100R (I = 100 uA) range. In practice, therefore, the reading errors are primarily determined by the accuracies of R1 to R4.

The DC millivoltmeter (designed around IC2) is a fairly conventional design. It is based on a CA3140 op-amp, which can respond to DC inputs down to zero volts. To enable the output to go slightly negative (for zero-setting purposes), a −600 mV supply rail is generated by R11 and D1. Resistor R9 is used to limit the maximum voltage to the meter to about 2 V, to eliminate the possibility of meter damage if the unit is incorrectly ranged. The sensitivity of the meter is variable over a limited range by PR1, for calibration purposes (to compensate for test-current errors).

PARTS LIST

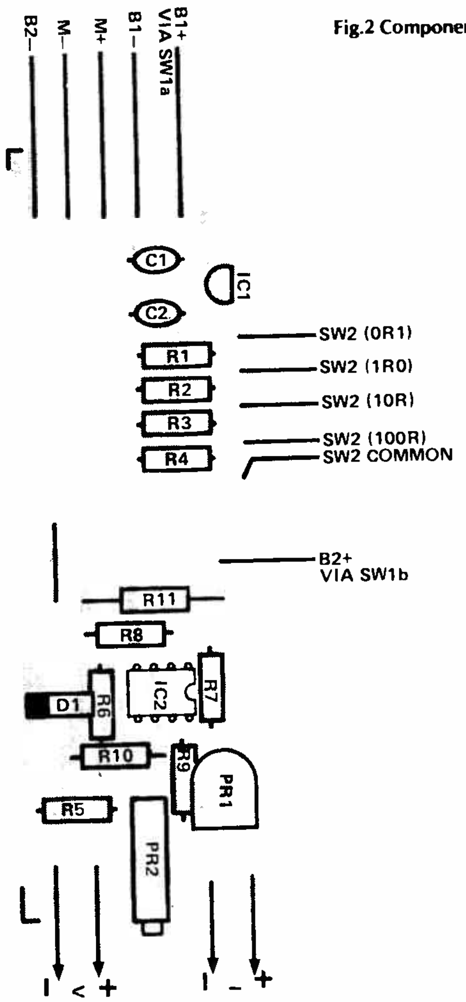
Resistors (¼W 5%, unless otherwise stated)	
R1	47R ½W
R2	470R
R3, 10, 11	4k7
R4,6	47k
R5	1M0
R7	82k
R8	1k0
R9	10k
Potentiometers	
PR1	47k miniature horizontal preset
PR2	10k ¾ inch cermet multiturn preset
Capacitors	
C1	330n polycarbonate
C2	10n polycarbonate
Semiconductors	
IC1	78L05
IC2	CA3140
D1	1N4148
Miscellaneous	
SW1	Miniature 2-pole biased toggle (normally off)
SW2	1-pole 4-way rotary switch
M1	Moving coil meter, 1 V FSD, sensitivity 100 uA or better.
Case, quick-connection terminals.	

BUYLINES

Absolutely no problems here: all components are readily available

When using the unit, note that the 'I' terminals supply a test current to the resistor being measured, and that the 'V' terminals indicate the voltage developed directly across the resistor. The 'V' terminals must therefore always be connected to the resistor 'inside' the 'I' leads, as indicated by the circuit diagram. When using the meter on its most sensitive (0R1) range, the 'I' leads should be kept as short as possible: on this range, 1R0 of lead resistance will introduce a maximum reading error of 2% on a 100 milliohm test resistance.

Fig.2 Component overlay.



ELECTRO SUPPLIES

TRANSISTORS

BC107	10p	BC237	12p	BF194	12p	BF595	30p	2N3055	45p
BC108	10p	BC337	15p	BF195	12p	BFR40	25p	2N3583	60p
BC109	10p	BC547	10p	BF197	14p	BFY90	50p	2N3702	10p
BC125B	8p	BD238	40p	BF245	30p	BUW81A	200p	2N3705	10p
BC149	10p	BD239	40p	BF256A	40p	MJE340AT	50p	2N3710	10p
BC154	12p	BD371A	30p	BF324	30p	MPF131	25p	2N4061	15p
BC159	9p	BDX94	65p	BF469	65p	MPF132	25p	2N4123	10p
BC171	10p	BDY92	120p	BF495	20p	MPU131	25p	2N4125	12p

LINEAR ICs

CA3012	45p	MC1349	90p	TAA320	40p	TDA0470	
CA3080	50p	MC1350	90p	TBA120S	60p	TDA1010	150p
LM324	60p	MC1558	100p	TBA651	100p	TDA1170	75p
LM741	15p	NE535T	50p	TBA661B	125p	TDA1190	200p
LM1458	40p	NE555	22p	TBA800	70p	TDA2524	150p
LM3900	60p	SAJ110A		TBA810S	80p	TDA2541	150p
MC1307	75p	SAS580	100p	TBA920	150p	TDA2560	150p
MC1310	100p	SAS590	100p	TCA270S	90p	TDA2581	175p

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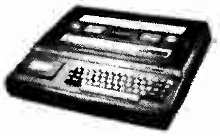

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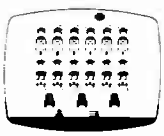

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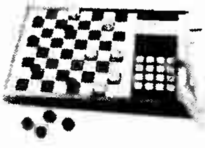

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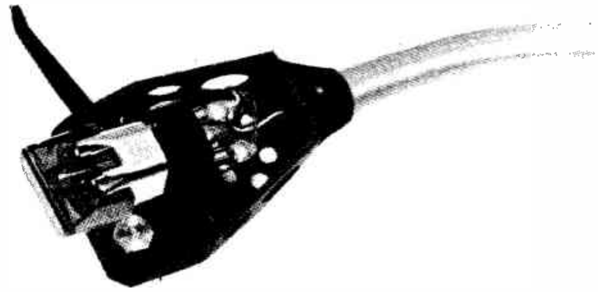


There have been many features on hi-fi in ETI. We have pondered preamplifiers. We have looked at loudspeakers. We have tested turntables. And now — Ron Harris gives you the needle!

The pickup cartridge is the smallest and most oft overlooked component in the hi-fi chain. Much debate has taken place of late as to the what, which and how of turntables and amplifiers. Speakers have also had their day in the centre of the stage, but cartridges — apart from the resurgence of the moving coil a few years back — have simply and quietly gone from strength to strength. Companies such as Goldring, Shure, Ortofon and Empire have continued to add more art to the science of music reproduction without always receiving due attention or accolade.

There have been many variations on the pickup theme. Such divergences as the electret/capacitive cartridge and the almost universal (cheap and cheerful!) piezo-electric are still for sale in most emporiums, but are of little importance to the main hi-fi market. Two main systems dominate; moving magnet and moving coil.

Both are based upon Faraday's laws of electromagnetic induction, which can be briefly, if a little impolitely, summed up as stating that if you move a magnet around anywhere near a coil of wire, you will cause a voltage to appear across that coil. The voltage will bear a direct relationship to the movement.

Elements Of Generation

Before moving on to a consideration of the important parameters and how they affect performance, let's take a look at how each of the systems work:-

1/ Moving Magnet And Induced Magnet

Figure 1 shows a very generalised view of a moving magnet cartridge. Figure 1a shows the relationship of magnet to record groove and the position of the pole pieces. Axis A allows the two drawings to be related.

As the stylus follows the groove wall the magnet transcribes a similar path, parallel to PR and at varying distance from PL. A voltage is thus generated in the coil which is directly related to the groove information.

All cartridges must be well shielded from external fields generated by such as mains transformers, as the flux changes are minute and such a field can induce an output comparable to the wanted signal. (Hence that all-too-familiar mains hum.)

The most oft employed variation upon this theme replaces the moving magnets with a single high permeability armature (usually iron). The magnets are fixed within the body, with a resulting drop in mass attached to stylus. A voltage is induced into the coils by the movement of the iron armature within the magnetic field. For this reason the technique is called 'induced magnet' or 'moving iron' and excellent examples are marketed by Ortofon and Empire amongst others.

Output levels are generally around 2-3 mV.

2/ Moving Coil

It may come as a surprise to some of the newer converts to the black arts of hi-fi to know that moving coil cartridges have a longer history than the ubiquitous moving magnet. Originally

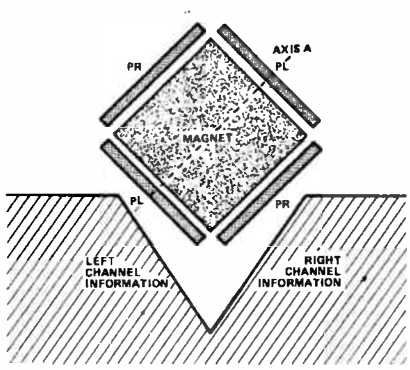


Fig. 1a The mechanical relationship between the pole pieces (which are fixed to the cartridge body), the magnet (which is attached to the stylus), and the record groove wall.

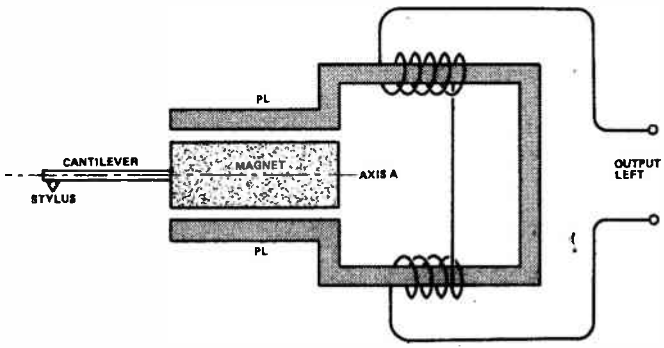


Fig. 1b Axis A can be referred to Fig. 1a to show the positioning of the generator within a moving magnet cartridge.

Strange looking things, but every home should have one. This particular point is a close-up Van der Hul stylus as employed in the Goldring G900IGC.

developed by Ortofon, their tracking-ability weaknesses and requirement for a step-up device led to their practical extinction a few years ago. However, the birth of the 'esoteric' hi-fi market and the subsequent interest of the Japanese audiophiles, has led to their virtues being prized over their vices once more.

The principle is extremely simple, and is illustrated in very general terms in Fig.2. The magnets are held in a fixed position within the cartridge body and the coils are mechanically linked to the stylus assembly. As the stylus follows the groove modulations the coils move relative to the magnets, thus generating the required signal voltages.

Output is generally lower, of the order of 0.2 mV and an extra amplification stage (step-up device) is required. However, a new generation of cartridges has arisen which utilise a far greater number of windings on the coils and more powerful magnets to generate a higher voltage level, comparable to moving magnet designs. The need for a step-up device is thus eliminated.

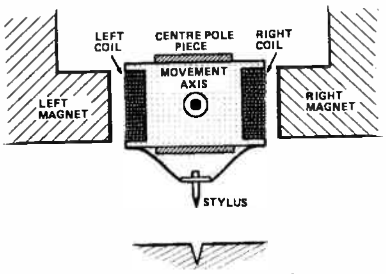


Fig. 2 Moving coil cartridge basics. As the stylus moves the coils, a current is generated within them by the magnetic field from the fixed magnets.

Two By Two

Considering the cartridge to be composed of two separate systems allows the different parameters of each to be evaluated correctly. The two systems are (i) dynamic components:- i.e. stylus, cantilever, pivot and moving generator (ii) static components:- i.e. body, fixed generator elements, electrical connections. If we define the task of the pickup as that of translating the mechanical movements produced at the stylus, by the LP, into an electrical signal for transmission to an amplifier, then we can consider the design requirements for each stage of that translation in turn.

Before proceeding, it should be noted that the pickup cartridge is an integral part of the record playing system as a whole. Many of the design parameters for the cartridge are correctly chosen to optimise the complete system under dynamic condition. In this article we cannot fully explore these interactions, but merely highlight them where they impinge upon the cartridge design directly.

Putting On The Stylus

In order to correctly interpret the record groove, a stylus must remain in contact with the groove wall, and be able to follow each and every modulation. The earliest stylus shape employed was a spherical one, simply because it was easiest to make and required least alignment. This suffered from the disadvantage of an inability to follow the highest frequencies recorded on a disc, because it will get "squeezed out" of the groove once the modulations become shorter than the length of the stylus, measured along the groove.

Elliptical stylii were introduced to overcome this by reducing that length and yet maintaining as large an area of contact with the groove wall as possible. Tracking weights had to be lower to prevent record wear increasing significantly, but the modulation tracing (tracking) deficiency of the spherical tip was overcome. Many companies have since attempted to refine this stylus configuration, with varying degrees of success. Only the Shure hyper-elliptical appears to offer any real advantage over the basic design, having an increased tracking ability and better high frequency definition.

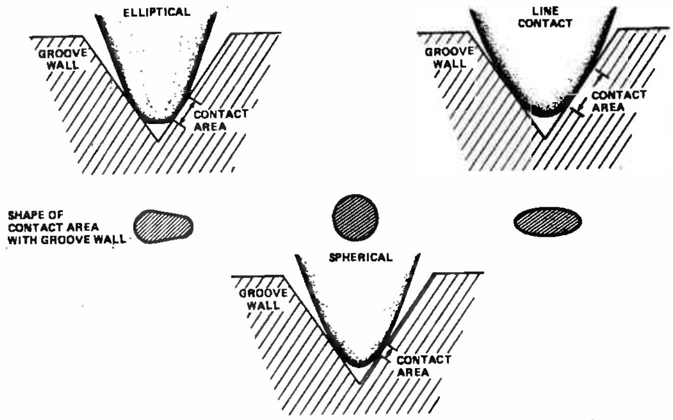


Fig. 3 The three most common stylus profiles and their relative parameters. Note that whilst the elliptical offers a greater tracking ability, its area of contact will generate increased record wear.

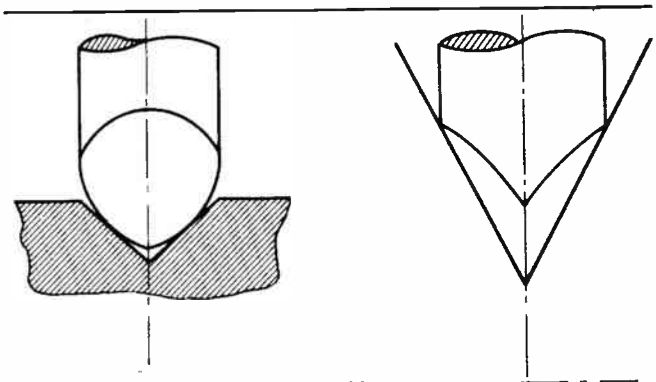
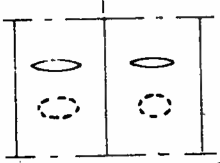


Fig. 4 Could this be the answer? Goldring's new Van der Hul point has great advantages over conventional tips, as its shape more closely mimics the cutting head and thus allows better tracking. The area of contact is also larger than for an elliptical (see small drawing).



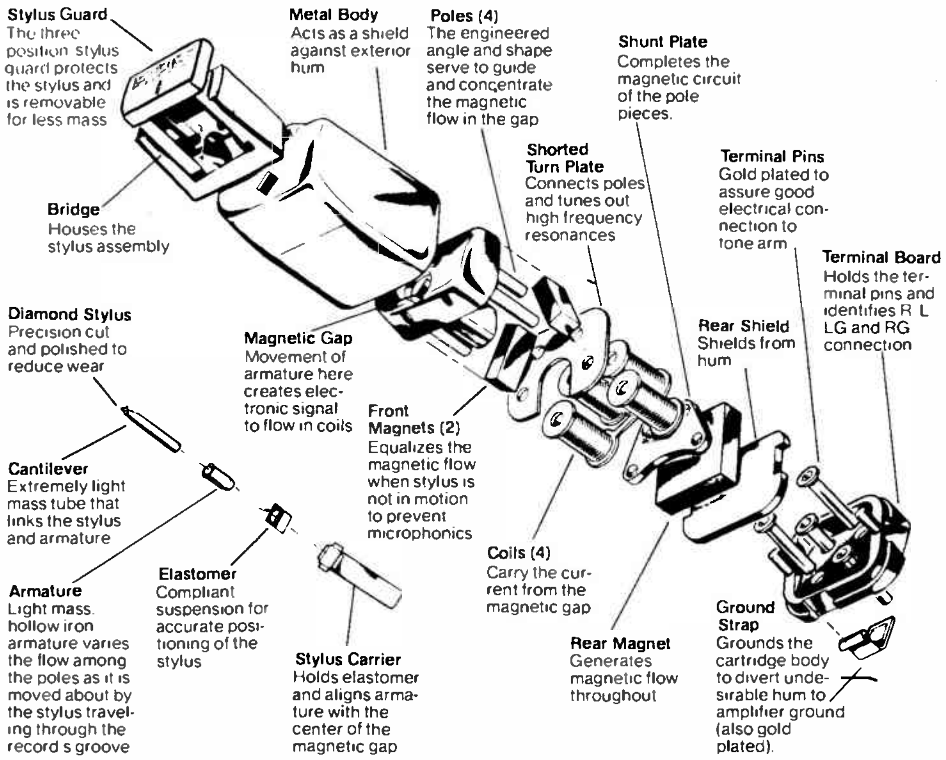
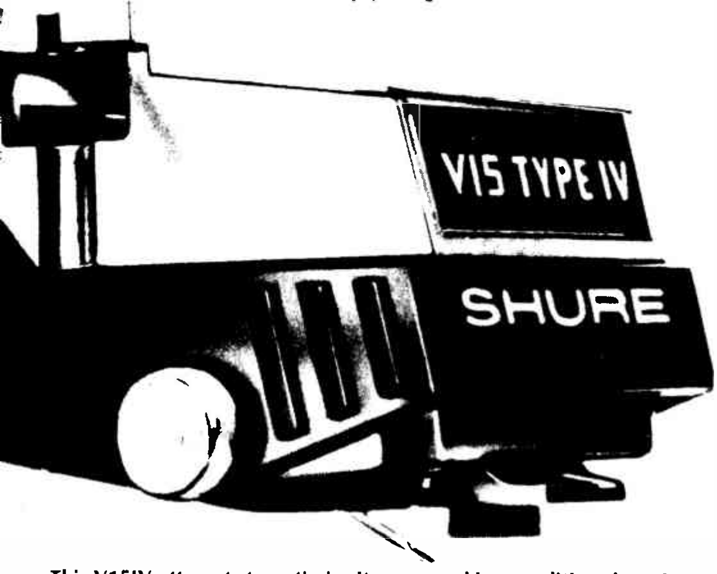


Fig. 5 This exploded view of an Empire induced magnet design gives an indication of the lengths that top manufacturers will go to in order to beat reasonances and colourations.

A still later development has been the line-contact stylus, (Shibata) which has attempted to get closer to the shape of the cutter head used in the initial production of the disc — this would obviously allow it to follow the groove more closely than anything else. Contact area would also be increased, with a resultant reduction in record wear. This type has reached its zenith with the introduction of the Goldring G900IGC cartridge and its Van der Hul stylus. It dramatically improved the performance of the G900 series and would seem, at the moment, to be closer to The Answer than anything else.



This V15IV attempts to optimise its own working conditions by using a damped, static-conducting 'rider' brush, operating ahead of the stylus. Warp effects are drastically reduced.

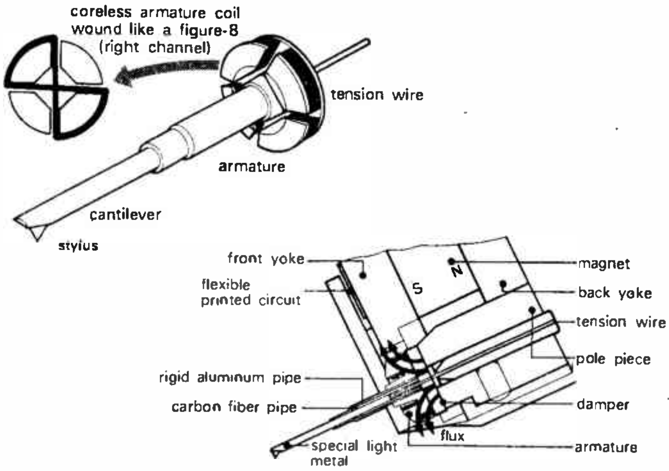


Fig. 6. A cross-section of a Sony moving coil pickup, showing how the coils are miniaturised to decrease the mass of the moving element, thus improving transient behaviour.

Cantilever Leavings

The stylus is joined to the generating element, be it coils or magnetic material, by the cantilever. It should be so attached that it tracks the disc at 20° to the vertical, (vertical tracking angle), since this is the cutting head angle and any deviation from this will be yet another source of distortion. (20° is, in fact, not yet a totally standard figure, but is the most used and best compromise figure we have).

If the cantilever were a totally rigid coupling then the pickup would be just as totally unable to produce a signal from the record, since the stylus would be prevented from moving with the groove. If it were too compliant, then the slightest warp or variation in surface would destroy the unit, with the arm mass inertia bending the cantilever out of shape.

Compliance is thus an important compromise parameter. The higher the compliance the lower must be the arm mass for the correct operation. This is because, like any mechanical system, the two working together will possess a resonant frequency — i.e. they will move easier at one frequency than any other, producing a non-linear response. Since the usable audio band extends approximately from 20 Hz-20 kHz and disc warps generally produce a signal somewhere around 6 Hz the ideal compromise is to place the system resonance between the two.

Combinations of compliance and arm mass are chosen to achieve this aim. Low mass pickup arms score a few points here as mass is easily added to these to 'tune' the resonance to an ideal frequency. If an arm is too heavy for a particular cartridge then there is little that can help — short of a hacksaw! For that reason alone, I tend to favour the SME Series III for all but a couple of cartridges — and those are low compliance, low output, moving coil designs, for which there exist specially designed carriers.

Compliance is normally measured in Compliance Units or CU where 1 CU = 1×10^{-6} cm/dyne.

Damping For All

All cartridge cantilevers are 'damped' to some extent, to control the resonances of the system. Some companies eg Ortofon (in the MC30) employ a complex mechanical linkage to overcome both the low frequency resonance and that at around 18 kHz — way at the other end of the spectrum — excited by the interaction between the record itself and the stylus. It is this resonace, and how successfully it is controlled which, more than any other single factor, determines how well a cartridge will audition.

A large number of factors are involved here; the mass of the stylus tip itself, the length of cantilever, compliance, damping of the pivot and the mass seen by the stylus reflected back from the arm through the cantilever, ie the effective mass of the system. It is an unfortunate fact that the better solutions to the problem are all expensive, which is why cartridges continue to cost a comparable amount of money, per ounce, to precious metals.

Generators

In the case of moving magnet designs the requirement for the fixed coils is fairly straightforward. The vast majority of amplifiers carry a 47k input, which is designed to accept these units. This makes electrical matching a fairly simple affair. The greatest source of contention will be the level of capacitance that the cartridge will be subjected to as a load. Too high a value will act as an HF filter and 'dull' the cartridge sound significantly. Too little will subjectively boost the treble, giving increased noise and a harsh brittle sound. Manufacturers always specify a capacitance value at which their unit performs best and this should be rigidly adhered to. Add about 150pF, for arm leads, to the input value of the amplifier and adjust by adding capacitors if necessary — ±15% will generally be close enough.

Some units, such as Grado are uncritical to a great extent, whilst others, eg Goldring, will have their subjective performance jeopardised if the value is not adjusted properly.

Moving coils present a more involved problem. The output here is too low to be connected directly to a conventional pickup, and so too is the impedance, so the step-up device must act as a buffer stage as well as providing the gain needed to allow normal usage. Impedance levels are of the order of 10-40R and as the device is essentially a current generator, noise will be a problem if matching is not precise. Again the easiest way around this is to stick with the manufacturer's recommendations as to which unit performs best with his cartridge.

High-Outputs

The latest generation of moving coil cartridges employ a generator technique which obtains outputs of around 2 mV, allowing their direct connection to a standard input. The coils in these models are generally wound with many more turns of wire to produce a higher voltage from the same magnetic field strength. The impedance is also 'padded' by this technique to improve matching. However, the resultant unit 'gain' has led some companies into problems with hum induction and electrical matching difficulties, despite their precautions.

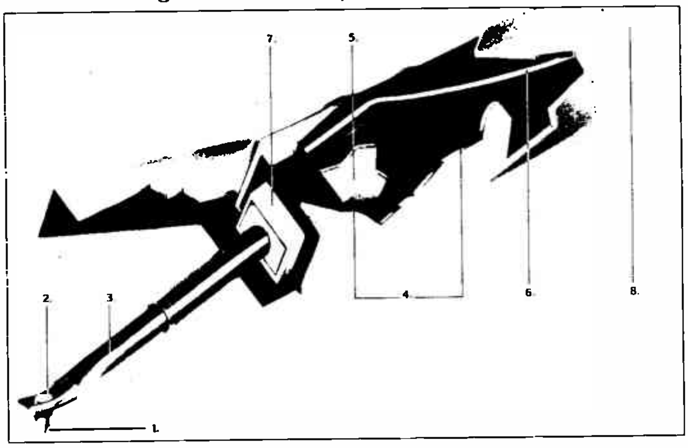


Fig. 7. So you thought cantilevers were simple? Take a look as this Shure version:- 1. Full diamond stone, meticulously shaped and polished, then assembled into an accurately machined mounting. Hyperelliptical in the V15 Type IV; hyperbolic in the M24H; biradial (elliptical) in the V15 Type III, and spherical in the V15 IV-G. 2. Doubly secure mounting — aligned, the diamond is first fitted into its socket, then high-temperature cemented to ensure permanent geometric orientation. 3. Ultra-thin-wall stylus shank — telescoped structure in V15 Type IV for low mass. Beryllium interior control lever in V15 Type III, M24H, M95 Series, M75 Type 2, and M91 Series for rigidity where needed to prevent tracking errors. 4. Viscoelastic suspension block — the efficient "heart" of the bearing which defines the pivot point of the stylus. In the V15 Type IV and M24H, a two-function bearing system separately optimized for high frequencies and for low frequencies. 5. High-energy magnet with electro-machined aperture for exact positioning of stylus shank. Pivot location ensures minimal contribution to effective mass of moving system. 6. Precisely adjusted, resonance-free support wire. 7. Pivot control — correct location and function of bearing and support wire ensured. 8. Stylus assembly carrier — placement of stylus assembly relative to pickup coils within cartridge body is optimised. Not so straightforward really, is it?

Ultimo produce perhaps the best known examples of high-output moving coils and they are also renowned for requiring very high capacitive loading, well in excess of the levels normally found in amplifier circuits. *Correctly* loaded, though they possess a very high sound quality and avoid the need (and expense) of a step-up device altogether.

Conclusions

Summarising briefly then, a cartridge has to extract the mechanical information from the record groove without passing on any appreciable vibration to the pickup arm if possible, and translate this into as faithful an electrical signal as possible; it must not be affected by warps or distortions in the vinyl surface; it must be impervious to electrical fields produced by motors, transformers etc and, ideally should be totally insensitive as to which pickup arm it is used in.

Any cartridge which met those requirements could be safely described as perfect, and whilst we are unlikely ever to have such a unit offered for sale, some of the approximations we do have are really incredible engineering achievements when you consider the difficulties involved, — whether you happen to like the sound of them, or not! **ETI**

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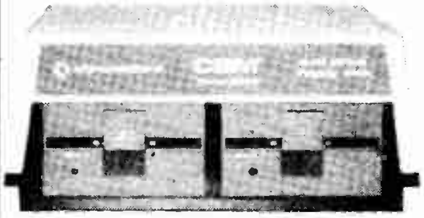

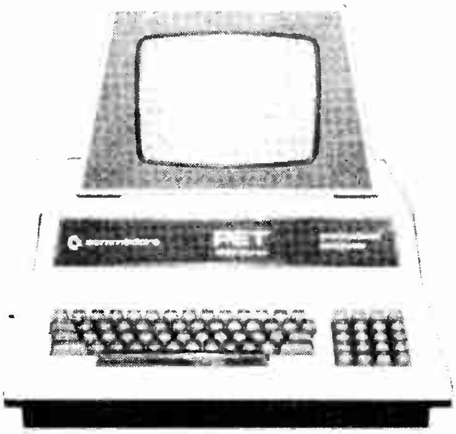

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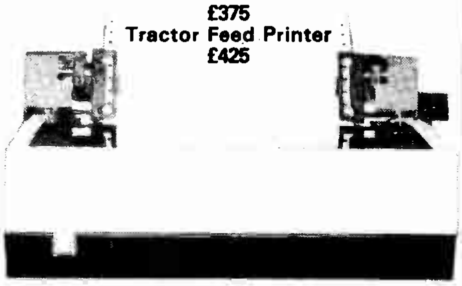

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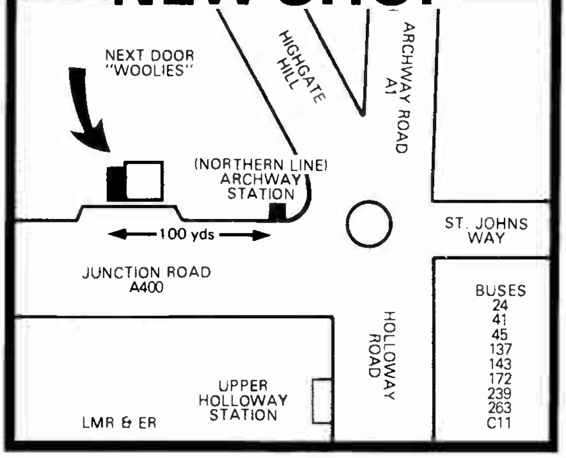

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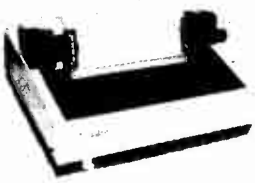

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MUSICAL BOX

Built in an evening, this project can provide hours of fun for kids of all ages, and illustrates charge pump principles. Guaranteed to break the ice at parties (the box has sharp corners). Design and development by Ray Marston.

This neat little novelty project contains a variable-frequency master tone generator and a variable-rate gate oscillator, both activated by a single built-in mercury tilt switch. The output of the tone generator is fed directly to a miniature acoustic transducer (sound generator); the frequency of this generator slowly rises when the tilt switch is open or slowly falls when it is closed. The gate oscillator is used to pulse the master tone generator on and off. Its operating rate is proportional to the switching rate of the tilt switch; the rate decays slowly towards zero when the tilt switch takes up a stable state.

Thus, if the unit is gently tilted downwards, a rising tone is generated; tilt the unit upwards, and a falling tone is produced. Give the unit a gentle shake and the tone will be pulsed on and off at a slow rate. Shake the unit vigorously and the pulse rate will rise to a high value. In all cases, the tone can be increased or decreased by suitably tilting the unit. A whole range of sounds can be produced by shaking and/or tilting the unit.

The unit is housed in a pocket-sized 'flip-top' black case. The unit's on/off switch is mounted directly on the PCB, access to the switch being gained by flipping open the case top. The unit is powered by a single PP3 battery.

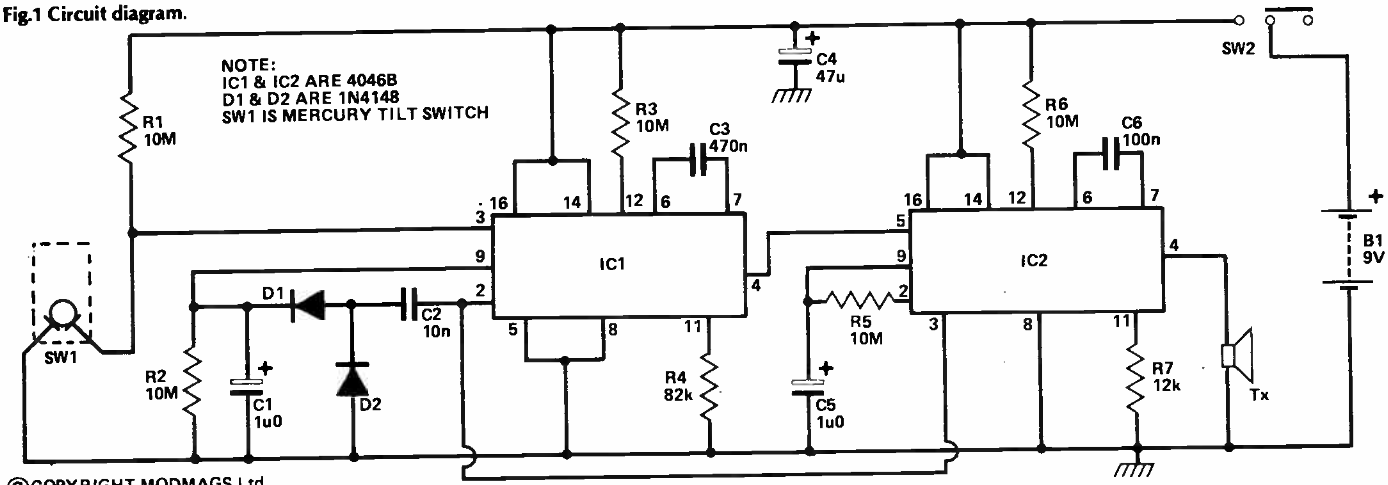
Construction

This is a very easy project to build, since all of the circuit's components (including the battery and the acoustic transducer) are mounted directly on a single PCB. The PCB is designed to fit into the Verobox mentioned in the list of components.

When building the unit, note that the two CMOS ICs should be mounted in suitable sockets. Other points to note are that two bridging links are used on the board and that the mercury tilt switch is fixed by soldering it to Veropins (see photograph). On/off switch SW2 is a sub-miniature PCB-mounting type, soldered directly to the board. Don't solder the transducer leads yet.

When construction is complete, fix the acoustic transducer (Tx) to the underside of the PCB (below the large unetched copper area) with double-sided sticky pads. Now pass the transducer leads through the hole near the centre of the board and solder them in place. Fix the PP3 battery in place on the PCB, again using sticky pads. Now fix the completed PCB into the specified case, after first drilling a large hole in the case below the position of the acoustic transducer. Finally, switch the unit on, snap the lid shut, give it a shake, and sit back and enjoy the sounds.

Fig.1 Circuit diagram.



HOW IT WORKS

The circuit contains two wide-range voltage-controlled oscillators (VCOs), each built around a 4046B IC, together with a mercury tilt switch and some switch-conditioning circuitry. The two oscillators are basically similar, their frequencies being determined by the input voltage on pin 9 (of the 4046B ICs) and by the values of the capacitors/ resistors connected to pins 6, 7, 11 and 12.

The 4046B ICs contain a variety of elements in addition to the VCOs. In our circuit, the most important of these is an EX-OR gate which, in our application, is wired as a simple pulse inverter with its input at pin 3 and its output at pin 2. We use these inverters as part of the switch-conditioning circuitry.

The mercury tilt switch is wired to the input of the built-in inverter (pin 3) of IC1: the output of this inverter (pin 2) is connected to the input of the inverter of IC2. If the tilt switch is opened, these two inverters cause the pin 2 voltage of IC2 to switch to a high value, so C5 starts to charge up via R5, thereby causing the VCO in IC2 to generate a rising tone signal in the acoustic transducer. When the tilt switch closes, pin 2 of IC2 switches low, causing C5 to discharge via R5 and so generating a falling tone.

The inverted switch output of IC1 (pin 2) is also fed to a charge pump circuit (designed around C2-D1-D2-C1-R2), which causes a small amount of charge to be fed to C1 each time that the tilt switch activates. This charge leaks away slowly via R2, so that the mean voltage of C1 is proportional to the rate at which the tilt switch is operated or shaken. The C1 voltage is used to control the VCO frequency of IC1, and the output (pin 4) of this IC is used to gate the VCO of IC2 on and off via pin 5.

Thus, the operating frequency of IC2 is controlled by tilting the mercury tilt switch and the pulse rate is controlled by shaking the switch.

PARTS LIST

Resistors (all ¼ W 5%)	
R1,2,3,5,6	10M
R4	82k
R7	12k
Capacitors	
C1,5	1u0, 16 V electrolytic (PCB-mounting)
C2	10n polyester
C3	470n polyester
C4	47u, 16 V electrolytic (PCB-mounting)
C6	100n polyester
Semiconductors	
IC1,2	4046B
D1,2	1N4148
Miscellaneous	
SW1	mercury tilt switch
SW2	sub-miniature PCB-mounting slide switch
Tx	PB-2720 transducer
Verocase, order no. 202-21317	

BUYLINES

The only unusual components here are the mercury tilt switch and the acoustic transducer. The transducer is available from Ambit International.

The tilt switch used in our prototype is available, to order, from Watford Electronics.

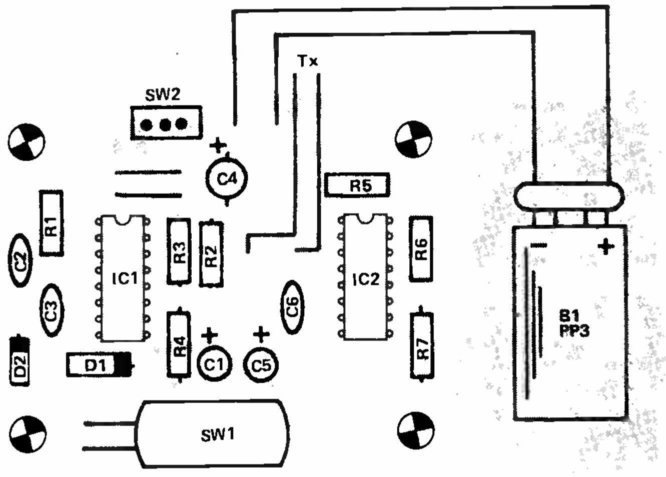
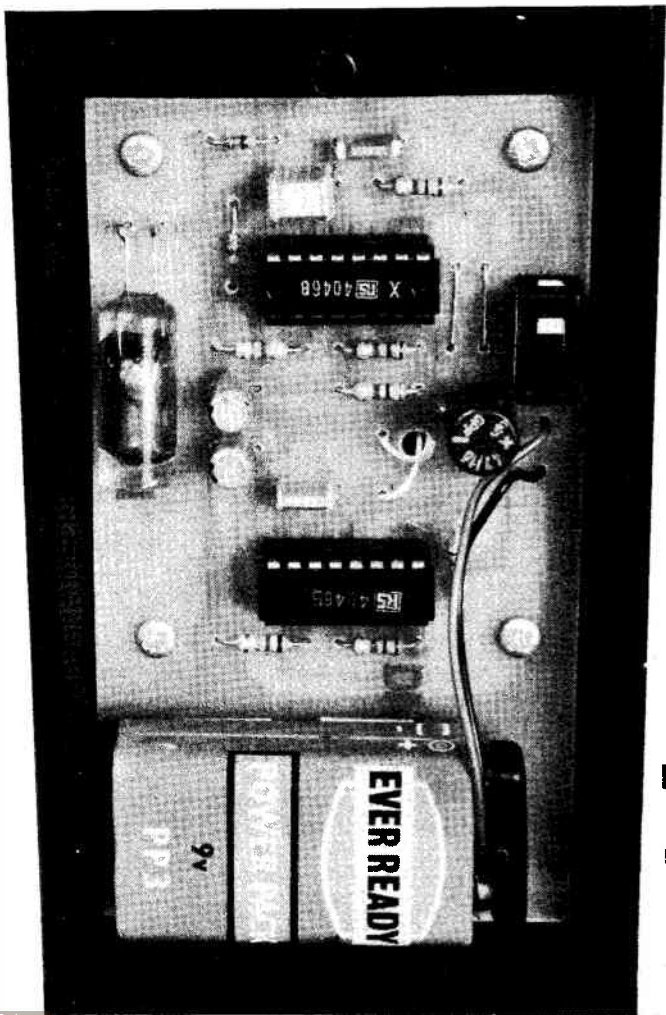


Fig.2 Component overlay for the Musical Box.



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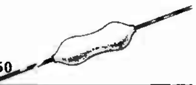

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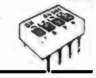

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Specification	PFA80	PFA120
Bandwidth	10Hz—	100KHz± 1d8
Output power RMS into 8Ω	80W (Vs=± 50V)	120W (Vs=± 55V)
T.H.D. from 1w to rated output at all audio frequencies	⩽0.008%	⩽0.005%
SNR	120d8	120d8
Slew Rate	20V/µs	20V/µs
Gain	X22	X22
Rin	30K	30K
Vs max.	± 70V	± 70V
Cost		
(built)	**£15.95**	**£22.85**
(kit)	**£13.95**	**£20.85**

Simple modification for bridge mode

POWERFETS

	CHAN	VDS max V	ID max A	PDISS max W	Price
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8D522	N	60	1.5	10	**85**
VMP4	N	60	2.0	25	**1250**
VN10KM	·N	60	0.5	1.0	**60**
VN64GA	N	60	12.5	80	**750**
VN67AF	·N	60	2.0	15	**80**
2SJ49	P	140	7.0	100	**340**
2SK134	N	140	7.0	100	**340**

· L/p protected. † our selection. VN/VM 120-page Design Cat. **45p.** Heat clips/sink TO202 **12p.** TO92 **8p.** TO3 **35p.**

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CA3086	**55p**	TL081	**29p**	709	**15p**
CA3140E	**45p**	TL082	**55p**	710	**25p**
DAC08EN	**250p**	2102	**80p**	733	**50p**
DM2502	**565p**	2114	**340p**	741	**18p**
HA12017	**80p**	40018	**17p**	78L06	**29p**
HA1397	**195p**	4007	**17p**	78L12	**29p**
LM3900	**43p**	40118	**17p**	78M05	**39p**
MC3401	**30p**	40138	**40p**	78M12	**39p**
NE529	**145p**				

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See next month's issue for more on the PFAs or send SAE for details.

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Specification

B.W.	20Hz-30KHz± 1d8
THD at rated o/p	0.003% type
SNR	85d8 (ref. 5mV RIAA) 105d8 (ref. 100mV flat)
Vs	± 20V
Output	1V (clips at +20d8)
Cost	
(built board less controls)	**£4.75,** 2 needed for stereo

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5	BC251	TO92	Plastic	PNP
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5	BC160	TO39	Metal	PNP
5	2N3055	TO3	Metal	NPN
2	BD312/MJ2955	TO3	Metal	PNP
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2	TIP30-32	TO220	Plastic	PNP
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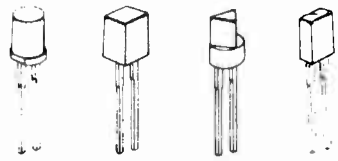

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403	0.33uF 16v	**0.11**	416	1uF 35v	**0.12**
404	0.47uF 16v	**0.11**	417	.22uF 35v	**0.12**
405	0.68uF 16v	**0.11**	418	.33uF 35v	**0.12**
406	1.0uF 16v	**0.11**	419	.47uF 35v	**0.12**
407	2.2uF 16v	**0.12**	420	.68uF 35v	**0.12**
408	3.3uF 16v	**0.13**	421	1.0uF 35v	**0.12**
409	4.7uF 16v	**0.14**	422	2.2uF 35v	**0.13**
410	6.8uF 16v	**0.15**	423	3.3uF 35v	**0.15**
411	10.0uF 16v	**0.16**	424	4.7uF 35v	**0.18**
412	22.0uF 16v	**0.28**	425	6.8uF 35v	**0.30**
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SE9031	NPN	80v	80v	10A	1000	TO220	**0.95**
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SE9401	PNP	-80v	-80v	10A	1000	TO220	**1.10**
TIP115	PNP	-60v	-60v	2A	1K	TO220	**0.40**
TIP117	PNP	-100v	-100v	2A	1K	TO220	**0.50**
TIP120	NPN	60v	60v	5A	1K	TO220	**0.60**
TIP121	NPN	80v	80v	5A	1K	TO220	**0.65**
TIP122	NPN	100v	100v	5A	1K	TO220	**0.68**
TIP126	PNP	-80v	-80v	5A	1K	TO220	**0.70**
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MICROBASICS

Having dealt with the hardware, Microbasics now takes a look at its use. Programmers aren't born, they're.... programmed? A.P. Stephenson explains how.

Programming entails far more than the mechanical mastery of the BASIC language. However cunning you are with the IF/THENs, however nifty with the FOR loops, however subtle with ON GOTOs and however flashy your attack on the keyboard, you can remain in a time-wasting rut unless all this brilliance is tempered with self-discipline.

The media in general and the American TV slush programs in particular would have us believe that programmers have an IQ of three figures and walk about with glazed eyes and swollen brains. This is absolute codswallop. The primary attribute required of a programmer is patience. The secondary attribute is a strong sense of method.

A programmer must also have compassion. Consideration for the poor wretch who must use the program afterwards is not always taken as seriously as it should be. Rather paradoxically, this compassion should also be directed inward. A month or so can elapse between the start and finishing date of even moderately sized programs, at the end of which the details of the structure seem to be indelibly printed in the mind... a dangerous and often entirely false assumption. A year after writing it, scrutiny of the listing may fail not only in recalling to mind how the thing works but in many cases may not even be recognised as one's own work! Superficially, this would appear to be unimportant. It worked when I wrote it so why the hell does it matter if I can't understand it now? This is a comforting philosophy if the program was perfect, complete, covered all possible variations and was immune to constructive criticism. The probability of this is about as remote as finding a farmer who confesses to making a profit. In truth, any program will eventually reveal annoying deficiencies or omissions with the result that modifications are reluctantly forced upon the original masterpiece. It is at this time that the programmer may wish a little more care had been taken in the original version. A few more REMarks, perhaps, or a few less purposeless GOTOs all over the place... in short, a little more compassion.

A programmer must also be willing to learn from others. To put it more bluntly, you must not be afraid to cheat a little by indulging in controlled plagiarism. Programs in magazines should be studied for novel twists, clever little short cuts or elegant new solutions to old problems. Most 'inventions' are ninety-nine percent other peoples' ideas, plus perhaps a few additions or rearrangements. The same applies to programs.

For example, the well known trick used in the PRESS ANY KEY TO CONTINUE situation:

```
200 GET K$ : IF K$ = "" THEN 200
```

must have been invented by somebody and yet we all use it at times. But this is obvious you might say. So is the safety pin *now*, but the 'inventor' is alleged to have made a fortune. There is of course a respectable middle of the road approach between blatent stealing of an entire program (perhaps with a few pathetic attempts at disguise by changing the names of a few variables) and complete avoidance of all previous ideas.

A programmer should be familiar with the programming language. This should be self-evident but surprisingly is not always the case. It is easy to become hooked on a small subset of the language and neglect some of the keywords because they are difficult to understand. The string handling keywords LEFT$, RIGHT$, MID$ AND STR$ are particularly neglected in BASIC and even subscripted variables are sometimes shunned. Before embarking on any ambitious project, any weaknesses in this area should be patched up by re-reading the manual and practising at the keyboard. Learning to program is like learning to play the piano. You practice difficult exercises even if they sound boring.

Last but certainly not least, a programmer must be dedicated. Once a program has been started, whatever difficulties arise, it must be finished. Shelving a program because it becomes difficult is disgraceful, pretending it was due to the usual 'lack of time' is worse. Unfortunately, it takes some time before you acquire an instinct for assessing the 'complexity potential' of a given programming project. However dedicated, it is no good carrying on if the project turns out to be beyond your capabilities. There is a balanced midway approach between dedication and pigheadedness which can only come with experience.

Before Sitting At The Keyboard

Serious works on programming have traditionally sneered at the thought of 'writing' a program at the keyboard. The correct approach, we are told, is to first draw the flowchart and then the coding on paper... only then should we sit at the keyboard. Whilst agreeing with the general principle, it is a little hard to stick rigidly to such idealistic advice. In the days when the main (or usually the only) peripheral was the printer and the keyboard was operated under time-sharing disciplines it was too expensive on paper and computer time to monopolise the keyboard for trial-and-error programming techniques. In the modern era of the personal computer the situation is easier and the advice can be taken less literally. However, it is advisable to scribble out a rough flowchart outlining the strategy to be employed before the bout of keyboard bashing.

Regarding flowcharts in general, there appears to be a growing doubt as to their usefulness in some quarters. It has even been suggested that most programmers write the program *first* and the flowchart *afterwards* just to please the academic Establishment. In other words the flowchart is used to explain how the program *was* designed rather than as a prelude to the actual design. The structure of a flowchart is beginning to show basic changes. A new idea entirely is superseding the old scheme. Thus, the flow in the new flowchart is from left to right with progressively more detailed levels of 'explanation' beneath. If you are experienced, the first left — right level is sufficient without assistance from lower levels. An idea of the difference between the old and the new can be gained by examining Fig.1 and Fig.2.

Deeper levels of even greater detail can be shown if desired. This leads on to the idea of structured programming which is a set of rules and regulations which advanced programmers are now expected to use when they are part of a team. Anyone interested should buy a book on the subject if they want to get with it!

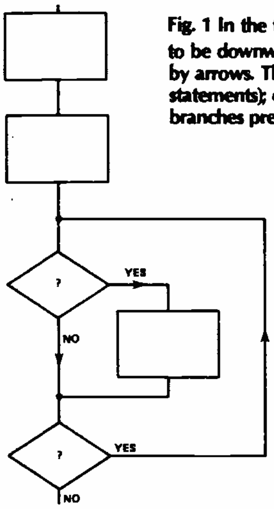

Fig. 1 In the traditional flowchart, data flow is assumed to be downwards or the right unless otherwise indicated by arrows. The diamonds are decision elements (IF/THEN statements); complex programs with many decision branches present a rather confusing appearance.

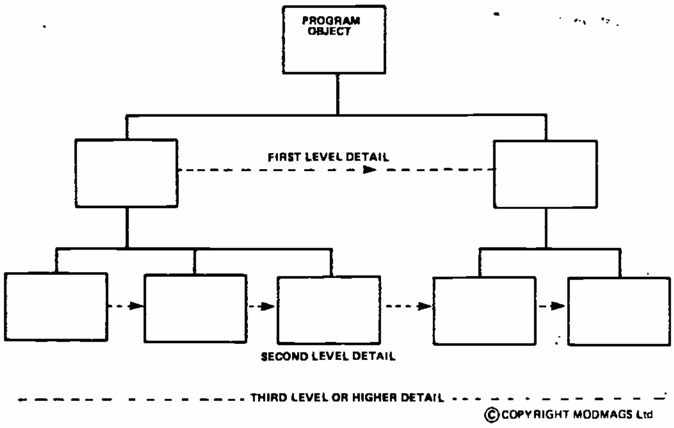

Fig. 2 In the modern flowchart, flow is only from left to right (the arrows shown are normally omitted). The different levels of detail simply 'explain' how the level above is programmed. If you are clever, the crude first level is sufficient to understand the program structure; the second level merely explains more fully how the first level works.

Back to earth again. Get hold of a folder, preferably a loose leaf ring binder, and collect vital pieces of information such as POKE numbers and codes, hex to decimal conversion tables, an abridged BASIC keyword list, the memory map (and in particular, the screen memory map), cuttings from magazine articles etc. etc. But watch the Parkinson syndrome. The binder can get fatter and fatter and particular information more and more difficult to locate as the collection grows. Be ruthless and periodically spit out the muck which, in this sense, means anything you now KNOW.

One final piece of advice. . . have some scrap paper and a pencil by the side of you. Once you get locked-on to a computer keyboard, it becomes an effort of will to get up and search for a pencil. Consequently you will try to memorise GOTO line numbers and almost certainly forget them once the listing scrolls back.

Starting At The Keyboard

Rule 1. Always have a blank (or rubbish) tape in the cassette, fully rewound, and another by the side. As soon as a reasonable segment of the program has been entered and roughly proved, get it onto tape and rewind it again. Then place the other tape in the cassette and continue with another segment and then tape it. The reason for this advice is based on the following possible hazards:

a. another member of the household or workshop, unacquainted with the volatile properties of RAM may suddenly decide to unplug the PET in order to use the iron!

b. the current segment you are working on has been the subject of an improvement. . . but a bug shows up and you get lost. Frantic efforts to remember the pre-modified version to get back to safety often fail miserably.

Under these conditions the advantage of a "fall-back" tape is obvious. By continually swopping the tapes as the program progresses, each one being a proven update of the last, much frustration can be avoided without the expensive assistance of the psychiatrist.

Rule 2. Risking the charge of advertising, PET owners should save up and get the PROGRAMMER'S TOOLKIT. This is without doubt the most useful aid to programming the PET you are ever likely to meet. Once you have used it, it appears to be indispensable. No more ragged line number sequences. No more endless searches to discover which variables have been used and which haven't. The ability to append subroutines to programs on tape is a joy to behold and operate. All this at seemingly lightening speed and idiot-proof in operation. (This should bring me a crate of whisky at Christmas).

One word of advice regarding the RENUMBERING facility. Avoid renumbering too many times during program development. This is not due to any technical reason but to the erasure of previously memorised GOTO line numbers. The TOOLKIT changes all the GOTO and THENs accordingly but it doesn't change your memory with it! As far as possible, renumber *after* the last bug has been hurled out of the system.

Developing The Program

There are no rules. . . just keep pegging away until you have 'finished'. To finish a program is perhaps the most elusive of all the arts. The elusive nature is seldom due to unexpected difficulties in the actual programming. It is a self-inflicted elusiveness resulting from, on the one hand a growing confidence, and on the other a dissatisfaction with the original terms of reference. The original moderate aim gathers momentum and the 'end' is pushed further and further away, the number of lines grow and grow, the number of variables increase, the facilities offered are increased until the bomb bursts with a polite but spine chilling message. . . "OUT OF MEMORY ERROR IN LINE 2.597E25".

The moral from all this can be summed up in one sentence: Decide the aim, stick to it, write it, debug it, test it, save it and switch off.

Testing The Program

After the crude bugs have been cleared and the programmer is satisfied with it, the real testing should now begin. It is necessary to enlist the aid of an independent guinea pig with no prior knowledge of computer keyboards. The luckless individual should be persuaded (or forced) to sit down and operate the program. Signs of consternation should be noted and the offending message from the screen should be earmarked for amendment. It is an astounding law of nature that if the message. . . "PRESS ANY KEY TO CONTINUE" meets the eye of certain guinea pigs, their diabolical little finger will jab at the STOP or the SHIFT LOCK keys; this in spite of there being about seventy other keys to assault. If you subsequently change this to PRESS SPACE BAR, the very size of the thing seems to make it transparent to the gaze and the eyes will be seen to oscillate wildly as they search for a key marked "SPACE BAR". The air usually becomes charged with emotion, sarcasm is freely interchanged between programmer and guinea pig, at times even escalating to full scale military activity. It is all very disappointing and sad for anyone trying to become a programmer. But don't let that discourage you. **ETI**

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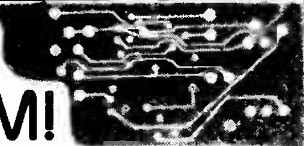

MILLIONS OF JOBS ARE THREATENED, BUT MILLIONS MORE WILL BE CREATED

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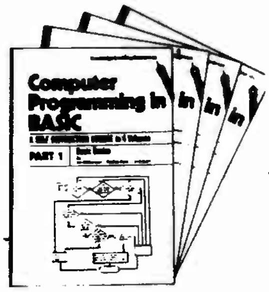

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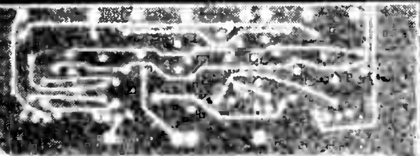

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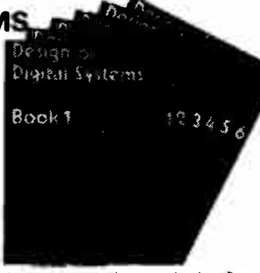

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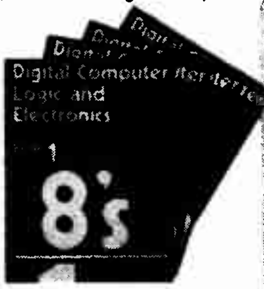

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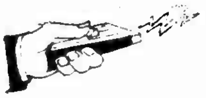

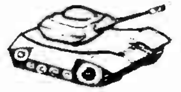

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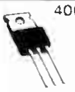

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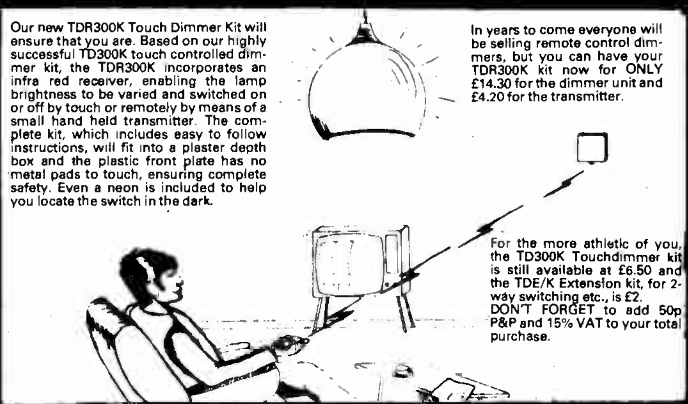

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	4.7	14p			
	10	20p			

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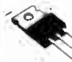

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BC212L	[illegible]	2N3442	90p
BC337	18p	2N3819	20p

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NOISE GENERATOR

Despite what the average audiophile will tell you, noise can be useful. This noise generator with sample and hold facility is the basic building block for Project 80 sound effects. Design and development by Charles Blakey.

Noise sources are essential for the synthesis of many sounds. These range from musical instruments, such as pipe organ and percussive devices, to natural sounds like wind, rain and surf, and to man-made sounds such as steam engines, explosions and gunfire. The 80-12 module provides white noise, which has the characteristic hissing sound, pink noise, which is deeper in intensity, and a low frequency noise (sometimes referred to as red noise). The low frequency noise may also be used as a random modulating source.

A sample and hold circuit, also incorporated, allows external sound sources to be sampled and converted into control voltages for, say operating a VCO. The sample and hold unit, therefore, provides a means by which the synthesiser can play itself.

Noisy Networks

In this design white noise is produced by reverse biasing an NPN transistor, since this method produces a wide bandwidth. The main problem with this technique is the low amplitude of the noise and often the need to try several transistors to attain the desired amplitude. This has been largely overcome by using a two stage amplifier, IC1a and IC1b, which allows the overall gain to be varied between about 100 to 5700 times. As an additional safeguard the transistor is mounted in a socket to facilitate trying other devices, should the amplitude prove insufficient. White noise is defined as having equal energy per cycle and pink noise equal energy per octave. To derive the latter requires the white noise to be filtered at — 3 dB/octave and, since filters usually have slopes of 6 dB/octave, a 3 dB type has to be approximated. Note that other variations in noise colouration may be obtained by filtering the white or pink noise with Project 80 filters 80-6 or 80-7. The low frequency noise is obtained by low pass filtering the pink noise using a 6 dB/octave filter with a cut-off frequency of about 16 Hz (constructed around IC1d). The white and pink noise outputs will be in the range 5-10 V p-p while the low frequency noise is 10 V p-p.

The sample and hold circuit uses the principle of gating a FET, Q2, on and off and storing the sampled voltage on C16, which is buffered by voltage follower IC5b. FET gating is achieved using a CA3140E, configured as a comparator such that a positive clock pulse will cause it to go high (about 13 V) and allow the signal through to be stored on C16. When the clock pulse is near zero, IC4 will swing to about -14 V and gate the FET off. If the signal being sampled is varying rapidly in amplitude, it is essential that the clock pulse be short otherwise the output will not be in discrete steps but will follow the variations in signal amplitude while the clock pulse is high.

The internal clock in the 80-12 uses a CMOS 555 timer whose sampling rate may be varied from about 1 cycle per 4.5 S to 25 Hz. The pulse width is adjustable and the output from the clock, buffered by IC3, is available for use as, say, a synchronising trigger on an ADSR. Provision is made for using an external clock and the pulse output from the 80-2 VCO or 80-3 VCLFO is suitable.

Achieving the desired results depends on the clock rate and the amplitude of the signal being sampled. The latter may be attenuated by RV2. Additionally, when using a VCO as the clock, the pulse width is another variable for special effects.

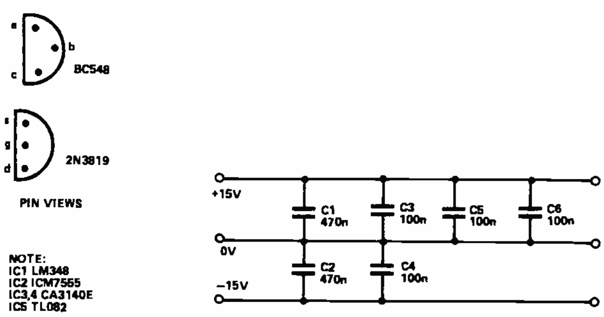
PROJECT 80 NEWSFLASH: Due to considerations of space and time, the final Project 80 module, a combined effects unit (containing an external Input Interface and Dual Ring Modulator), the system keyboard and the keyboard controller will now be available in a booklet at the end of February. To get your copy send a cheque or postal order for £2.95 (including postage and packing) to: ETI/Project 80, 145 Charing Cross Road, London WC2H 0EE.

Construction And Setting Up

Setting up the noise generator is simply achieved by adjusting PR1 to obtain the desired amplitude. This may be done in three ways: (a) using a DMM on the white noise output and adjusting PR1 until a reading of about 1V8 to 3V2 is obtained on the AC range; (b) using an oscilloscope and observing the white noise output while adjusting PR1 to obtain a peak to peak output of 5-10 V; or (c) connecting the output of the low frequency noise at R16 to a DC voltmeter and adjusting PR1 until occasional readings of about - 7 V are obtained when observed over a period of a few minutes. With most analogue meters the above readings will be approximately halved. With some transistors it may be possible to obtain the correct amplitude of the white and pink noise by increasing the gain with PR1, but the amplitude of the low frequency noise will be too high. In the latter circumstances the best approach is to try another NPN transistor rather than alter the value of R14.

Only one adjustment is required in the sample and hold section, namely, to adjust PR2 to obtain a short pulse output from the internal clock based on IC2. This adjustment should be made in the following sequence:-

a) Connect the low frequency noise output to the signal input of the sample and hold with RV2 fully clockwise.



b) Connect the output of the sample and hold to a VCO with the coarse frequency control set to mid position and one of the waveforms connected to an amplifier.
c) Set RV1 (clock rate) to about 75% rotation which should give a sampling rate of about 2-3 Hz.
d) Turn PR2 fully anti-clockwise and switch power on.
e) After a few seconds delay slowly turn PR2 clockwise until the VCO output starts changing frequency in a step-wise manner.
f) Finally check that the VCO continues to change step-wise over the full range of the internal clock (RV1) and if necessary turn PR2 further clockwise until this is achieved.

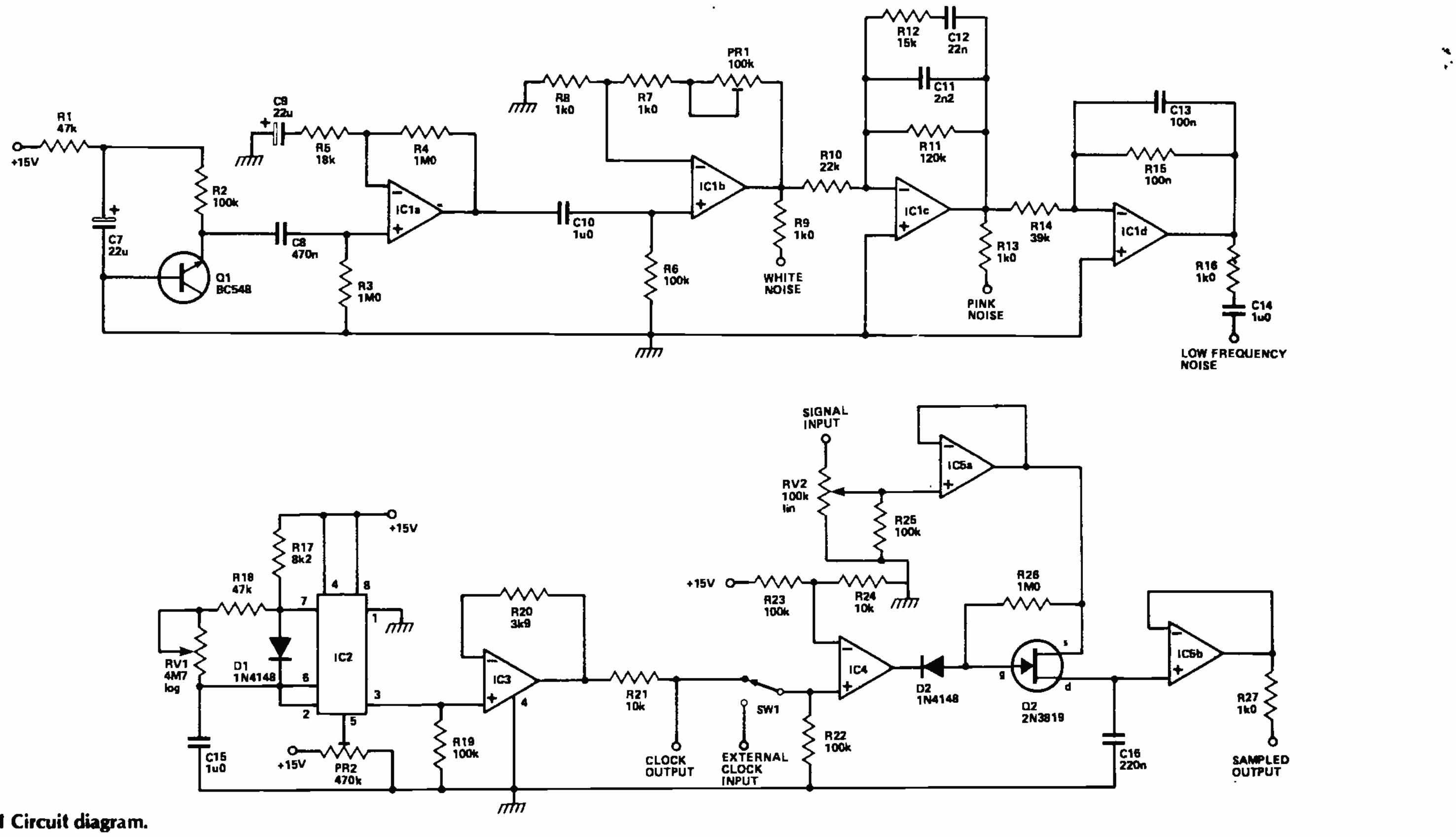


Fig.1 Circuit diagram.

HOW IT WORKS

Reverse biasing the NPN transistor, Q1, will generate noise at its base-emitter junction. The few millivolts of noise at the output of Q1 has to be amplified to the levels required for the synthesiser and this is achieved with two AC coupled non-inverting amplifiers configured around IC1a and IC1b. The gain of IC1a is fixed at about 56 while the gain of the IC1b amplifier may be adjusted from 2 to 102 by means of PR1. The overall gain of the amplifier section may, therefore, be varied from 113 to 5760 times. The amplified white noise is available via R9.

To obtain pink noise it is necessary to filter the white noise by -3 dB/octave and a close approximation over the audio range is obtained with the active filter built around IC1c. R11 and C11 form a first order low pass filter with a cut off frequency of 663 Hz, while R12 and C12 are an augmenting integrator which has an output proportional to the input signal added to an output proportional to the time integral of the input signal. The frequency response of the latter is relatively flat above about 1 kHz and below this frequency the incoming signal is attenuated at a rate of 6 dB/octave. The combination of R11/C11 with R12/C12 achieves the -3 dB/octave response and the pink noise output is available at R13. The low frequency noise is obtained by using a first order low pass filter with a cut off frequency of about 16 Hz and this is obtained with IC1d, R15 and C13 with the output being available via R16 and C14.

In the sample and hold network a signal is applied to the source of FET, Q2, via IC5a configured as a voltage follower and whose signal input may be attenuated by RV2. When Q2's gate is positive, the signal passes through and the voltage present at the signal input will change the voltage on C16 accordingly. If Q2 is gated off the last voltage on C16 is held, since leakage is kept low by buffering it with a voltage follower based on IC5b. By sampling the input for only very short durations, the voltage on C16, available at R27, will be a series of discrete steps which may in turn be used to control voltage controlled modules. The negative to positive voltage transition for gating Q2 on for sampling is obtained with IC4 configured as a comparator. With a near zero voltage at the non-inverting input of IC4 its output will be close to the negative rail voltage of -15 V and Q2 will be off. When a positive pulse is applied to the non-inverting input then IC4 goes positive (about + 13 V) and turns on Q2 so that a sample of the signal voltage can be taken and stored on C16. The internal clock used to turn Q2 on and off via IC4 is based on CMOS 555 timer, IC2. The pin configuration and operational features are the same as a bipolar 555 but the CMOS version has advantages in terms of power consumption and absence of crowbarring the power supply during the output transition. A conventional astable configuration is used and, while D1 allows a wide range of duty cycle, the main adjustment for the latter is the application of a positive voltage to its control voltage input, pin 5, via PR2. The output of the timer is buffered by IC3 so that it may be used for external synchronisation purposes. The output also goes via an SPDT switch, SW1, to comparator IC4. The switch allows external clock sources to be used.

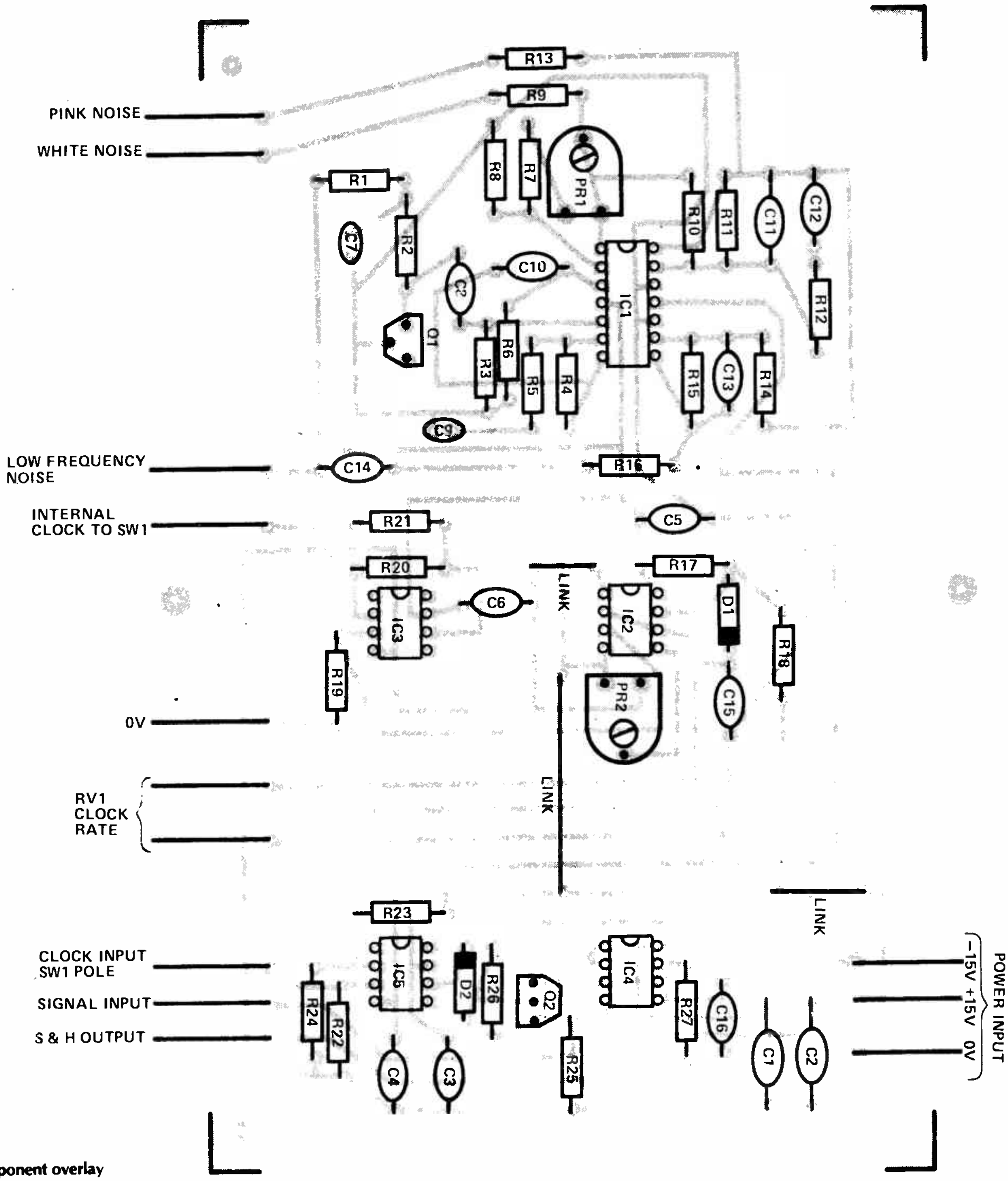
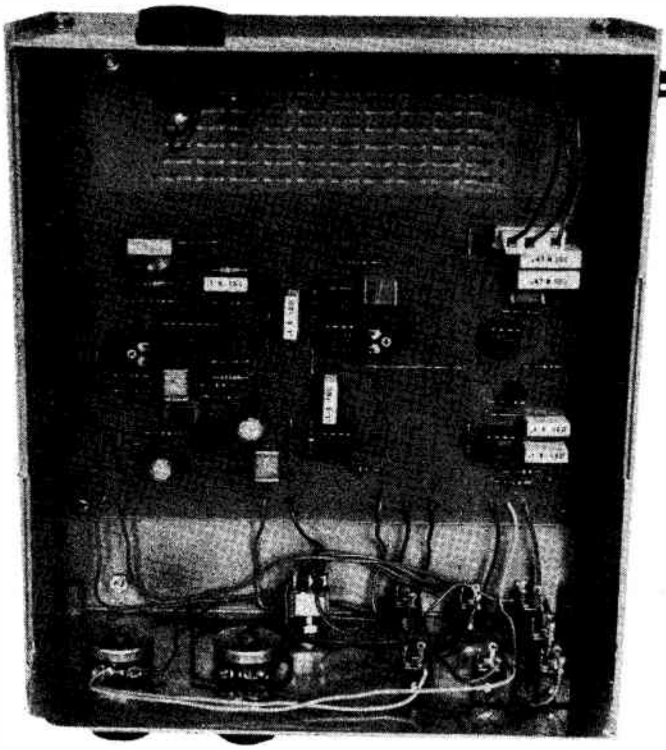
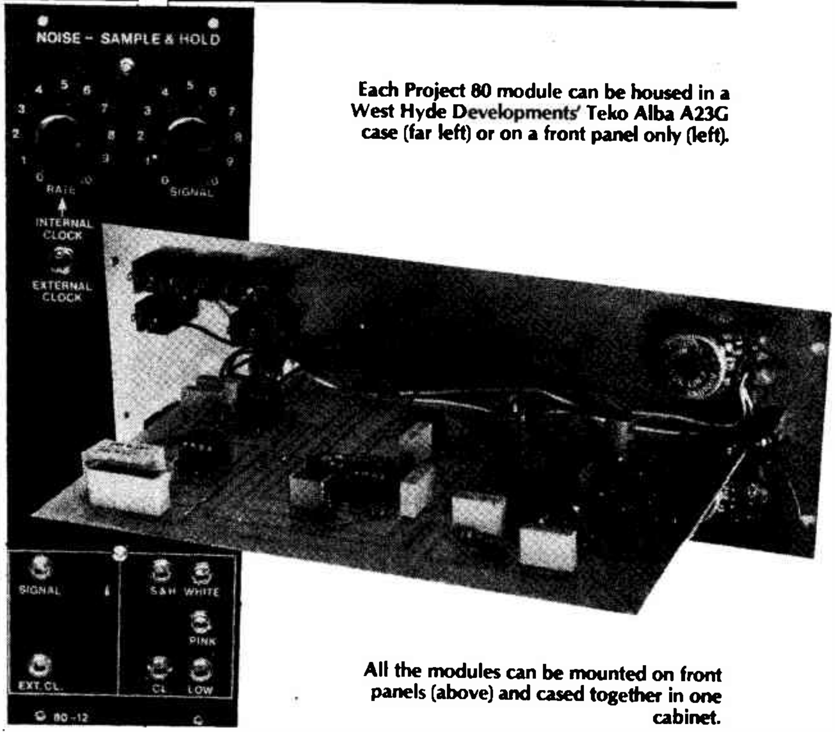


Fig.2 Component overlay

PARTS LIST

Resistors ¼ W 5% carbon		**Capacitors**		**PR1**	**100k carbon**
R1,18	47k	C1,2	470n polyester	PR2	470k carbon
R2,6,15,19,22,23,25	100k	C3,4,5,6,13	100n polyester	**Semiconductors**	
R3,4,26	1M0	C7,9	22u 25V PCB electolytic	IC1	LM348N
R5	18k	C8	470n MKH polyester	IC2	ICM7555 IPA
R7,8,9,13,16,27	1k0	C10,14,15	1u0 MKH polyester	IC3,4	CA3140E
R10	22k	C11	2n2 polystyrene	IC5	TL082 CP
R11	120k	C12	22n polycarbonate	D1, 2	1N4148
R12	15k	C16	220n MKH polyester	Q1	BC548
R14	39k			Q2	2N3819
R17	8k2	**Potentiometers/Trimmers**		**Miscellaneous**	
R20	3k9	RV1	4M7 linear	SW1	5PDT miniature toggle
R21,24	10k	RV2	100k linear	Transistor holder	





Each Project 80 module can be housed in a West Hyde Developments' Teko Alba A23G case (far left) or on a front panel only (left).

All the modules can be mounted on front panels (above) and cased together in one cabinet.

BUYLINES

The 80-12 Noise Generator — Sample & Hold module is available as a kit with PCB and all listed components for £13.17, inclusive of postage and VAT, from Digisound Limited, 13 The Brooklands, Wrea Green, Preston, Lancs. PR4 2NQ.

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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

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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

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3X010	6+6	6.64
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

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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
4X028	110	1.09
4X029	220	0.54
4X030	240	0.50

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TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
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
5X028	110	1.45
5X029	220	0.72
5X030	240	0.66

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TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
6X014	18+18	6.25
6X015	22+22	5.11
6X016	25+25	4.60
6X017	30+30	3.75
6X018	35+35	3.21
6X026	40+40	2.81
6X028	110	2.04
6X029	220	1.02
6X030	240	0.93

300VA — *110mm dia. x 50mm, Weight 2.6 Kg* — £12.27
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TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
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
7X028	110	2.72
7X029	220	1.36
7X030	240	1.25

500VA — *140mm dia. x 60mm, Weight 4 Kg* — £16.35
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TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
8X017	30+30	8.33
8X018	35+35	7.14
8X026	40+40	6.25
8X025	45+45	5.56
8X033	50+50	5.00
8X028	110	4.54
8X029	220	2.27
8X030	240	2.08

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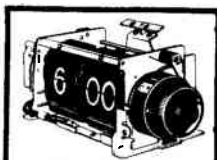

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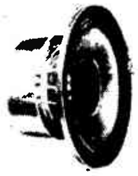

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DESIGNER'S NOTEBOOK

Certain elementary safety precautions must be taken when handling CMOS ICs or designing CMOS circuits. Ray Marston explains all in this month's 'Notebook'.

Early CMOS ICs earned a reputation for being easily damaged by static electricity, either when being handled or when being soldered into circuit boards, etc. Subsequently, manufacturers tried to overcome this 'fragility' problem by providing the ICs with extensive built-in input and output protection on each gate in each package. These protection networks do a fairly satisfactory job, but provide the design engineer with a few extra problems when designing CMOS circuits. This month's Notebook takes an in-depth look at the subject.

CMOS Protection Networks

CMOS ICs are, by definition, Metal-Oxide Semiconductor devices, in which the input signal is applied to the near-infinite impedance (about 10^{12} ohms) of the metal-oxide gate. Typically, the gate oxide has a breakdown voltage of about 80 V: if a gate oxide break-down does occur, the resultant damage to the device is catastrophic and irreversible. To protect the CMOS against excessive input voltages (particularly arising from static energy), all modern CMOS ICs are provided with extensive built-in protection on all inputs and outputs.

Figure 1 shows the standard protection network that is used on the vast majority of B-series CMOS devices. Here, all diodes marked as 'D1' are used to prevent the input or output from swinging more than 600 mV below the V_{SS} (0 V) rail, and all diodes marked as 'D2' are used to prevent the input or output from swinging more than 600 mV above the V_{DD} (supply positive) rail. D3 is intended to prevent the V_{DD} terminal from swinging negative to the V_{SS} pin (electrostatically) when the device is being handled.

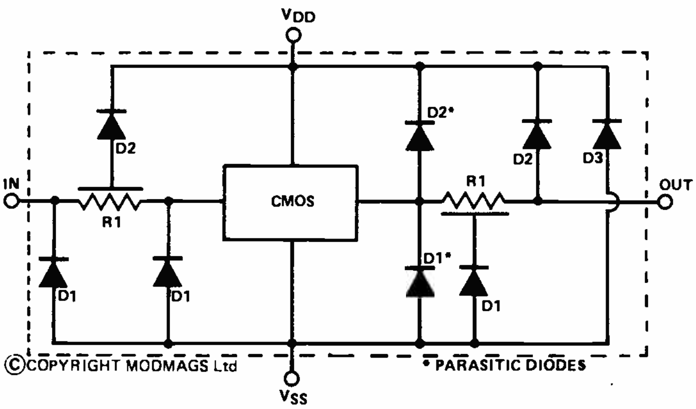


Fig. 1 These are the standard electrostatic-discharge protection networks used on most B-series CMOS ICs. The two diodes associated with the resistors are distributed across the entire resistance, as shown.

There are a couple of minor exceptions to the standard version of the protection network. One of these is the type used on the 4049B and 4050B series of hex buffer/converters which, as shown in Fig. 2, have their inputs free to swing well above the V_{DD} rail. These particular ICs are specifically intended for use in logic-level conversion applications, in which (for example) the input may come from a 12 V CMOS network but the output and the IC supply rail are matched to a 5 V TTL network.

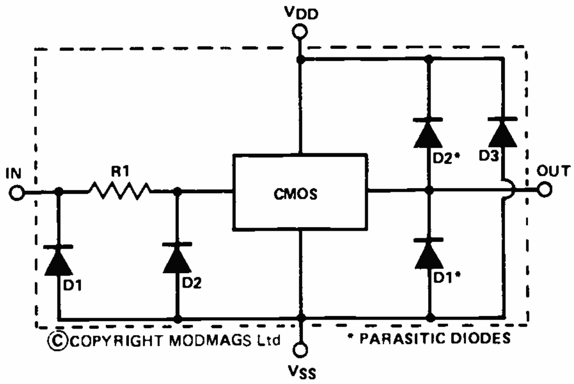


Fig. 2 This protection network is used on the 4049B and 4050B hex buffers. Note that the input is free to swing above the positive supply (V_{DD}) rail.

Another exception is the 4066B type of transmission gate or bilateral switch, and its equivalents. These devices comprise a bilateral electronic switch and a switch-control network. In these circuits, all switch-control networks have the type of input protection shown in Fig. 1, but the switches themselves have the simple protection network shown in Fig. 3.

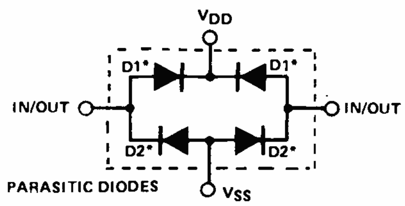


Fig. 3 The 4066B quad bilateral switch has standard B-series protection on its gate control input terminals, but has this simplified form of protection on its 'switch' elements.

Note in Figs. 1-3 that all diodes marked with asterisks are 'parasitic' devices, which just happen to occur fortuitously as an inherent part of the CMOS manufacturing process, while all other diodes are specifically designed into the circuits. Also note that the networks are intended only to give protection against 'normal' electrostatic discharge voltages. When the networks are subjected to ordinary DC signals, the diodes are liable to burn out if their forward currents exceed 10 mA or so, thereby causing possible catastrophic damage to the IC substrate.

Major CMOS manufacturers such as RCA reckon that an electrostatically charged human body can be approximated by the circuit of Fig. 4, in which the 'body' has an effective capacitance of 100pF and a source resistance of 560R. The manufacturers have carried out extensive tests with this model by charging the 'body' to various voltages and then discharging it (via the 560R series resistor) into different terminal combinations (input, output, V_{SS}, V_{DD}) of CMOS devices to establish worst-case capability figures for the three types of electrostatic-discharge protection networks. It should be noted in these tests that the 560R series resistor acts as a current-limiting voltage dropper, so the voltage actually reaching the CMOS device is far lower than the initial electrostatic voltage.

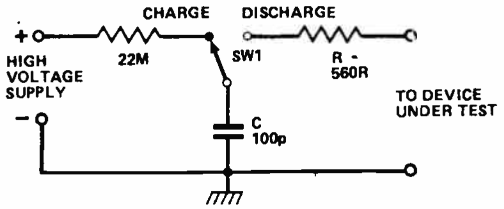


Fig. 4 Manufacturers use this equivalent-body discharge network when evaluating the capabilities of their CMOS protection networks.

The results of the manufacturer's protection capability tests are shown in Fig. 5. As you can see, the standard protection network can withstand a 4 kV electrostatic discharge. A quick calculation shows, however, that this represents a peak protection-diode current of several amps, yet we've already seen that these diodes can withstand DC currents of only 10 mA or so. Puzzled?

PROTECTION NETWORK	WORST – CASE CAPABILITY
STANDARD B–SERIES	4 kV
4049B AND 4050B	1 kV TO 2 kV
4066B BILATERAL SWITCH	<800 V

Fig. 5 These are the worst-case capabilities of the three different CMOS protection networks, when tested with the network of Fig. 4.

Up The Junction

Just about the only way of destroying a diode is to literally vaporise its junction, and this can only be done by applying an adequate amount of power for sufficient time for the melting process to take place. Since a junction must inevitably be formed on a substrate, which has a finite mass, all junctions inevitably have a certain amount of thermal inertia and are, in fact, destroyed by energy overloads (power-time product), rather than by simple power overloads.

Consequently, it is quite normal to find that a diode rated at 1 A (for example) can, in fact, withstand brief current surges up to several hundred amps. Similarly, CMOS protection diodes, which have very low DC current ratings (10 mA), can withstand very high levels of surge current (several amps), provided that the surge current duration is very brief. Figure 6 shows the typical surge current capabilities of these protection diodes. Remembering that the 100p — 560R 'human body' equivalent circuit has a time constant of a mere 56 nS, it no longer comes as a surprise to note that these diodes can withstand several amps of peak current from a 4 kV discharge!

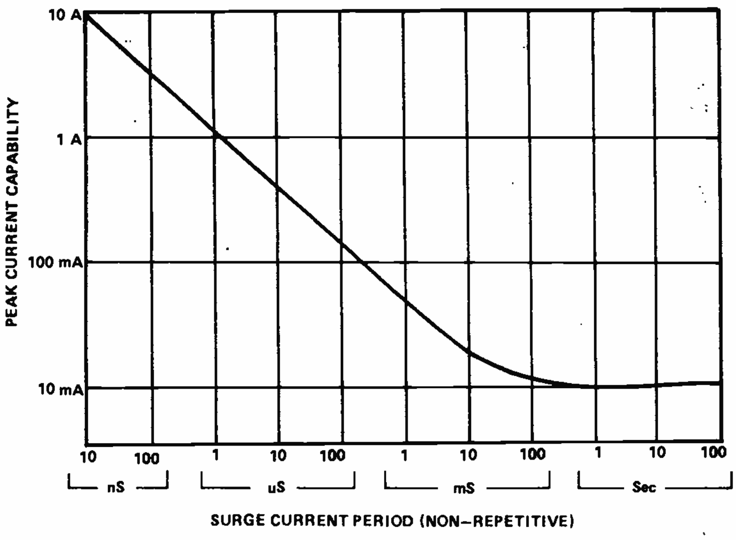


Fig. 6 Typical surge-current capabilities of CMOS protection diodes.

CMOS Circuit Design

By now you will have gathered that you can effectively destroy a CMOS device by simply blowing one or more of its 'protection' diodes with a DC current as low as 10 mA. Consequently, when designing CMOS circuits, precautions must be taken to ensure that excessive diode current cannot flow in the CMOS chips.

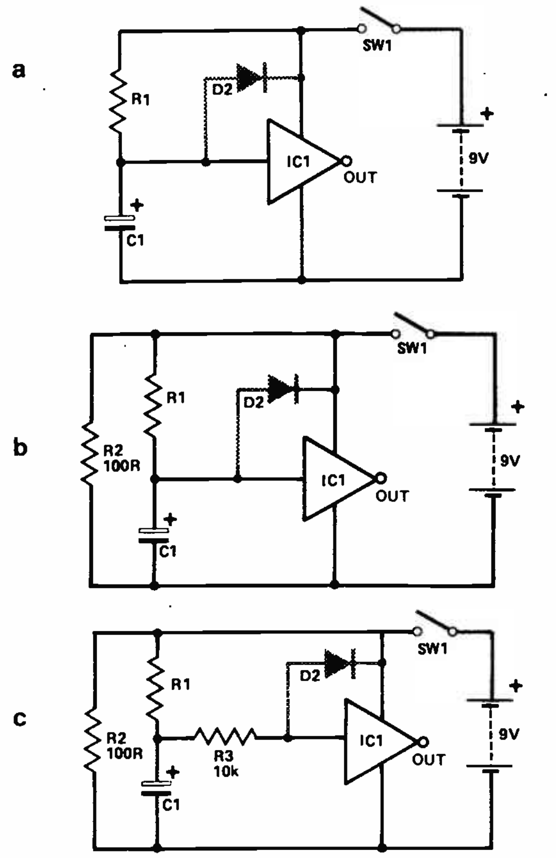


Fig. 7 Circuits (a) and (c) are safe, but circuit (b) will almost certainly cause a front-end 'blow'. See text for explanation.

CMOS ICs can be 'blown' by excessive signals applied to either the input or the output terminals. If several CMOS stages are cascaded, empirical experience shows that a front-end blow will usually destroy only a single device (because low energy levels are normally involved), but a rear-end (output) 'blow' will often have a ripple effect (because high energy levels are involved) and cause the destruction of all ICs in the chain.

The most common cause of front-end 'blow', and its cure, are illustrated in Fig. 7. Here, a capacitor is connected directly between the IC gate and the 0 V line: when SW1 is closed, the capacitor charges up via R1 and eventually attains the full positive supply potential. When SW1 is opened (to switch the circuit off), C1 tries to discharge via D2, the 'upper' input protection diode of the gate.

In the Fig. 7a circuit, the only discharge path for C1 is via D2 and the IC's supply terminals; consequently the discharge currents will be quite low and the IC will probably suffer no damage. In Fig. 7b, on the other hand, a 100R resistor is connected across the supply terminals, so C1 will try to discharge to ground via D2 and R2, and the resulting 90 mA peak current will almost certainly result in the destruction of the chip. In practice, R2 may well take the form of various resistors and semiconductor devices distributed throughout the total circuit.

Figure 7c shows the cure for the Fig. 7b design problem, a 10k resistor wired in series with the gate to limit the C1 discharge currents to a safe value. Whenever you design CMOS circuits and have to connect a capacitor between a gate and the 0 V rail, always make sure that the capacitor discharge current is limited to a safe value, either by a series gate resistor or by some other factor.

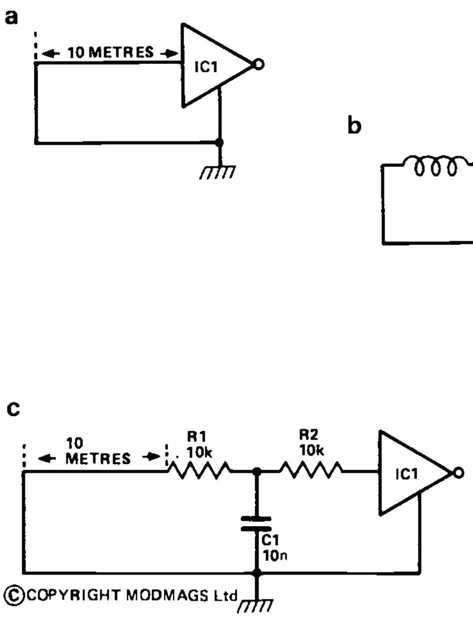


Fig. 8 Long input cables, as in (a), can be equivalent to an inductor (b), and present another front-end blowing hazard. The cure is simple (c).

Figure 8 illustrates another possible cause of front-end 'blowing', and its cure. In Fig. 8a, it seems that the IC's input is safely grounded by the 10 m of input cable (in practice, this cable may go to a low impedance sensor, etc), but in actual fact (Fig. 8b) this cable will inevitably be inductive and can easily pick up unwanted radiation and possibly feed destructive signals to the IC input. Figure 8c shows that the circuit can be rendered safe with a simple filter (R1-C1) and a series gate resistor (R2).

Back-end Blowing

The most common cause of back-end blowing is unexpected back-EMFs (from inductive loads) reaching the CMOS output by breaking through from power-driving circuitry.

Inductive loads, such as relays, can generate surprisingly large back EMFs as their fields collapse at switch-off, as can be proved by connecting a relay in the 'buzzer' mode shown in Fig. 9. Typically, a 12 V relay will generate a back-EMF of about 300 V! If you ever use CMOS to switch a relay or other highly inductive load using a transistor driver, always protect the transistor with a pair of 1N4001 diodes connected as shown in Fig. 10a. If you want to be really safe, you can use another pair of similarly-connected diodes to directly protect the output of the CMOS stage, as shown in Fig. 10b.

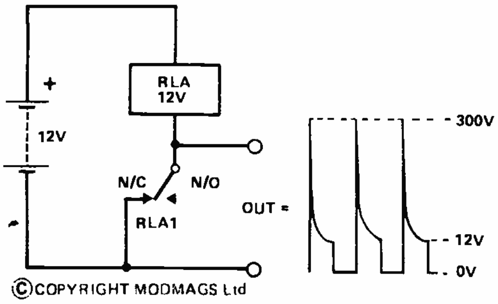


Fig. 9 This 'buzzer' circuit can be used to check the magnitude of the back-EMF from a relay. 300 V is typical!

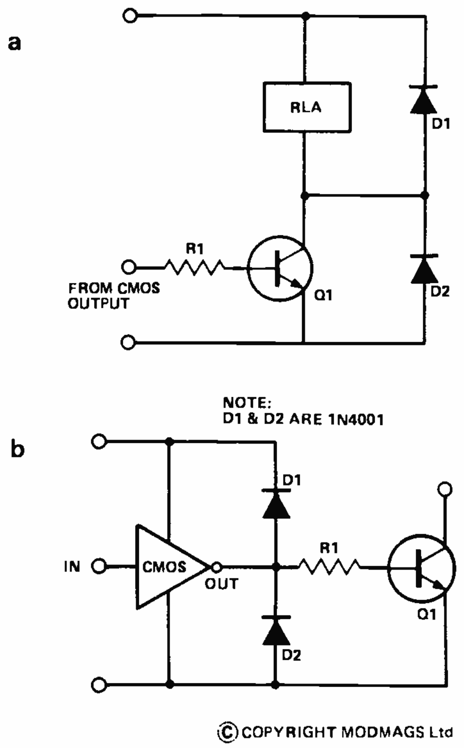


Fig. 10 (a) A transistor relay-driver can be protected with a pair of diodes. (b) The output of a CMOS stage can be given added protection with a similar arrangement.

ETI

ASTROLOGUE

Ian Graham looks at NASA's aeronautical research and answers a common Astrologue inquiry.

Say NASA and most people think of rockets and moonshots. One side of NASA's activities that doesn't hit the headlines is its aeronautical research. The work falls into four categories:

Proof of concept — flying hardware to prove a theory eg the X-series of research aircraft.
Extension of the art — building upon the contemporary state of the art.
Future needs — meeting broad and far-reaching research goals.
Problem solving — trouble-shooting design problems.

The research reaches into almost every aspect of aviation — fluid physics, propulsion, materials, structures, electronics and human factors, all of which came together to support the development of safer, environmentally compatible (quieter and pollution-free), fuel-efficient aircraft.

Flying Circus

Testing out the drawing board ideas has brought some weird machinery into existence. The Bell Tilt Rotor Research Aircraft can, as the name implies, tilt its engines vertically and take off like a helicopter. Once off the ground, the rotors tilt forward into the horizontal attitude and, together with the fixed wing, generate lift in the normal way. This programme is aimed at developing more advanced vertical and short take-off and landing aircraft for use in difficult airport areas where long runways and shallow glide paths are impossible. They could also be a regular feature of future 'bus-stop' airports close to city centres.

Pivoting Wings

We naturally expect aircraft to be symmetrical vehicles. The port wing is always swept back at the same angle as the starboard wing. An aircraft with one wing swept forward and one swept back wouldn't fly. Wrong! Several decades ago, NASA's Robert T. Jones tested the idea in a wind tunnel and it worked. Scepticism and insufficiently advanced technology meant that the aircraft has not been built until now. It even has advantages over conventional first generation supersonic transports, producing a substantially quieter sonic boom. At low speed, the wing is kept at right angles to the fuselage. At high speed, the whole wing pivots up to 60° to reduce drag. In this configuration, the aircraft looks rather like a pair of flying scissors.

HiMAT

Inevitably, NASA is involved in a great deal of military aircraft research. The next generation of fighters must combine very high speeds and manoeuvrability, but remain within the g-forces that a pilot can withstand. To this end NASA has flight tested a scaled down remotely piloted airframe called HiMAT (Highly Manoeuvrable Aircraft Technology). The futuristic airframe is dropped from a modified B-52. The HiMAT pilot stays on the ground and flies the aircraft from the Dryden Flight Research Centre in front of typical flighter cockpit displays. If ground control is lost, an airborne pilot can take over. If both fail, HiMAT automatically flies in circles until control is regained (or it's fuel runs out). I hope to look at HiMAT in detail in a future Astrologue.

Windy Caverns

The traditional image of aero research at this level is of a cavernous wind tunnel containing a full-size mock-up of the aircraft. This certainly still goes on, but much more advanced techniques can provide a means of 'flying' the aircraft before it is built. Computer dynamic analysis is still used to predict the behaviour of the new design in flight. A tethered scale model can be 'flown' in a wind tunnel to study the aircraft's behaviour at the limits of its performance. All the data from these studies can be used to program a simulator computer to give crewmen experience in handling the aircraft in potentially dangerous situations before they get off the ground in the real thing. →

Computer analysis, model testing and simulator flights all contribute to the designers' and pilots' understanding of the behaviour of the aircraft in the air. The fourth stage is the acid test — a NASA research pilot must actually strap the strange new machine to his seat and probe the limits of the flight envelope for himself.

Where Can I Get.......

The most common inquiry I receive in the Astrologue mail is, 'Where can I get slides, posters, photos, etc of astronauts, spacecraft, rockets, the planets.....?' I can answer you all by saying Space Frontiers. They will gladly supply sets of slides, postcards, charts, posters, mission badges, T-shirts, video tapes, movies, sound cassettes and replica plaques.

The slide sets cover Mercury, Gemini, Apollo, Skylab, Apollo-Soyuz, Space Shuttle, Mariner, Viking, Pioneers 10 and 11, Voyagers 1 and 2, stars and planets, rockets, storms and weather, space centres, 21st century space colonies and UFOs. They come in everything from five-slide sets at £1.75 to mammoth 80-slide sets at £16. A general set called 'Image of Space' (15 slides), showing an Apollo launch, the Earth from space, Earth-rise over the Moon, Buzz Aldrin on the Moon, UV activity in the Sun, a Skylab spacewalker, etc is available for £5 all inclusive. Quality and presentation are first class.

Science Museum

If you're in London, you can come by a set of Space Frontiers postcards at the Science Museum (nearest tube — South Kensington). 'Men in Space', a six-card set, and 'Man On The Moon', a 12-card set from the Hansen Planetarium in Salt Lake City, are available from the Museum shop.

While you're there it's worth popping into the ground floor 'Exploration' display. The theme is 'the extension of mankind's faculties by artificial means.' This special area is regularly brought up to date. In addition to the third floor space exploration and rocketry display, 'Exploration' features the Apollo 10 Command Module (not a replica — it's the real thing) and a full-size copy of the Apollo 11 Lunar Module.

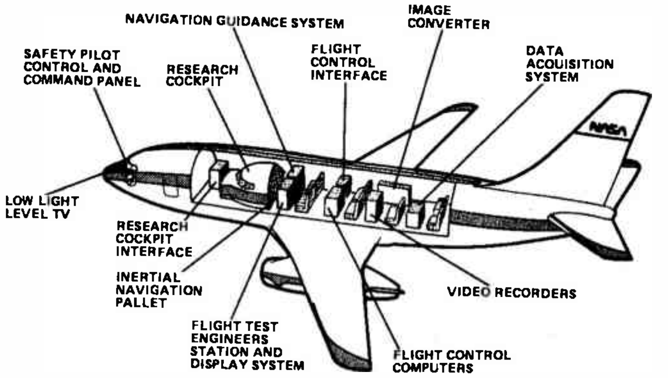


Fig.1 This modified Boeing 737 was used to study flying and take-off/landing routines in bad weather and the use of 'smart' avionics to assist in air traffic control. The Terminal-Configured Vehicle (TCV) can be flown from the research cockpit with the conventional cockpit crew providing a safety back-up. The aim of the programme is to reduce hold-ups at airports due to bad weather, reduce the separation of aircraft on take-off and landing and save fuel by using the most fuel-efficient landing programs. The end result — airlines and airports can substantially cut their losses.

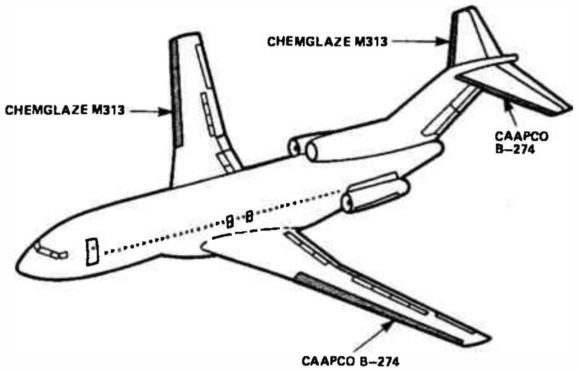


Fig.2 An Air Micronesia Boeing 727 was used to experiment with plastic coatings to reduce skin friction drag on wing and tail surfaces in a tropical environment. Two types of coatings — Chemglaze M313 and CAAPCO B-274 — are being investigated. The location and extent of the coatings on the 727 are shown above. Potential fuel savings from small drag reductions are substantial.

SHORTS

The Arianespace consortium has signed a $150 million contract with the Columbian government to launch two telecommunications sateliites, Satcol 1 and 2, into geostationary orbit in 1984.

The Mark II version of the Skyflash medium range, air-to-air missile has fallen prey to the latest defence cuts. The Mk. II version would have incorporated an improved homing head and electronic counter measures. The Mk I will have to be improved if it is to be a worthwhile weapon in service until the late 1980s.

BUYLINES

All manner of spaceflight memorabilia are available from Space Frontiers Ltd, 30 Fifth Avenue, Havant, Hampshire PO9 2PL. Tel:0705 475313. Send for details, price lists, etc.

Ed White floats in space, the solar wind experiment rises on the moon and supermen exercise in Skylab. Space Frontiers will supply these and many, many more in full colour.

Our lead photograph is the Apollo 10 Command Module, now on display in the Exploration section of the Science Museum, South Kensington.

ETI

DRUM MACHINE

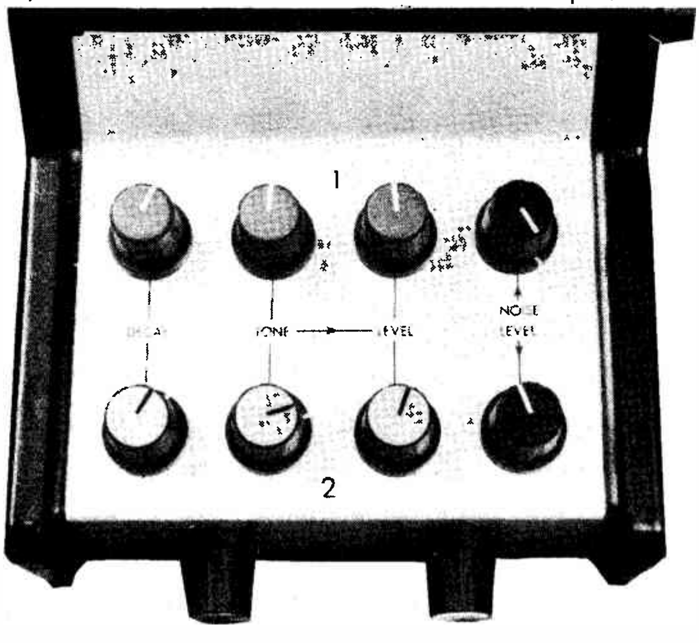
Drums, cymbals, snares and bongos. You can simulate these instruments with this 'double percussion' project. The instruments can be played either manually or automatically using a built-in sequencer. Design by Ray Marston. Project development by Steve Ramsahadeo.

This attractive little musical instrument has two 'percussion simulator' channels. Channel 1 can be used to simulate the sounds of normal drums only: channel 2 can be used to simulate the sounds of all types of drums, including snares, plus metallic percussion sounds such as cymbals, etc. On each channel, the envelope decay times and the basic musical tones, etc., are fully variable using the manual controls, to enable a wide range of percussion sounds to be simulated. The outputs of the two channels are mixed internally and can be fed to an external power amplifier from a single output socket. The complete instrument is powered from a 12 V battery pack.

Play It, Sam

The instrument can either be played manually, automatically, or by a combination of the two methods. In the manual mode, each channel can be played using a small speaker, connected to the channel input: the speaker acts as a 'drum head' transducer and triggers a percussion sound when the cone is tapped with a finger or stick.

The instrument can be played automatically using the built-in eight-step double sequencer. Each channel of the sequencer is used to control one of the channels of the percussion instrument, and can be programmed with a DIL package of eight SPST switches to generate any one of a variety of rhythms. The sequencer can be used in the fully automatic mode, in which it continuously cycles through the eight-step sequence, or can be used in a triggered, or manual initiate, mode in which it runs through a single eight-step sequence each time that an external switch is momentarily closed. The manual initiate facility enables the internally-generated rhythm to be manually synchronised to an external beat (with a foot switch, etc), or to be introduced into the music only in those parts where it is required.



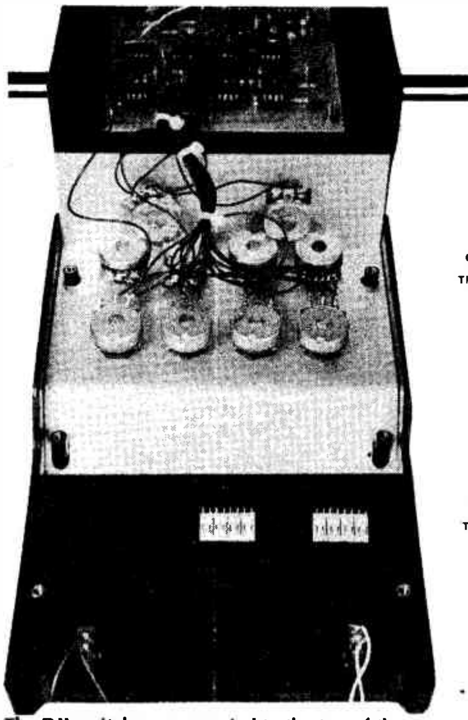
The manual and automatic playing methods operate in the OR mode. In other words, manually-initiated percussion sounds can be played at the same time as the automatically initiated sounds. A particularly attractive way of using the instrument is to play it mainly in the manual mode, but to occasionally bring in a few bars of automatic sequencing with a foot switch, using the manual initiate facility. The unit thus acts as a highly versatile musical instrument.

Construction

The circuitry is built up on two PCBs, a single large board being used to hold all of the components (except the pots and switches) of the main double percussion instrument, and a smaller board being used for the components of the sequencer circuit. The unit uses a good deal of interwiring between the PCB and the total of eleven control pots, etc., so some care is required in the construction.

Start the construction by building up the main PCB, taking the usual care over the component polarities. Use Veropins to facilitate the connections from the PCB to the ten control pots.

When construction of the main PCB is complete, give it a functional check by temporarily connecting the ten pots to the unit, wire a couple of small speakers (impedance not important) to the two input terminals, connect the unit to a 12 V supply and take the output to an external power amplifier. Check that plain drum sounds can be manually generated on channel 1, and all types of percussion sounds from channel 2. Note on channel 2 that Q5 is used as a white noise source (for generating cymbal



The DIL switches are epoxied to the top of the case as shown here. The sequencer board can then be secured by plugging the DIL sockets onto the exposed pins.

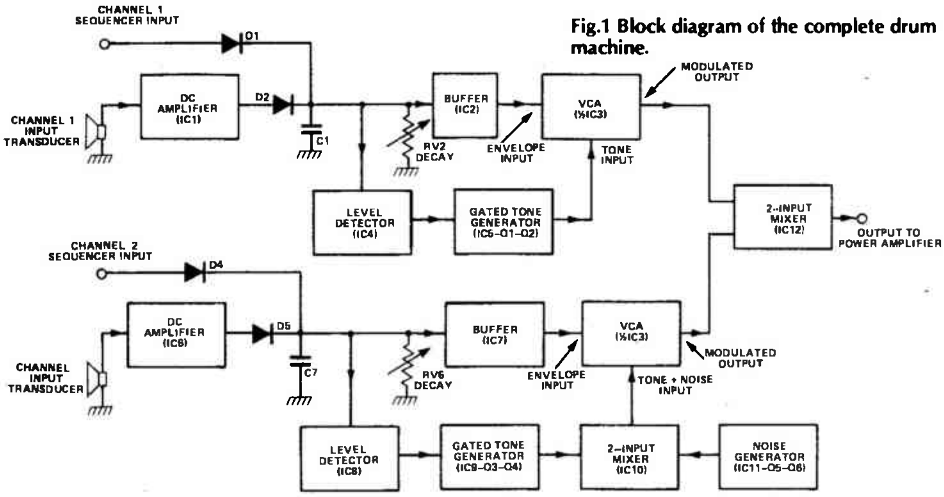


Fig.1 Block diagram of the complete drum machine.

BUYLINES

No unusual components are used in this project, your local emporium should meet your requirements. However, if you experience difficulty in obtaining the NE570, Watford Electronics are stockists of this device.

Collet knobs are available from Electrovalue Ltd. and the case from West Hyde Developments, order as BOC668.

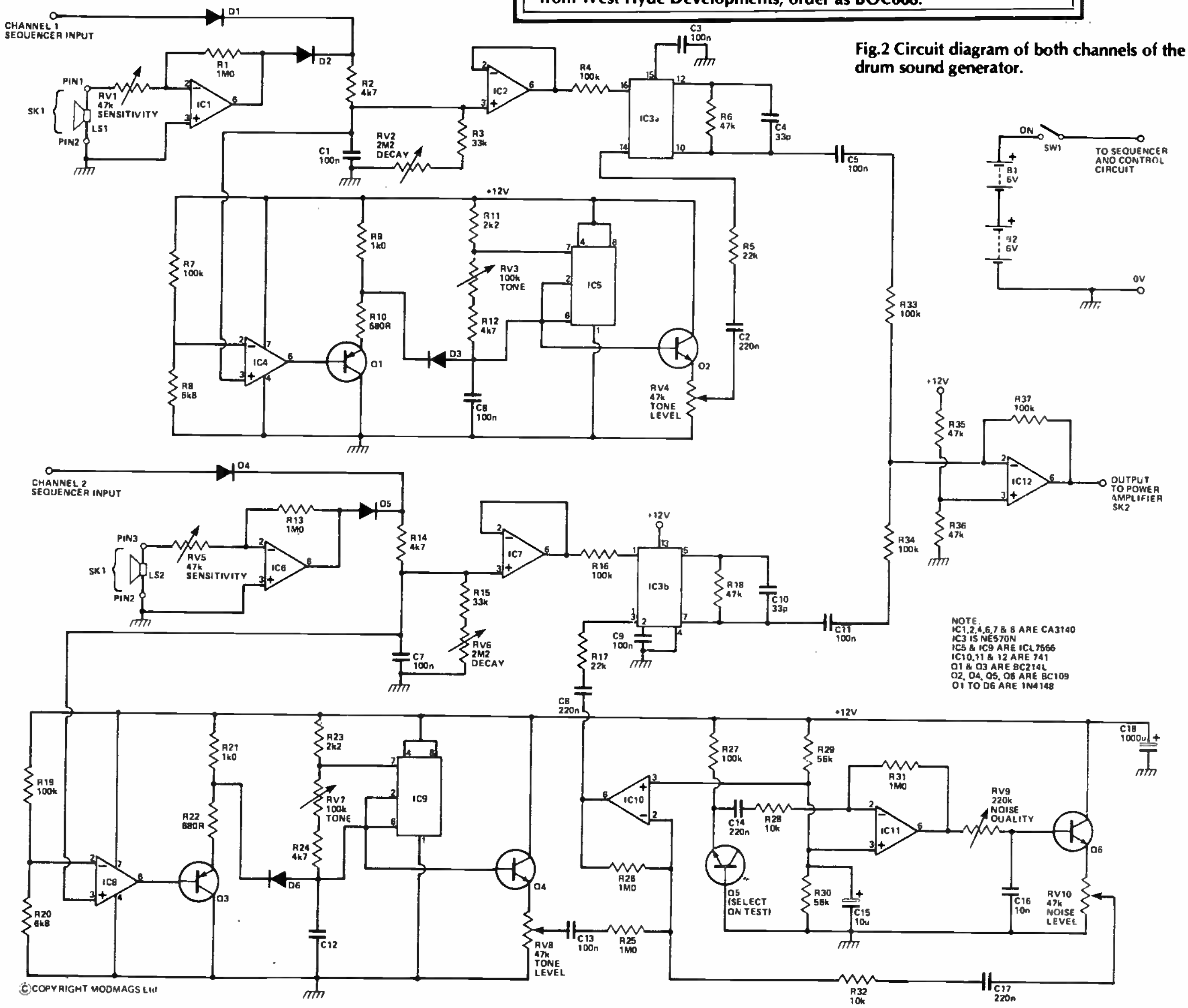


Fig.2 Circuit diagram of both channels of the drum sound generator.

HOW IT WORKS

The basic instrument contains two essentially similar channels (see block diagram), each comprising a voltage-controlled amplifier (VCA), a gated tone generator and an envelope generator. The envelope generator produces the characteristic fast-attack/slow-decay modulation waveform of a percussion instrument and can be activated by either an external transducer (a speaker) or the pulse input of an automatic sequencer unit.

The outputs of the two channels are added in a two-input mixer and are made available at a phono socket, where they can be fed to a power amplifier. The channel 1 circuitry produces modulated tone signals only, and can be used to generate a range of simple drum sounds. The channel 2 circuitry incorporates a noise generator and a two-input mixer as well as a tone-generator, and can be used to reproduce all of the sounds of channel 1 plus snare drums, cymbals, etc.

The two channels of the instrument are basically similar, so let's start off with a detailed description of channel 1. When used in the manual mode the instrument is played using an external transducer such as a speaker (LS1), which is connected to the input of high-gain DC amplifier IC1. Each time that the transducer is tapped, the output of IC1 jumps abruptly positive and rapidly charges C1 via D2-R2: C1 then discharges exponentially via R3-RV2, to produce the characteristic fast-attack/slow decay modulation waveform of a percussion instrument. The waveform is then fed to one half of dual VCA IC3 via unity-gain buffer IC2, where it is used to control the gain of the VCA.

Note that the C1 modulation generator can be activated by either the transducer or by a pulse signal fed to C1 via D1-R1 from the independent sequencer circuit (auto mode). The C1 voltage is monitored by comparator IC4, which gates on astable IC5 whenever the C1 voltage exceeds a few hundred millivolts. The astable generates a symmetrical ramp waveform, which is buffered by Q1 and fed to the 'tone' input of VCA via level control RV4. The tone of the astable can be varied over the range 83 Hz to 1.4 kHz with RV3.

Thus, each time the channel is activated (by the transducer or by a sequencer) a modulation waveform is fed to one input of the VCA and a tone signal is fed to the other, to produce a modulated tone signal at output pin 10 of IC3. The signal is fed to one input of two-input mixer IC12. A wide variety of drum sounds can be simulated by suitable adjustment of RV2, RV3 and RV4.

Channel 2 is similar to channel 1, except that the output of the tone generator (from RV8) is fed to the VCA via a two-input mixer designed around IC10. The other input to this mixer is derived from a noise generator designed around Q5-IC11 and Q6. Here, the reverse-biased base-emitter junction of Q5 is used as a noise source and the noise signal is then amplified by IC11, filtered by RV9-C16 and made available via level control RV10.

The instrument is powered from a 12 V supply, derived from eight 1V5 cells. This supply is also used to power the Auto-Manual Eight-Step Sequencer unit.

The sequencer unit has two output channels, each of which produces a single or repeating sequence of up to eight 5 mS output pulses: the sequencing period can be varied over a wide range by a clock (or 'tempo') generator, and individual pulses can be programmed in or out on each channel with a dual-in-line package of eight SPST switches. The unit is designed to automatically sequence the double percussion instrument.

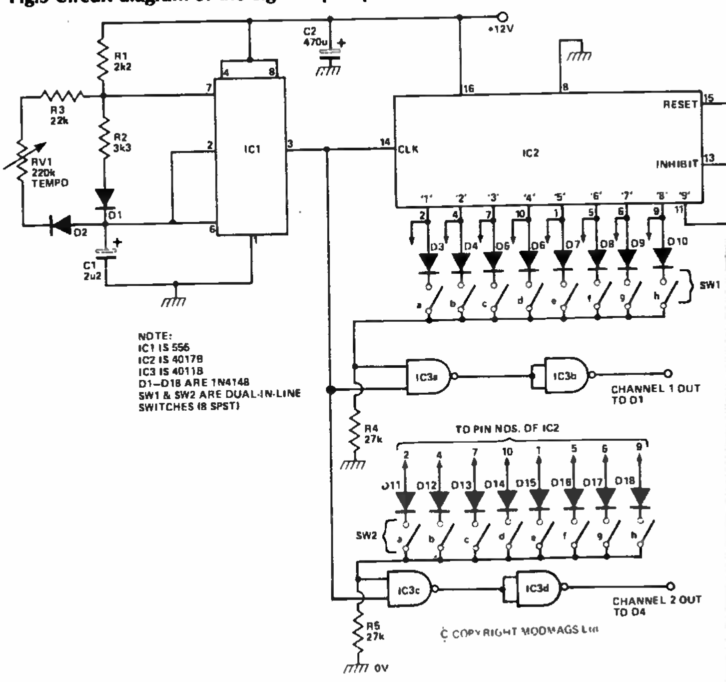
The unit comprises a clock generator (IC1), a 4017 counter (IC2) and two sets of switch-programmable clock/decoder coincidence detectors (IC1 and D3 to D18). The clock generator is designed around a 555 astable and generates a series of 5mS pulses, with the inter-pulse period variable over a wide range by RV1. The pulses are used to clock IC2.

IC2 is a 4017 counter with ten decoded outputs. These outputs sequentially go high on the arrival of each new clock pulse, with only one output being high at any moment in time. On each channel the decoded 4017 outputs that are required are fed to one side of a two-input AND gate (IC3a-IC3b or IC3c-IC3d) via a bank of diodes and switches, while the 5mS clock pulse is fed to the other side of the AND gate. The programmed sequence of 5 mS pulses are thus generated at the output of each AND gate.

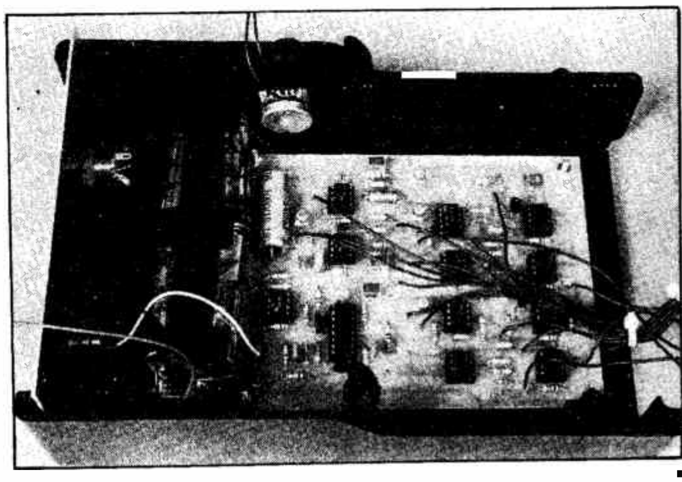
When the unit is operated in the manual mode, the 4017 sequences automatically for the first eight clock pulses and then stops as its '9' output goes high and activates the inhibit pin: the single automatic sequence can be re-initiated by momentarily closing PB1 and thus resetting the 4017, so that the '1' output goes high on the arrival of the next clock pulse. The manual facility enables the sequencer to be manually synchronised to an external beat.

When the unit is operated in the auto mode the reset and inhibit pins of IC2 are shorted together by SW3. This configuration effectively causes the 4017 to see a double clock pulse as the '9' output goes momentarily high, thereby causing the '0' output to go high as the IC resets but then causing the '1' output to go high almost immediately. The net effect of all this is that the sequence repeats continuously when SW3 is set to the auto mode.

Fig.3 Circuit diagram of the eight-step sequencer unit.



Below: the sound generator board and batteries are mounted in the lower half of the case. RV1 (tempo control) can be seen mounted on the side — all other pots are situated on the front panel.



sounds, etc), and may have to be selected on test to produce an adequate noise level.

Proceed next with the construction of the sequencer circuit on the smaller PCB. Note that the two sets of DIL switches MUST be mounted in sockets, and that capacitor C2 is mounted on the *underside* of the PCB.

You can now proceed with the assembly of the two boards and all other components in the specified case. Note the following points. The large PCB is secured to the base of the case with stand-off pillars: leave sufficient space at the rear of the case to accommodate the battery pack (eight 1V5 cells). The ten percussion-control pots are mounted on the front section of the top half of the case.

The sequencer board is secured to the rear half of the top section of the case by the board's DIL switches, which are epoxied to the case. Proceed as follows.

First, hold the board in position below the case top and very carefully mark out the precise outlines of the two switches. Now cut two holes in the case top, to allow the switches to pass through the case. Next, remove the switches from their PCB sockets, push them into the holes so that the top faces are flush with the case top and then fix the two switches into place with epoxy or super-glue. When the glue has set, fit the PCB to the switches (and thus the case) by carefully inserting the DIL switches in the sockets. Tempo control RV1 is mounted on the right hand side of the lower half of the case.

Finally, to complete the construction, fit all the remaining switches and sockets into place and complete the interwiring. We recommend that you use jack sockets to connect the two 'drum head' speakers to the unit, configured so that the input pins short out if the speakers are removed.

When using the completed unit, note that, if the 'drum head' speakers are not used, they must be replaced by short circuits, to eliminate the possibility of circuit instability.

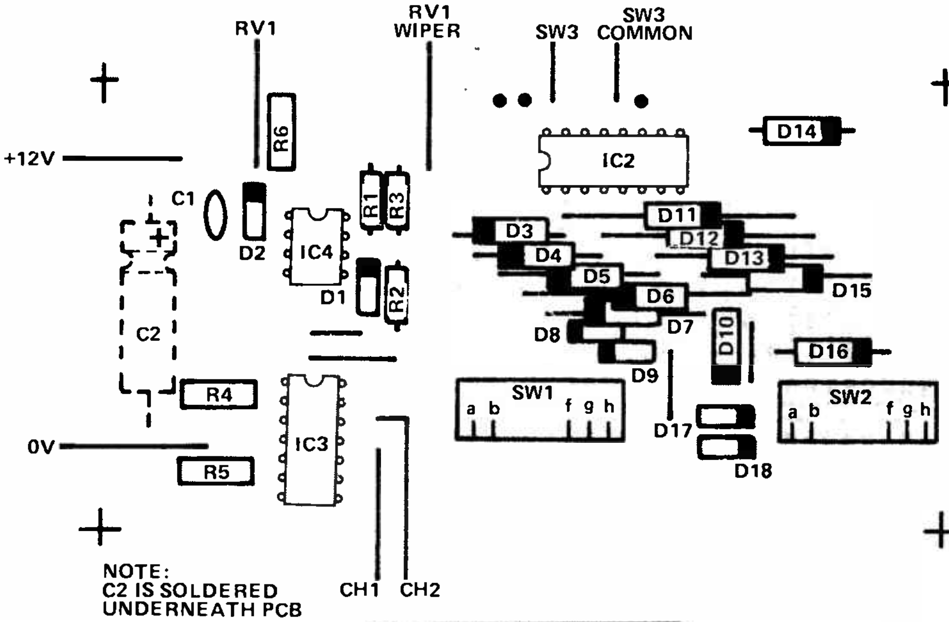
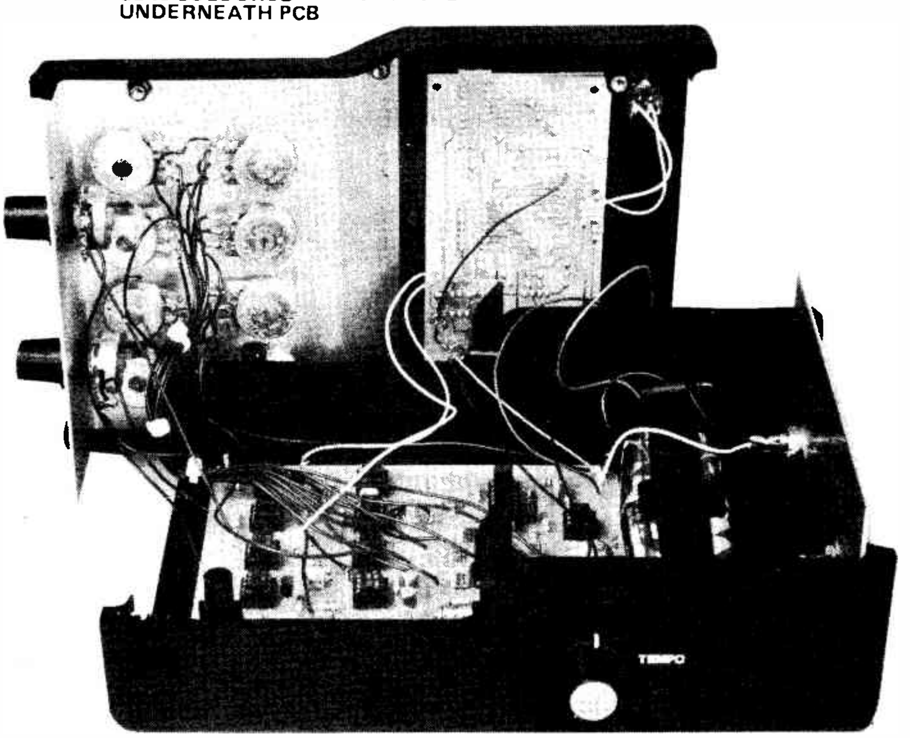
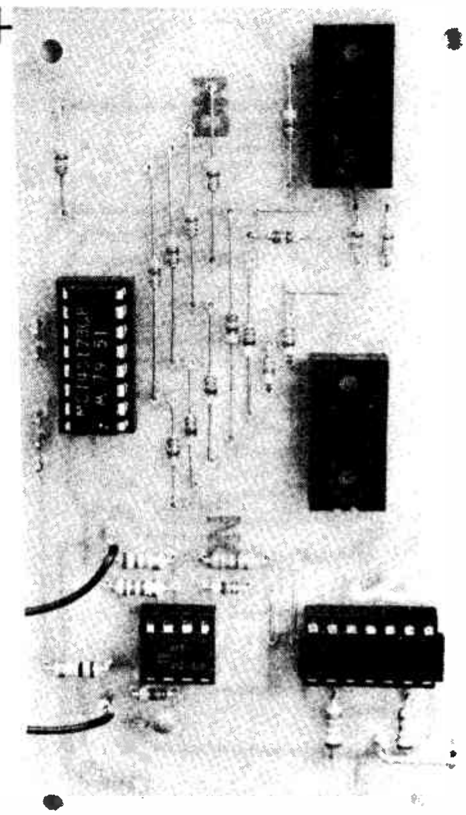


Fig.4 Component overlay for the sequencer board. Note that C2 is soldered underneath the PCB, and an insulated link should be soldered between IC2 pin 8 and the 0 V rail.

Below left: with the case open you can see how the boards and controls are interwired. The sequencer board (below) is secured to the top of the case by pressing the empty sockets onto the pins of the DIL switches.





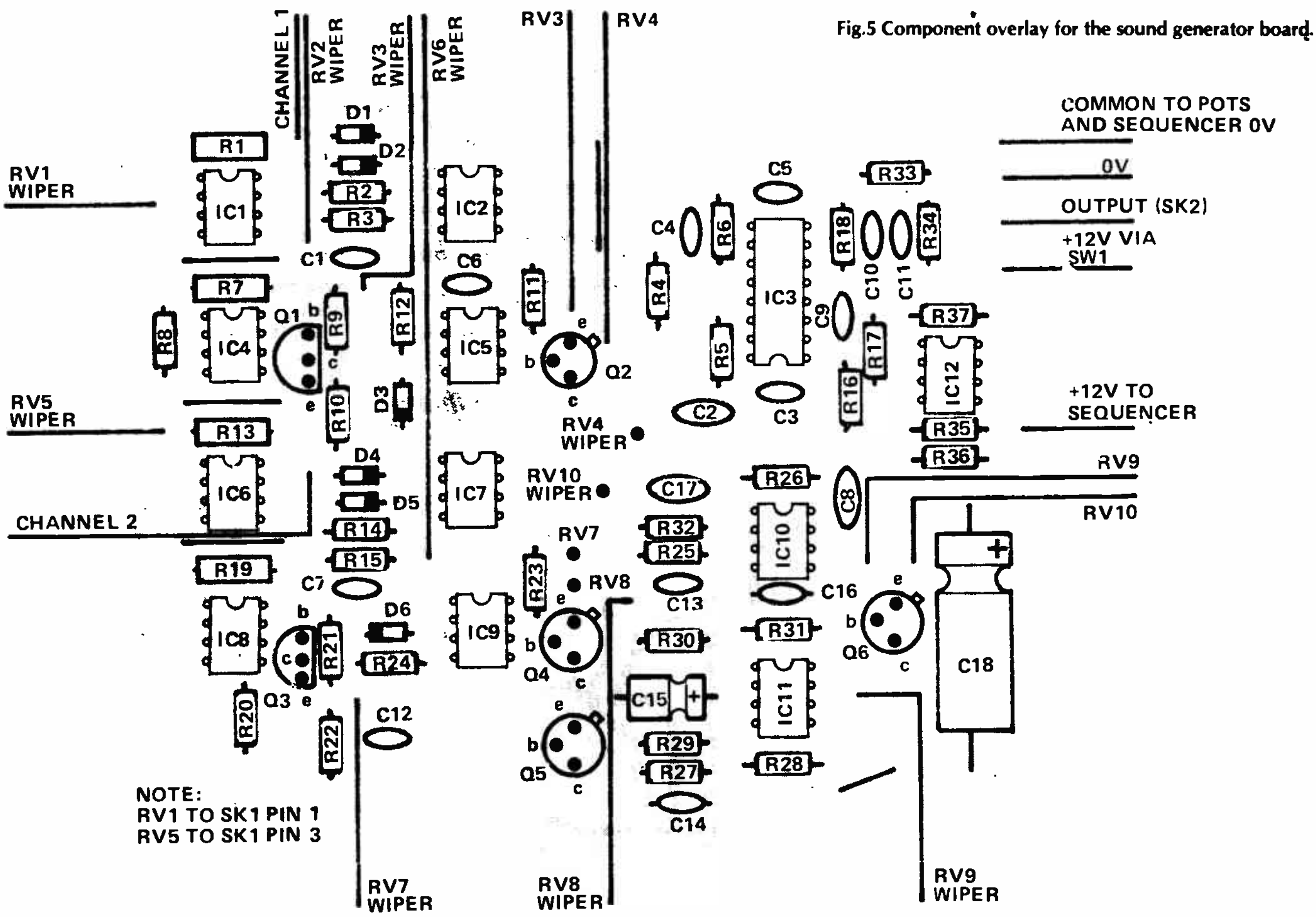


Fig.5 Component overlay for the sound generator board.

PARTS LIST

CONTROL CIRCUIT

Resistors (all ¼W, 5%)

R1,13,25,26,31	1M0
R2,12,14,24	4k7
R3,15	33k
R4,7,16,19,27,33,34,37	100k
R5,17	22k
R6,18,35,36	47k
R8,20	6k8
R9,21	1k0
R10,22	680R
R11,23	2k2
R28,32	10k
R29,30	56k

Potentiometers

RV1,4,5,8,10	47k linear
RV2,6	2M2 linear
RV3,7	100k linear
RV9	220k linear

Capacitors

C1,3,5,6,7,9,11,12,13	100n ceramic
C2,8,14,17	220n polycarbonate
C4,10	33p ceramic
C15	10u 25 V axial electrolytic
C16	10n ceramic
C18	1000u 16 V axial electrolytic

Semiconductors

IC1,2,4,6,7,8	CA3140
IC3	NE570N
IC5,9	7555
IC10,11,12	741
Q1,3	BC214L
Q2,4,5,6	BC109

Miscellaneous

SW1	SPST miniature toggle
SK1	3 pin DIN socket and plug
SK2	phono socket
LS1,2	50 mm loudspeaker

10 off collet knobs, caps and nut covers
Case (see Buylines)
2 off HP7- four section battery holders
8 off HP7 batteries

SEQUENCER

Resistors (all ¼W, 5%)

R1	2k2
R2	3k3
R3	22k
R4,5	27k
R6	100k

Potentiometers

RV1	220k linear

Capacitors

C1	2u2 35 V tantalum
C2	470u 25 V axial electrolytic

Semiconductors

IC1	555
IC2	4017B
IC3	4011B
D1-D18	1N4148

Miscellaneous

SW1,2	8-SPST dual-in-line lateral switches
SW3	SPST miniature toggle
PB1	momentary push button

1 off collet knob, cap and nut cover

ETI

TEKTRONIX STORAGE OSCILLOSCOPE. Type 434, as new 12 months' warranty **£1,950.**
TEKTRONIX OSCILLOSCOPE. Type 647, with 10A2 and 3B11. **£500**
TEKTRONIX STORAGE OSCILLOSCOPE. Type 564 with 3A6 and 3B4 **£350.**
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74122	**12p**	74C02	**16p**	74C86	**50p**
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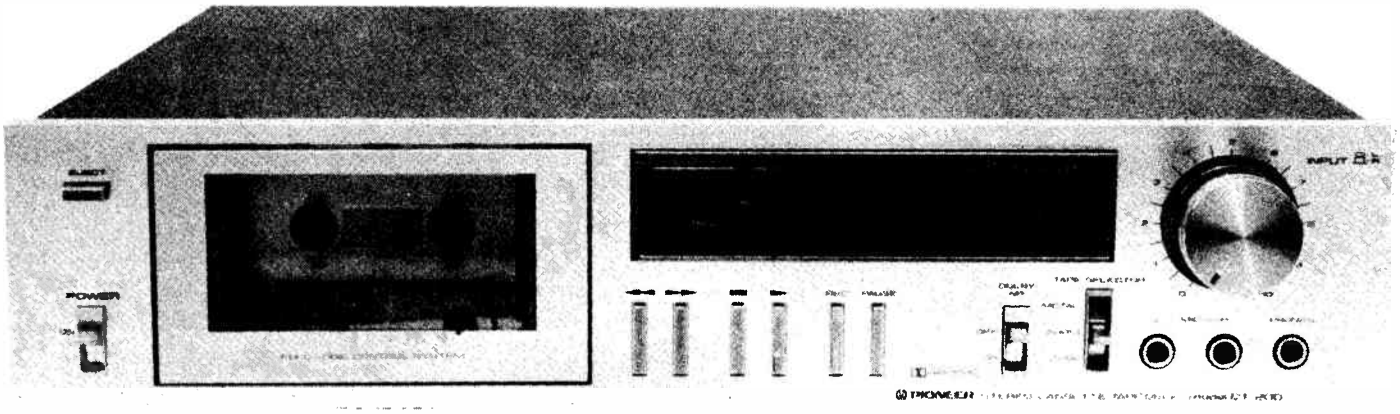
AUDIOPHILE



Yes, you read it right... Audiophile is back! Ron Harris takes pen in hand again to review a couple of Pioneer tape decks, and enthuses over some old friends.

Right. Put down the trannie radios, pack away the pine needles — Audiophile has returned! That man at the back with the yellow handbag who whispered "Oh gawd, not again" can leave now of his own accord, or be carried out later when the boys get round to landscape his anatomy.

To all my regulars who sorely missed these pages and who wept and wailed their grief to the dawn — thank you. To any tasteless cloth-eared ingrate who thinks I should have stayed away — read on, read on, there is yet hope and charity for such as ye in the halls of the righteous! (ie here...).

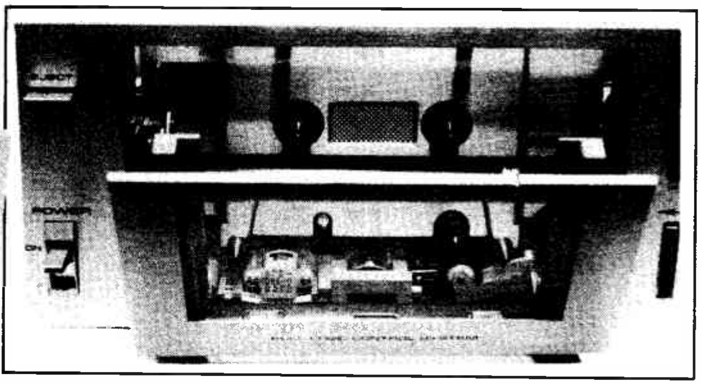
For my return trick, I'm taking a look at two tape machines from Pioneer's cassette deck range, one from each end: the CTF-1250, which is their flagship design, and the CT-200, an interesting new release at the budget end of the price scale. Thus we shall be all things to all men... I think.

Tape For All Seasons

The new CT-200 is a basic, no-nonsense machine intended mainly for the first time hi-fi man who doesn't wish to have to upgrade again in a hurry. It is compact and sports little in the way of excess controls. Normal VU meters are fitted, with no peak indicators. Logic control is employed for the tape transport mechanism and, strangely, Pioneer have opted for captive phono leads on the input/output connectors. Surely a yard of screened lead and a phono plug can't cost less than a plain ordinary panel socket?

Apart from this the CT-200 is distinguished only by its normality! There are no frills and no gimmicks at all. The controls worked impeccably at all times and the meters were fast enough to give reliable results when recording.

As you can see from this detail of the control section of the CT-200, Pioneer have kept it simple. The meters are conventional VU, with no peak indicators, but this should not deter an intended purchase, as they are still pretty good at their jobs! Transport controls are solenoid operated, a plus point at the price.



Unusual is the way in which virtually a whole section of the front panel unhinges to accept a cassette. Can be a little un-nerving the first time, you think something somewhere has dropped off, if you'll pardon the expression!

The heads are easily accessed for cleaning.

The one minor annoyance was the switching 'thump' generated whenever the mains power was interrupted. A small thing, but one which Pioneer should attend to, ASAP.

Resulting Tests

The test bench brought forth no gremlins from the design and a scrutiny of the results will show that good figures were returned on all counts. The signal-to-noise and metal tape figures are particularly impressive for a machine in this price bracket.

Sensitivity was slightly below the spec., at about 80 mV, but this is still a very reasonable figure and one that, together with the input impedance of 90k, should ensure that the CT-200 will work happily with the majority of amplifiers.

Wow and flutter is very well controlled and proved unobtrusive in use. All in all the machine gave a surprisingly good account of itself under test and one which does it credit at the price.

Frequency response : (−20 dB)	LH tape :-	25 Hz — 14 kHz ±4 dB
	CrO_2 :-	25 Hz — 17 kHz ±3 dB
	Metal :-	25 Hz — 18 kHz ±2 dB
	FeCr :-	25 Hz — 18 kHz ±3 dB
Signal-to-noise Ratio :- (best result, Dolby on)		−65 dB
Wow and Flutter :	DIN :-	±0.15%
	WRMS :-	±0.05%
Harmonic Distortion :-		1.2% (0 dB)
Line Sensitivity :-		80 mV
Input Impedance :-		90k

Table 1 — Test Results CT-200

Auditioning

Having duly done my duty with the meters and measures, it was down to the nice part of the job — settling back in a chair and listening to the deck playing coherent music as opposed to all those monotonous tones. Again the CT-200 provided a surprise — put simply, it sounded better than I suppose I'd expected. The sound was clean and sharp, with little trace of the old 'cassette sound' that was so immediately recognisable a couple of years back. The machine was always detectable against a reference, as would be expected for a £100 deck, but was never anything less than satisfying to listen to.

Overall it represents very good value for money and can be thoroughly recommended. It just goes to show how far budget hi-fi — and tape in particular — has come of late.

Battleship Engineering

The CTF-1250 is a massive machine which is some 16½ x 7½ x 14½ inches in size, and 26 lb in weight. Once more into the truss dear friends, or block up the living room with tape deck . . .

For all that, the front panel is tightly packed with controls, buttons and things that glow in the night. There is even a control to turn down the brightness of the fluorescent display, lest its brilliance offend thee.

Basically the machine is possessed of full tape optimisation facilities, a digital tape counter, full logic controls which can be operated from the counter, and peak reading meters which can be set to one of *three* modes.

Rather than waste an issue describing it all in a thousand words, take a look at the photo and diagram, the caption to which should explain the myriad machinations of the machine.

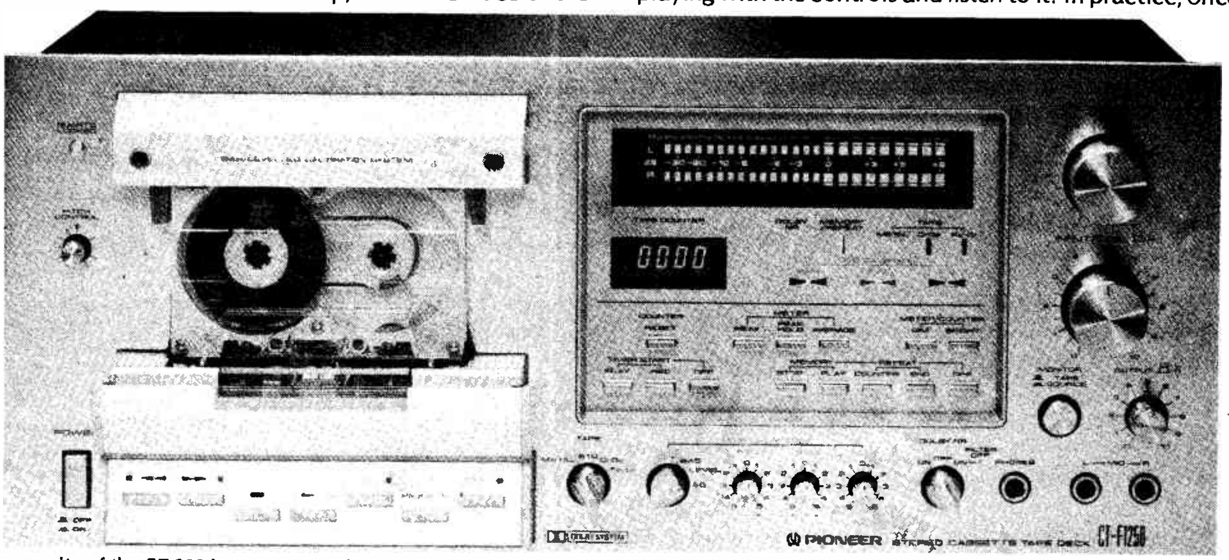
Results Of A Test

Table 2 gives a brief extract from the test results, in a form which can be compared to those for the CT-200. As you can see, there is not the difference you may expect, considering how many more bits of green paper are required to obtain the 1250. Those buttons cost money.

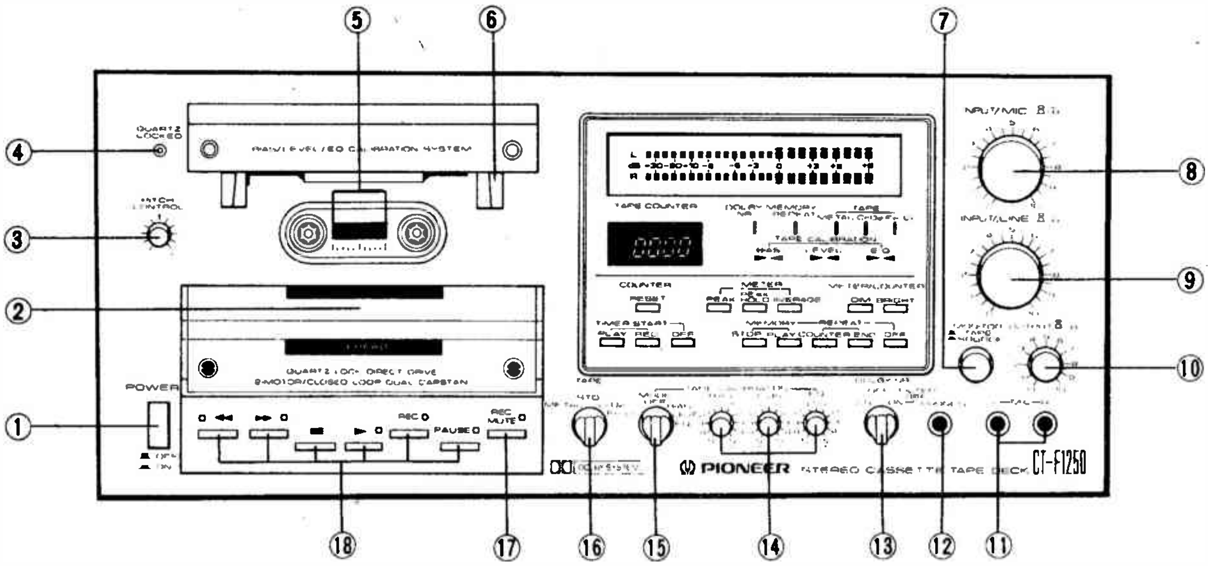
All results are given with the machine optimised for the tape in use. With the system employed here, such a set-up is easy and certainly yields improved results for relatively little effort. The figures are generally 'good' for a cassette deck but are nothing outstanding by any means. The CTF-1250 turned in solid, repeatable performance on all the important parameters.

Listening In

Under audition the 1250 proved a difficult machine to live with. No insult intended, it was just well-nigh impossible to stop playing with the controls and *listen* to it! In practice, once a par-



The exact opposite of the CT-200 in every way! This is the daunting 1250, Pioneer's tape flagship. Those impressive meters have three modes of operation, peak reading or hold and average.



Rather than attempt to describe the 1250, I've taken the visual approach and stolen this illustration from the Pioneer handbook!
1) *Mains Power:* **One fault here is that it is not 'de-thumped'. 2)** *Dust Cover:* **fits over the heads which would otherwise be very vulnerable. A nice touch this. 3)** *Pitch Control:* **yes, that's right the speed is quartz locked and can be varied if required. 4)** *PLL Indicator:* **activates when speed is correctly set. 5)** *Remaining Tape Markers:* **just the usual backlight to show how much tape is left. 6)** *Tape Guide:* **accurately machined guide paths to make sure you put the cassette in straight. 7)** *Monitor:* **standard stuff for a 3-head design, chooses tape or source. 8)** *Mic Level:* **ganged input control for the front panel jacks. 9)** *Line Input:* **ditto for the two inputs on the rear panel. Friction linking is a little** *too* **strong! 10)** *Output Level:* **click stopped at 0 dB. 11)** *Mic Inputs:* **¼" jack sockets. 12)** *Headphone Output:* **provides a healthy output to drive a pair of dynamic phones. 13)** *Dolby/Filter:* **allows use of the NR with/without MPX filtering. 14)** *Tape Calibration:* **just set the Mode switch to required parameter and adjust the appropriate control until the calibration lights indicate purity. Simple and efficient. 15)** *Mode Control:* **used with 14. 16)** *Tape Selector:* **standard choice of four tape types. 17)** *Record Mute:* **useful for killing ads. when taping from radio etc. 18)** *Solenoid Controls:* **all transport controls are logic locked and virtually idiot-proof.**

ticular brand of tape has been settled on, and the control settings noted, there is little reason to fiddle around at all.

The metering is superb and about the most useful I've encountered anywhere. The sound quality is, again, good, but not as good as can be obtained elsewhere for £450. Some sacrifice has to be made if you want to buy all those lovely facilities.

Best results — regardless of optimisation, strangely enough — were obtained with Maxell tapes and in particular the UDX-II. Sony Metal came a close second, which although providing a cleaner result, showed some signs of treble lift whatever I did to the optimiser.

Frequency response : (−20 dB)	LH :-	25 Hz — 15 kHz ±3 dB
	CrO_2 :-	25 Hz — 17 kHz ±3 dB
	Metal :-	25 Hz — 19 kHz ±3 dB
	FeCr :-	25 Hz — 16 kHz ±3 dB
Signal-to-noise Ratio :- (best result, Dolby on)		−66 dB
Wow and Flutter :	DIN :-	0.1%
	WRMS :-	0.03%
Harmonic Distortion :-		0.9% (0 dB)
Line Sensitivity :-		60 mV
Input Impedance :-		50k

Table 2 — Test Results CTF-1250

Sum Summary

Adding it all up, the CTF-1250 comes out as a very crafty compromise; one that will appeal to many. Its sound is not of the ultimate quality, but its facilities and versatility are second to none.

The CT-200 is a well-conceived and well-executed budget deck that offers excellent value for money and an outstanding sound quality for the class.

Audio Updates

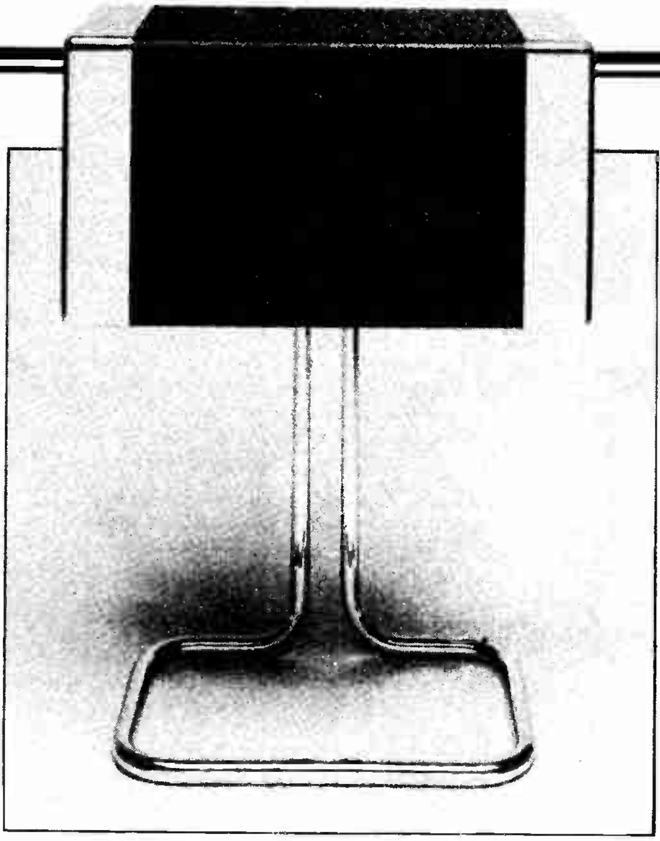
At present I'm working on a feature called 'Sonic Holography' for next month's ETI — and if you don't know what that is (S.H. not ETI!) then you're gonna have to buy our next issue, 'cos I ain't gonna tell you now — as part of which I've had the chance to renew my acquaintance with the Gale loudspeakers. I thought that since such opportunities occur but rarely, I'd drop the reader's letters and ramble on about them for a while instead.

Any Port In A Gale?

Few products, especially loudspeakers, can claim to have stood the ravages of time and changing tastes as successfully as the Gale GS401. It is now many years since Ian Gale first unleashed his chrome-end, unconventionally horizontal transducer upon the ears of the world and, if anything, its standing has risen with the passing of the summers.

Infinite baffle enclosure (330 x 605 x 270 mm)
Four unit design (2 x 200 mm; 1 x 100 mm; 1 x 19 mm dome)
Crossover frequency : 475 Hz and 5 kHz
Efficiency : 20 W produces 96 dB at 1 m
Power handling : 40 W — 200 W RMS per channel into 8R amplifiers recommended
Fuse-protected against overload

Table 3 — Specification of Gale GS401A



It is basically a four unit, infinite baffle (sealed box) design of prodigious power handling and excellent imaging. Long before 'phase linearity' gathered unto itself the role of buzzword, the Gales were presenting an essentially phase stable performance, witnessed by the incredible square wave performance. This is one of the few loudspeakers through which such a signal may pass and emerge with some semblance of accuracy.

I had the Gales at home for a period of some weeks and grew to appreciate their virtues more with time. Comparing them to my usual reference — the KEF 105 II — they have a relatively similar approach to music. The 105 has a better defined bass register and a more transparent treble, but the Gales run them mighty close indeed — and at half the price!

Anyone who is about to spread over £400 on the counter for a pair of speakers would be well advised to hold onto the cash until he'd given the 401s a chance to show what they can do. They are more room dependent than most transducers in this league and less coloured than any when set up correctly. Still an outstanding design then, and a lasting credit to their designer.

Above: the imposing Gale 401, in chrome livery. The stands are also available in a black finish and personally I prefer it that way!

Trailer

Next month it's back to pickups for a trio of moving coils from Mayware, Ultimo, and Ortofon. I'll also be putting down some words on a new Japanese speaker (shock horror . . .), the Mitshubishi DS-32B which has been specially designed for non-oriental ears.

ETI

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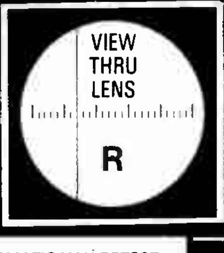

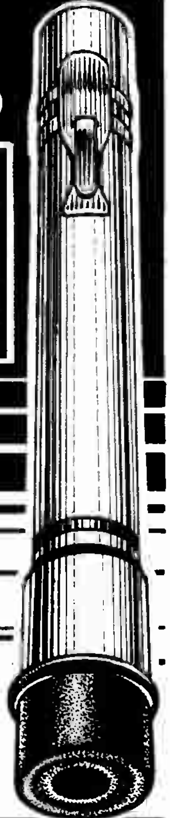

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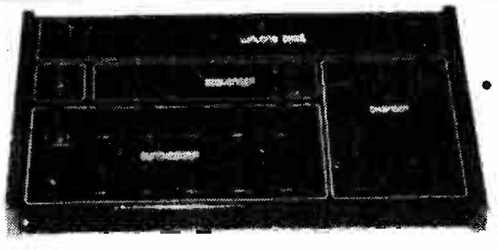

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7430	18p
7432	25p
7440	16p
7442	68p
7448	75p
7473	32p
7474	32p
7475	40p
7476	40p
7490	35p
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7493	50p
7496	45p
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74154	90p
74157	55p
74122	45p
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74LS20	18p
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74LS27	45p
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74LS74	30p
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74LS123	63p
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74LS126	50p
74LS132	79p
74LS138	69p
74LS139	75p
74LS148	170p
74LS151	75p
74LS153	75p
74LS155	65p
74LS157	74p
74LS160	115p
74LS161	78p
74LS163	90p
74LS164	90p
74LS165	150p
74LS168	190p
74LS173	100p
74LS174	99p
74LS175	99p
74LS181	280p
74LS190	110p
74LS195	87p
74LS196	100p
74LS221	110p
74LS240	210p
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74LS244	175p
74LS245	220p
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4012	24p
4013	38p
4014	70p
4015	73p
4016	35p
4017	75p
4018	76p
4019	42p
4020	88p
4021	100p
4022	88p
4023	22p
4024	50p
4025	20p
4026	130p
4027	43p
4028	75p
4029	80p
4030	50p
4031	195p
4033	145p
4035	104p
4036	290p
4037	105p
4038	110p
4039	290p
4040	99p
4041	75p
4042	73p
4043	86p
4044	88p
4045	160p
4047	99p
4048	56p
4049	38p
4050	40p
4051	69p
4052	75p
4053	73p
4054	111p
4055	121p
4056	121p
4059	560p
4060	112p
4063	112p
4066	56p
4067	422p
4068	19p
4069	19p
4070	28p
4071	25p
4072	25p
4075	20p
4076	88p
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4099	180p
4501	25p
4502	112p
4503	68p
4507	52p
4508	288p
4510	76p
4511	125p
4512	75p
4514	250p
4515	290p
4516	109p
4518	99p
4520	99p
4521	230p
4526	105p
4527	130p
4528	99p
4529	140p
4531	150p
4532	125p
4538	150p
4543	160p
4556	70p
4560	225p
4569	240p
4572	46p
4584	79p
4585	125p

74C

74C20	30p
74C76	60p
74C85	145p
74C97	125p
74C98	125p
74C107	100p
74C160	110p
74C161	145p
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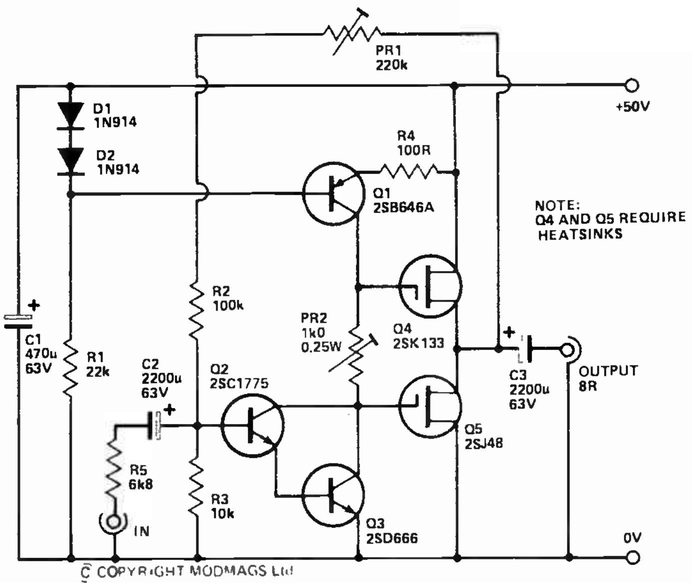
SPOT DESIGNS

20 W MOSFET Amplifier

Although power MOSFETS were originally only used in super-fi amplifiers, they have fallen in price to the point where they can be given serious consideration for use in any amplifier where an output power of between about 20 W and 100 W RMS is required. This simple design gives good quality results with the level of total harmonic distortion well below 1% at all audio frequencies provided the maximum output power is not exceeded. The maximum output power is a little over 20 W RMS if a 50 V supply is used and approximately 30 W RMS if a 60 V supply is employed with the unit (both are loaded voltages).

The circuit is basically quite conventional with Q2,3 being used as a Darlington pair, common emitter driver stage. The main collector load for this is formed by a constant current generator circuit using Q1 and its associated components. This gives a current of about 6-7 mA in the driver stage. Such a low current is acceptable due to the very high current gain of the complementary source follower MOSFET output devices. PR2 is used to set the appropriate quiescent output current through the output stage and the slightly negative temperature coefficient of the output devices makes any thermal stabilisation here totally unnecessary. R2,3 and PR1 are used to bias the amplifier. No phase or frequency compensation components are needed due to the excellent high frequency performance of the two output transistors.

Before initially connecting the supply to the circuit, set PR1 at about half maximum resistance. PR1 is then adjusted to give half the supply voltage at Q4 and Q5 source terminals and PR2 is advanced to give the circuit a quiescent current consumption of approximately 100 mA. The circuit has an input sensitivity of about 500 mV into 6k8 for full output. Current consumption is about 800 mA RMS at 20 W RMS output and almost 1 A with an output of 30 W RMS. The transistors are available from Ambit International.



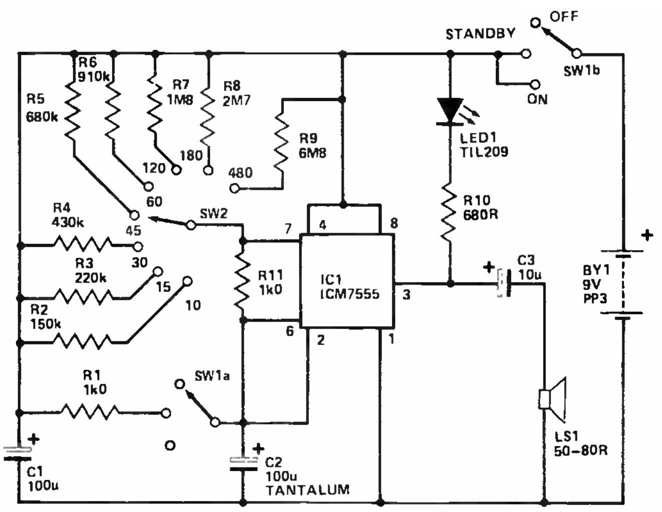
Call Charge Reminder

The idea of this simple circuit is to give the user some idea of the number of units that are being accumulated while a telephone call is in progress. It is not intended to give a readout of the number of units, but instead gives a warning (clicking) sound each time an extra unit is accumulated. This enables a very simple and inexpensive circuit to be used and is effective in that it prevents the user from losing track of time.

A CMOS version of the 555 timer device (the ICM7555) is used as the basis of the unit. Using the CMOS version has the advantage of giving a much lower current consumption (about 100 uA). Before starting to dial the required number the unit is switched to the standby mode using SW1. This connects power to the circuit, but the 555 astable is blocked from operating properly by R1 which holds timing capacitor C2 into a charged state.

When the call is answered, SW1 is switched to the on position and R1 is then disconnected so that the unit is able to function normally. However, the astable cycle does not start at the normal point with C2 charging from zero. Instead, C2 is rapidly discharged to one third of the supply voltage through R11 and IC1 and then starts to charge again. This is important, since the initial cycle of the circuit would otherwise be significantly elongated (an effect that occurs with virtually all astable circuits).

The operating frequency of the unit is controlled by SW2 and the series of timing resistors (R2-9). The telephone dialling instructions booklet should be consulted to ascertain the time per unit of the call you are about to make and SW2 is then set to the appropriate time. The output of IC1 is normally high, but at the end of each cycle it briefly goes low, giving a clicking sound from LS1 and giving a brief flash from optional indicator LED 1. Each click, including the one that occurs as the unit is switched to the on position, indicates an extra unit has been accumulated.



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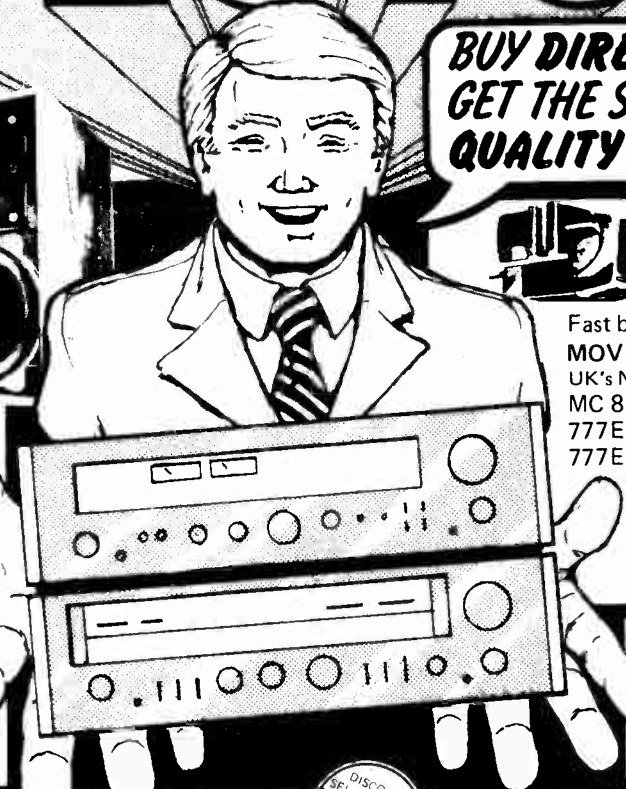

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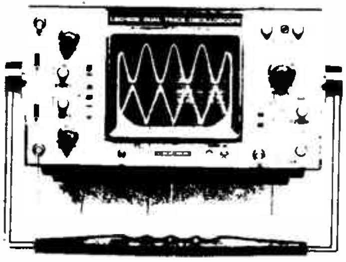

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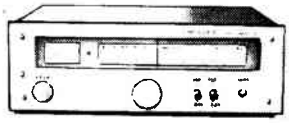

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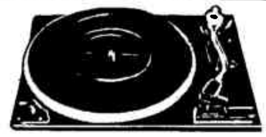

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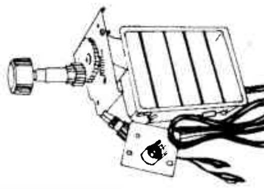

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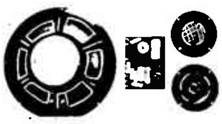

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THE LEPTONS

No, not more aliens for Captain Kirk to deal with, but a family of subatomic particles. Lepton means 'light particle', but some of them aren't, and they may not be made up of quarks either. Confused? So are the particle physicists. A.S. Lipson explains.

Once upon a time, physics was simple (well, nearly...). Subatomic physics especially, seemed to be fairly clear cut. Around the turn of the century, J. J. Thomson had discovered the electron, which carried a negative electrical charge. A few years later, Max Planck had stated the existence of the photon, or 'particle of light'. There was one other particle; the proton, which was positively charged, and had a mass about 1836 times that of the electron. The proton and electron were known to exist within atoms. That was the entire list of subatomic particles, and it looked as though everyone would live happily ever after.

Then things got complicated. In the 1930s and 40s, more particles started turning up, and they have continued to do so to the present day. First there were the neutron and mu-meson. Then there were the pi-mesons, or pions (three different ones!), the Kaons, the positron, the anti-proton, the anti-neutron, the anti-muon, a few different particles called Sigmas, and no less than four variations on a type of particle known as a neutrino (of which we will see more later).... The list seemed endless.

Eventually, the physicists managed to start simplifying the situation. It became apparent that many particles — the proton and neutron, for example, might be made up of various combinations of a few even more basic particles — called quarks. Instead of having all those different particles, maybe everything could be explained in terms of just three or four quarks. There was a particular group of particles, however — collectively known as 'leptons' — which did not seem to be made up of quarks. It's these particles which concern us in this article.

Light Matter

The word lepton comes from the Greek word 'lepto', meaning light, since the earliest leptons discovered were particles with relatively little mass. It is now known that not all leptons are light, after all, but the name has stuck.

The first lepton to be discovered was the electron, which has a negative electric charge of 1.6×10^{-19} coulombs, and a mass of 9.1×10^{-31} kg. (It will be convenient for the purposes of this article to refer to particles as having a mass of so many times the mass of the electron, so for the moment we can say simply that an electron has mass 1. Using this scale, a hydrogen atom has a mass of nearly 2000). The next particle to enter our story is the neutron. The neutron is not a lepton, but its relationship with the electron leads us to the next important point — the neutrino.

The neutron is a fairly massive particle; on the electron's scale it has a mass of 1839. It carries no net electrical charge — hence its name. One important feature of the neutron is that, like many particles, it is unstable. An isolated neutron will tend, after an average time of 15 minutes or so, to disintegrate, producing a proton (mass 1836) and an electron. You will notice that, since the neutron carries no charge, when it turns into a positively charged proton, it is necessary that an equal and opposite charge — the electron — is created at the same time, so that the total charge remains zero. All well and good, then; sometimes a neutron spontaneously changes into a proton and an electron.

Particle	Mass (x electron mass)	Charge (in coulombs)	Lifetime	Lepton
Proton	1836	1.6×10^{-19}	Stable	No
Neutron	1839	Zero	About 15 min	No
Electron	1	-1.6×10^{-19}	Stable	Yes
Electron-neutrino	Very small	Zero	Stable	Yes
Muon	207	-1.6×10^{-19}	2.2×10^{-6}S	Yes
Muon-neutrino	Very small	Zero	Stable	Yes
Tau	About 3500	-1.6×10^{-19}	Less than 3×10^{-12}S	Yes
Tau-neutrino	Very small	Zero	Stable	Yes

Table 1. Particles discussed in the article (antiparticles left out for simplicity).

Think Of A Particle...

Unfortunately, it isn't quite that simple. You see, when this reaction was first observed to happen, physicists weren't too happy with it. It seemed that certain physical laws which had always held before weren't holding any more. But then it was spotted that all the laws *would* be holding, if only there was another particle taking part in the reaction. This particle, although it had never been observed, was christened the 'neutrino', from Italian words meaning 'little neutral one' — since the neutrino, if it existed, would have little or no mass and be electrically neutral. The fact that the neutrino had never been detected was easily explained — all the methods used to detect subatomic particles depended on their having measurable masses and charges. The neutrino had neither. In fact, neutrinos react with other matter very rarely. If a beam of neutrinos was aimed at a concrete slab a light-year thick, by far the majority would get through easily!

You may think it a little bit far-fetched that scientists would actually *invent* a new particle — one that had never been found — just to explain why some physical laws didn't seem to work. Why not just change the laws? Well, all through the history of science, it has invariably turned out that the simplest explanation of a set of events is the correct one. In this case, it was simpler to keep the old, simple set of laws and invent a new particle, than it would have been to invent a whole new set of more complicated laws. This, at least, was how the physicists reasoned, and as it happened, they were right! In 1956, twenty-five years after its original invention, the neutrino was discovered! In fact, it was found that the particle produced when a neutron turned into a proton and an electron was not a neutrino, but its 'antiparticle', the antineutrino. This, however, was a small point, and the discovery of the actual existence of the neutrino is regarded as a major triumph for theoretical physics, which had predicted its existence all those years before.

So now our family of leptons contains two particles; the electron and the neutrino (and their antiparticles — the 'positron' and the 'antineutrino' respectively). This wasn't the case for long, though. In the late 1930s, another lepton was discovered in cosmic rays high up in the atmosphere. This particle was called the mu-meson, or muon for short. It was given the symbol μ , the Greek letter mu. There are only two real differences between the muon and the electron. Firstly, the muon has a much greater mass, about 207 times that of the electron; and secondly, the muon, like the neutron, is unstable, although on average it has a much shorter lifetime. Under normal conditions, a muon will disintegrate after only about one five hundred thousandth of a second, turning into an electron and producing two neutrinos. Apart from these two differences, however, the electron and muon are strikingly similar. For instance, both carry the same charge, -1.6×19^{-19} coulombs. The anti-muon carries a positive charge of the same magnitude, just as does the anti-electron, or positron. The similarity between the two particles has been puzzling physicists ever since the discovery of the muon. But there's one more thing puzzling them, too. . . .

Identical Twins?

It was found that many of the reactions involving electrons also involved neutrinos. Similarly, many reactions involving muons also involved neutrinos. The neutrinos that reacted along with electrons didn't seem to be the same as those which reacted along with muons. Apparently, there were two types of neutrinos. If you examined a neutrino from a reaction involving an electron, you would find that it could not be made to take part in a reaction involving a muon. Similarly, a neutrino from a muon reaction could not be made to react with an electron. Neutrinos, then, had to be divided into two groups; 'electron neutrinos' and 'muon neutrinos'. What is the difference between the two types of neutrino? The somewhat embarrassing answer (for a physicist) is that, even today, nobody really knows. They *are* different, but we don't know why. All we do know is that reactions involving electrons tend also to involve electron neutrinos, whereas reactions involving muons tend to involve muon neutrinos. When a reaction involves both electrons and muons, both types of neutrinos are involved. For instance, when a muon turns into an electron, a muon neutrino and an electron antineutrino are produced (see Fig.1b). The two types of neutrinos are like almost-identical twins — you can't tell the difference just by looking at them, but only by looking at the different ways they behave. And, of course, each of the two types of neutrino has its own anti-neutrino, as well.

Three's A Crowd. . . .

As if the situation wasn't already complicated enough, experiments conducted in the last five years or so indicate (wait for it) that there's yet another lepton. This one, called the tau particle (and given the symbol τ — the Greek letter tau) is, again, just like the electron and muon, but with a still greater mass (about 3500 times the mass of an electron — nearly as massive as a molecule of hydrogen! As far as subatomic particles go, this is well into the heavyweight league), and with a still shorter average lifetime before it distintegrates into other particles. As yet, experiments are not conclusive, but it seems that the tau particle also has its own pair of neutrinos — the tau neutrino and the tau antineutrino. Unsurprisingly, these neutrinos refuse to take part in electron or muon reactions, unless a tau particle is also involved.

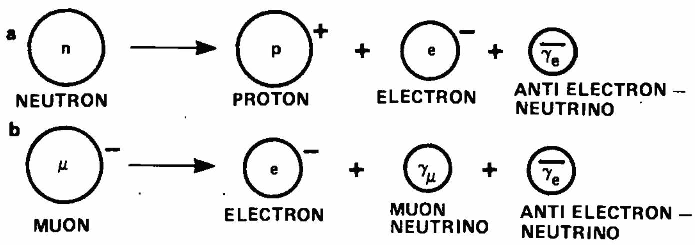

Fig. 1. (a) Neutron turning into proton and electron, giving off anti-neutrino. (b) Muon disintegrating to produce electron, muon-neutrino and anti electron-neutrino.

Any Answers?

So that is the situation at the moment. There are three known leptons which carry electric charge — the electron, the muon and the tau (each also having a positively charged antiparticle) and correspondingly, three sets of a pair of neutrinos — the electron-, muon- and tau-neutrinos, with their antiparticles. There are a lot of questions still to be answered. Are there any more leptons, like the electron, muon and tau, but with still greater masses, and shorter average lifetimes? If there are, do they also have their own neutrinos? And for that matter, what is it that makes, say, a muon neutrino different from a tau neutrino? There's one more major problem too. . . . . .

A Massive Question

It has been known for several decades now that neutrinos have very little, or perhaps no mass at all. In fact, there has been a tendency among physicists to believe that the latter is the case — that the neutrino has no mass, although this has never been proved. Very recent experiments, however, make it look as though perhaps the neutrinos do have masses after all. If this is so, then physicists may have to rethink a lot of theories. Do neutrinos have mass? We shall just have to wait and see and maybe everyone *will* live happily ever after. . . . . **ETI**

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BC212L	**★8p**
BC213L	**10p**
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BC214L	**★8p**
BC238	**18p**
BC261B	**23p**
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BC328	**17p**
BC461	**40p**
BC477	**35p**
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	4007A	**13p**	4017A	**40p**	7490	**23p**	1N4007	**6p**	ZD9V1	**5p**	TIP31A	**22p**	SN76115N	**50p**	640 uF/16V	**4p**
	4011B	**15p**	7420	**13p**	OA91	**5.5p**	1N5404	**10p**	BF244C	**14p**	TIP3055	**22p**	33uF/40V	**4p**	WOO5	**16p**

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K116	10	MPSL01 NPN 140V TO92
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K129	8	AA113 diodes
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GUITAR NOTE EXPANDER

If you've ever built a conventional fuzz/sustain unit, you may have been disappointed by the harshness of the sound. If so, we present the answer to your problems — soft clipping. Design by Q.A. Rice. Development by Plamen Pazov.

A good number of fuzzbox circuits have appeared in the past which attempt to emulate the sound of an over-driven valve amp; the majority of these look great on a scope but still sound rough. The chief characteristic of valve amps is the way they overload; rounding off the peaks as opposed to transistor circuits which clip off the peaks, producing predominant odd harmonics. FET amps produce overload in a similar way to valve amps, and a cheaper and better (or worse) way to obtain this is to use CMOS gates in the linear mode. Figure 1 shows the overload for a triangular waveform. In the final circuit we have used a very versatile and much under-used CMOS IC, the CD4007 dual complementary pair and inverter. One complementary pair is wired as a second inverter — the two inverters are used as amplifiers and give a combined gain of 60 dB. One of the remaining CMOS FETs is used as a voltage-controlled resistor which can vary between from several megohms to a few hundred ohms. The output of the amplifier is passed to a detector which controls the resistance of the FET, and this is fed back to various parts of the circuit to give the expansion and compression effects. Figure 2 shows the input/output characteristics for the various functions. The compressor is effective over a 30 dB range.

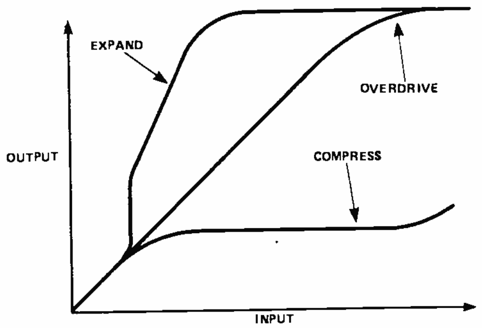


Fig.2 Input/output characteristics for various functions of the effects unit.

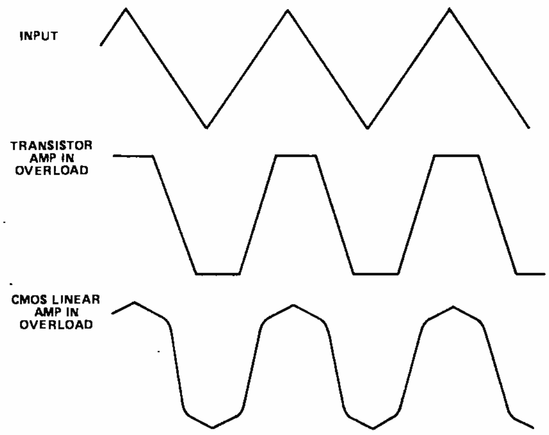


Fig.1 Clipping characteristics for two types of amplifier under overload conditions.

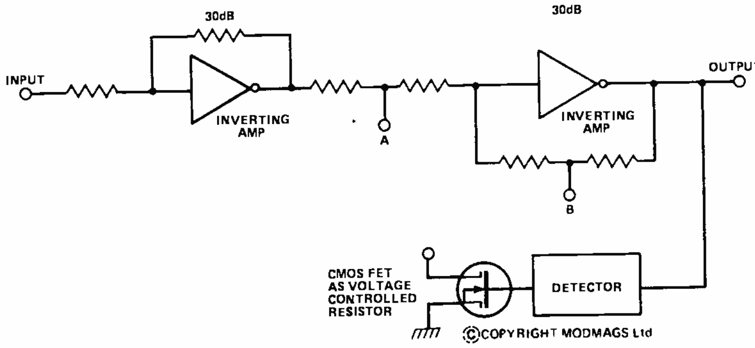
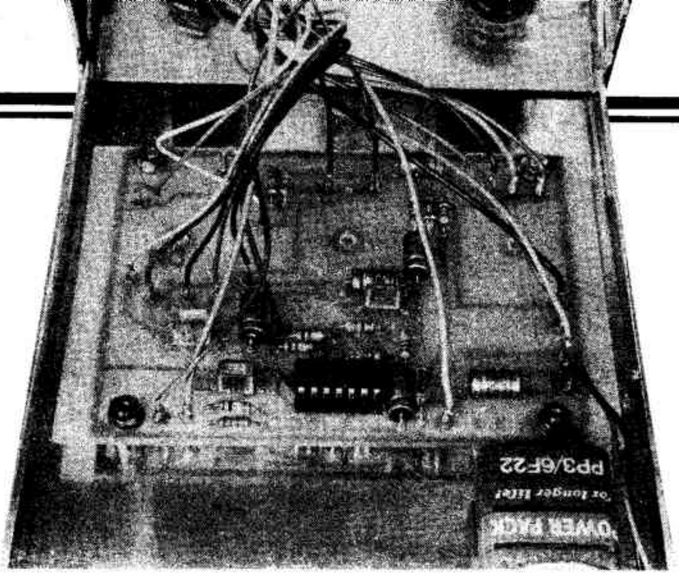


Fig.3 This diagram shows the basic principle of the unit.



The unit has six functions, as follows:

1. Overall overdrive
2. Overall compression, for sustaining
3. High frequency compression, for bass overdrive
4. Overall expansion, for sustained overdrive
5. Mid expansion, for mid to high accentuation
6. High frequency expansion, for high accentuation

The effect of all these functions is variable, with the exception of overdrive.

Construction

The PCB is designed to accept the control components (SW2 and pots) if PCB-mounting of these components is preferred, to give a very compact construction. For the prototype this was not necessary as we used a custom-built housing (see Buylines). The box comes unpunched so if you want to arrange the controls and sockets differently you can get a drill and do your own thing. If you use a different housing remember that a metal case should be used to maintain proper screening.

We used a volume control with a built-in on/off switch instead of the standard method of using the input jack, as the latter approach produces a 9 V peak back into the source circuit and can cause damage if this circuit is active.

If the guitar has a low sensitivity pickup, it may be necessary to increase the value of R2 accordingly. The unit only consumes 3 mA so the batteries should last quite a while.

HOW IT WORKS

CMOS inverters may be used in the same manner as op-amps in the inverting mode, with the added bonus that they are self-biasing. The input is fed into IC1a, configured as a high gain, high impedance amplifier to give a gain of around 30 dB. This is decoupled and passed through a resistor pair to a second amplifier stage, which has a resistor pair in its feedback (see Fig. 3). If point A is now taken to ground via a resistance, gain is reduced; if this is done to point B, gain is increased. The final output is passed through a detector to give a voltage proportional to the signal level; this voltage is used to control the CMOS FET. If the FET is taken to point A or point B, then the overall gain is proportional to the final output signal. Thus if the output reduces the signal, it is self compressing. If it increases it, the signal is expanded. By making these gain variations frequency-dependant, we can accentuate or subdue the high frequency as required, at various break points to give the effects required. The output signal has to be attenuated to return it to its original level.

PARTS LIST

Resistors (all ¼W, 5%)	
R1, 10	100k
R2	3M3
R3, 4, 7	4k7
R5, 6	150k
R8	1M0
R9	470k
Potentiometers	
RV1	10k logarithmic
RV2	100k logarithmic with integral switch
Capacitors	
C1	220n polyester
~~C2~~, 3, 4, 6, 10, 11	2u2 16 V axial electrolytic
C5	22n polyester
C7	3n3 ceramic or polycarbonate
C8	1n0 ceramic or polycarbonate
C9	10n polyester
Semiconductors	
IC1	CD4007
D1, 2	OA91
Miscellaneous	
SW1	DPDT latching footswitch
SW2	2-pole 6-way rotary switch
SK1, 2	mono jack sockets
~~Battery clip~~ (PP3), metal box (see Buylines).	

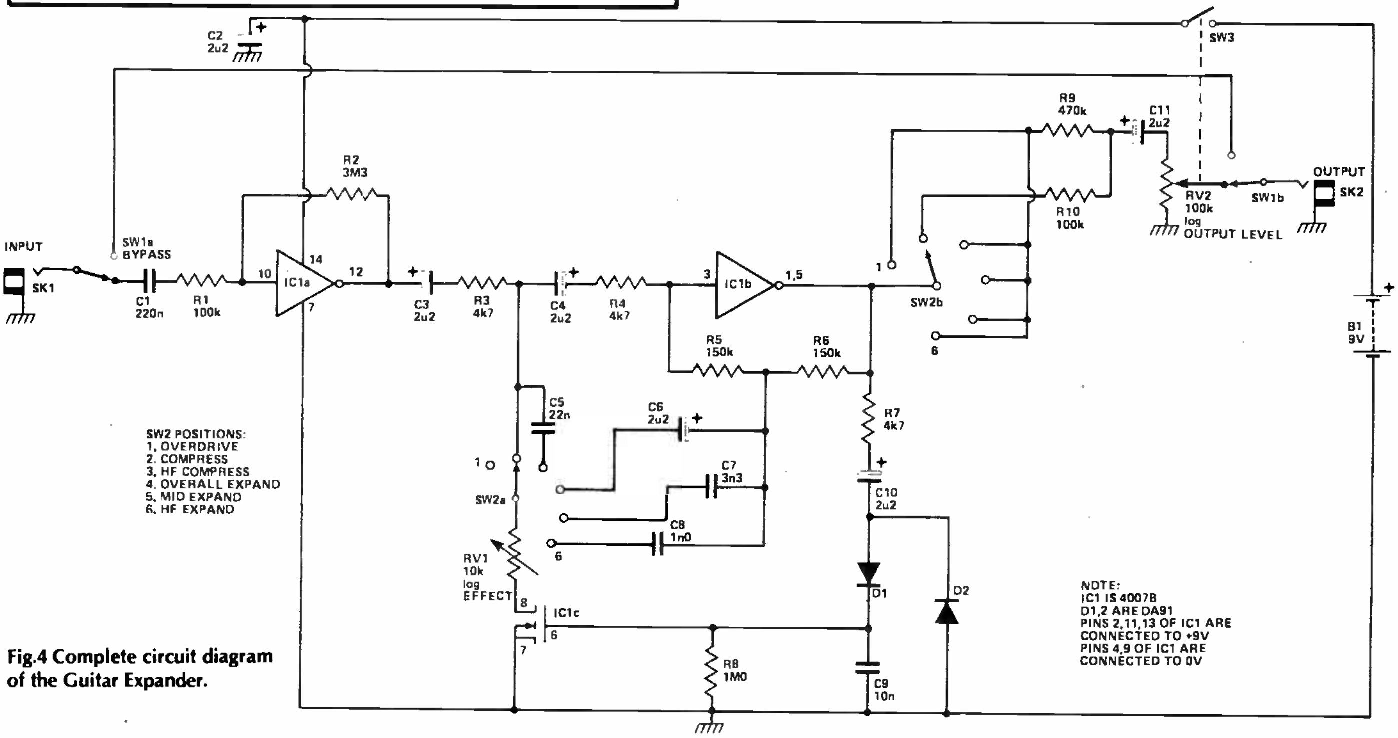
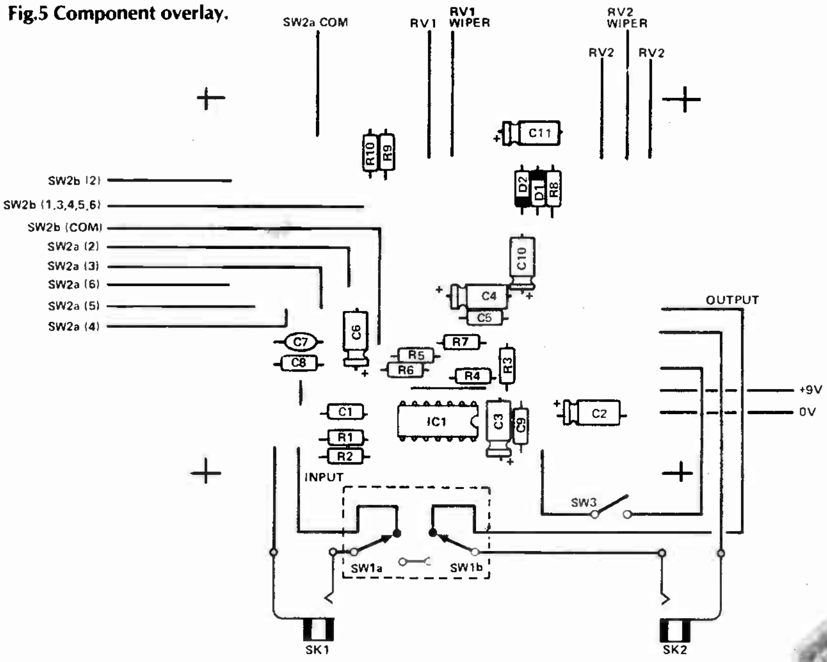
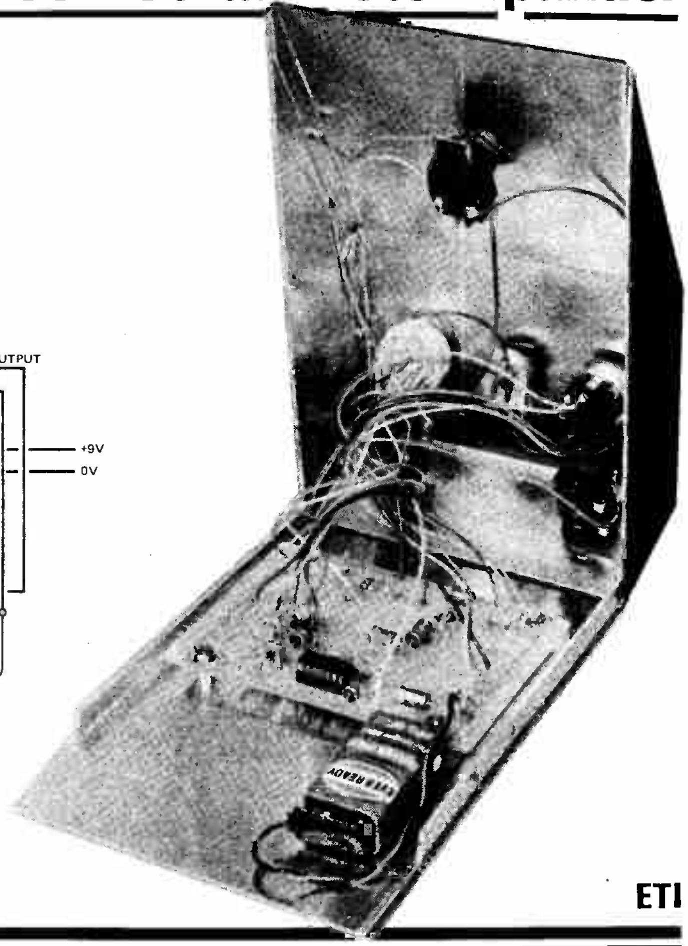


Fig.4 Complete circuit diagram of the Guitar Expander.

Fig.5 Component overlay.





BUYLINES

As mentioned in the text, we have arranged for the construction of a custom case for this project, or indeed any other of your musical projects. H.L. Smith & Co Ltd, 287 Edgware Road, London W2 1BE will supply the box, ref. ETI-1 for the modest sum of £2.00.

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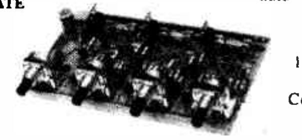

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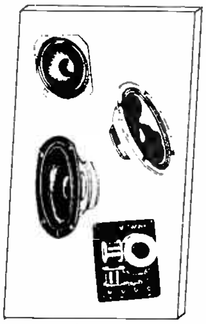

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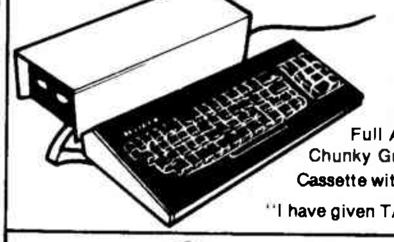

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IK 16 parallel I/O lines. Cassette Interface—1 serial I/O line. 2 x 16 BIT counter timers OPTIONS TK RAM total—32 parallel I/O lines. 4 x 16 BIT counter timers—RS232. 20MA current loop.
10K MICROSOFT BASIC—£49
System Rack—**£49** in black/tangerine in brushed aluminium.
Full Ascii Keyboard with numeric pad—**£60.85.** Cabinet available—**£20.** Lower Case option—**£9.48.**
Chunky Graphics Pack—**£6.52.** Tanram Full Memory Expansion to 40K—**£119.00.** Mini Motherboard—**£10.00.**
Cassette with counter—**£21.70.**

"I have given TANGERINE five bonus points for getting just about everything right"—E.T.I. Mag., May 1980

video genie

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•16K user RAM plus extended 12K Microsoft BASIC in ROM •Fully TRS-80 level II software compatible •Self-contained, PSU, UHF modulator and cassette •Simply plugs into video monitor or UHF TV.

16K £299 Expander from £195.00

COMMODORE	8K	£399.00
	16K	£499.00
	32K	£649.00
SHARP MZ80	20K	£449.00
APPLE	16K	£599.00
Epsom Printer		£349.00

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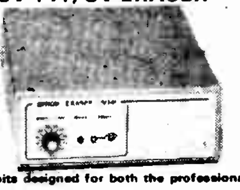
UV 141, UV ERASER



Two easy to use units designed for both the professional and amateur UV-prom user

Features

- Can erase up to 14 proms.
- Special short wave ultraviolet tube.
- Erase time variable between 5 and 50 minutes in 5 minute steps (preventing over exposure which may shorten prom life).
- Sliding tray carries proms on conductive foam.
- Safety interlock switch prevents the timing circuit from operating and switching on the tube with the tray open.
- "Mains On" and "Tube On" indicators.
- Smart textured case.
- Complete instructions supplied.

Supplied complete with mains plug and flex

Model UV 141. Price £77.70
Also available without timer as
Model UV 140: Price £61.20

TEX MICROSYSTEMS "EPROMPT" UV ERASER

A low cost alternative to the above erasers (UV 140/141) claimed by the manufacturer to erase up to 32 chips in 15-30 mins. This is the cheapest eraser we have seen. The unit has no timer, power switch or safety interlock switch. The user places up to 32 chips into loose conducting foam in the erasure tray (16 along the base, 8 on each side). The chips are held in place by the UV tube which sits in the tray. (Unlike the UV 140/141, no special precautions have been taken to prevent the seepage of UV light, but the manufacturers state that incident light from this device is quite safe at distances above 12 inches.)

(Dimensions — 325×64×38mm)

EPROMPT ERASER **Price £33**

EUROCARD COMPUTER BOARDS

'Custom 80' Modular Z80 Based System. Details in preparation, free on request.

"BIG BOARD" Z80 COMPUTER KIT

We hope this item will be in stock by the time this advert reaches you, but please check to see before sending any money! Features: 64K Dynamic RAM. Floppy Disk Controller. 80 x 24 Char. Video output £395. CP/M Disk Operating System to suit. £99.

MODULAR COMPUTER SYSTEM CARDS

A range of 'International' (114 x 203mm) size cards which may be purchased individually as desired, or to build up a complete system. Further details available on request. All boards are epoxy glass with gold plated edge plug.

VDU A, B, G (set of 3)	£27.20
SC/MP-2 SC/MP CPU	£9.40
MPA 7 Buffered SC/MP CPU	£9.40
MZB-3 Z80-CPU	£9.40
MXA-1 2K of 2102	£9.40
MXA-3 8K of 2114	£9.40
MXD-2 16K of 4116	£9.40
PRM-2 4K of 5204	£9.40
PRM-8 8K of 2708	£9.40
RRM-14 8K of 2516 + 6K of 2114	TBA
SIO-2 RS-232 (two)	£9.40
TPA-2 Tape Interface	£8.90
IP-2 Input Port	£9.40
DCR 6 Keyboard Input	£8.90
OP-3 Output Port	£9.40
PP-2 PROM Programmer	£9.40
PSU-A4 Power Supply	£8.90
PSU B 5V Power Supply	£5.50
PSU C 25V Power Supply	£5.50
13-slot backboard, can be used with most of the above boards. 13" x 4⅜" ISBUS-1 1	£11.50

CMOS

These cut prices for Amateur Users and Export. Note: Industrial users — quantity prices available. Mostly Motorola, RCA

4000	18p	4042	80p	4095	£1.97	4410	£8.55	4531	£1.45
4001	25p	4043	90p	4096	£1.97	4411	£10.72	4532	£1.30
4002	25p	4044	90p	4097	£5.98	4412VP	£14.93	4534	£5.60
4006	95p	4045	£2.63	4098	£1.92	4415V	£5.24	4536	£3.69
4007	18p	4046	£1.10	4099	£2.00	4422	£5.66	4537L	£26.10
4008	80p	4047	£1.71	40100	£1.92	4433	£12.30	4538	£1.20
4009	40p	4048	77p	40101	£1.69	4435V	£5.40	4539	97p
4010	50p	4049	45p	40102	£3.67	4450	£3.81	4541	£1.19
4011	25p	4050	49p	40103	£3.67	4451	£3.81	4543	£1.80
4012	18p	4051	80p	40104	£1.85	4461	£3.93	4549	£4.38
4013	50p	4052	80p	40105	£1.85	4462	£4.41	4552	£14.85
4014	84p	4053	80p	40106	92p	4490FP	£4.20	4553	£4.50
4015	84p	4054	£2.18	40107	£1.28	4490VP	£3.14	4554	£1.38
4016	45p	4055	£2.55	40108	£7.54	4500	£6.95	4555	78p
4017	80p	4056	£2.55	40109	£1.28	4501	29p	4556	72p
4018	89p	4059	£9.23	40110	£3.00	4502	£1.20	4557	£3.86
4019	45p	4060	£2.10	40114	£1.77	4503	70p	4558	£1.25
4020	99p	4062T	£10.00	40160	£1.54	4505	£5.71	4559	£4.38
4021	£1.10	4063	£1.90	40161	£1.54	4506	50p	4560	£2.50
4022	£1.00	4066	55p	40162	£1.54	4507	55p	4561	81p
4023	27p	4067	£7.21	40163	£1.54	4508	£2.90	4562	£5.60
4024	78p	4068	27p	40174	£1.54	4510	99p	4566	£1.59
4025	27p	4069	27p	40181	£5.03	4511	£1.50	4568	£2.38
4026	£3.25	4070	30p	40182	£1.90	4512	80p	4569	£2.50
4027	50p	4071	25p	40192	£2.41	4514	£2.65	4572	40p
4028	84p	4072	25p	40193	£2.41	4515	£3.00	4580	£4.77
4029	99p	4073	29p	40194	£3.27	4516	£1.10	4581	£2.62
4030	74p	4075	25p	40208	£7.54	4517	£4.46	4582	£1.14
4031	£4.31	4076	£1.07	40257	£2.31	4518	£1.00	4583	90p
4032	£1.31	4077	29p	4160	98p	4519	80p	4584	90p
4033	£2.63	4078	29p	4161	98p	4520	£1.00	4585	£1.27
4034	£2.00	4081	27p	4162	98p	4521	£2.50	4597	£2.44
4035	£1.10	4082	27p	4163	98p	4522	£1.11	4598	£2.98
4037	£1.99	4085	£1.35	4174	90p	4526	£1.08	4599	£6.95
4038	£1.20	4086	£1.35	4175	£1.15	4527	£1.50	4700	£1.75
4039	£2.78	4089	£2.91	4194	£1.16	4528	£1.20		
4040	£1.00	4093	80p	4408	£9.37	4529	£1.30		
4041	£1.59	4094	£2.50	4409	£9.37	4530	70p		

74C

		74C76	57p	74C163	£1.15	74C904	57p	74C926	£5.81
		74C83	£1.34	74C164	£1.00	74C905	£7.53	74C927	£5.81
74C00	20p	74C85	£1.34	74C165	£1.00	74C906	57p	74C928	£5.81
74C02	20p	74C86	67p	74C173	90p	74C907	57p	74C929	£17.00
74C04	20p	74C89	£4.82	74C174	90p	74C908	£1.00	74C930	£17.90
74C08	20p	74C90	80p	74C175	90p	74C909	£1.00	80C95	85p
74C10	20p	74C93	80p	74C192	£1.15	74C910	£7.45	80C96	82p
74C14	90p	74C95	£1.00	74C193	£1.15	74C911	£7.30	80C97	85p
74C20	20p	74C107	£1.27	74C195	£1.00	74C912	£7.30	80C98	92p
74C30	20p	74C150	£3.81	74C200	£7.46	74C914	£1.46	82C19	£0.28
74C32	20p	74C151	£2.95	74C221	£1.41	74C915	£1.15	88C29	£2.00
74C42	95p	74C154	£3.81	74C373	£1.79	74C918	£1.10	88C30	£2.00
74C48	£1.43	74C157	£2.20	74C374	£1.79	74C921	£17.07		
74C73	57p	74C160	£1.40	74C901	57p	74C922	£3.78		
74C74	50p	74C161	£1.15	74C902	79p	74C923	£3.86		
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74LS

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		74LS63	£1.50	74LS153	76p	74LS245	£3.50	74LS375	£1.60
74LS00	14p	74LS73	46p	74LS154	£1.70	74LS247	£1.90	74LS377	£2.12
74LS01	14p	74LS74	41p	74LS155	96p	74LS248	£1.90	74LS378	£1.84
74LS02	16p	74LS75	48p	74LS156	96p	74LS249	£1.90	74LS379	£2.15
74LS03	16p	74LS76	40p	74LS157	76p	74LS251	£1.34	74LS384	86p
74LS04	16p	74LS78	40p	74LS158	96p	74LS253	£1.42	74LS386	86p
74LS05	20p	74LS83	£1.15	74LS160	£1.28	74LS257	£1.10	74LS390	£2.30
74LS08	22p	74LS85	£1.18	74LS161	98p	74LS258	£1.46	74LS393	£2.30
74LS09	22p	74LS86	43p	74LS162	£1.38	74LS259	£1.60	74LS395	£2.18
74LS10	20p	74LS90	60p	74LS163	£1.18	74LS261	£4.50	74LS396	£2.15
74LS11	22p	74LS91	£1.04	74LS164	£1.14	74LS266	52p	74LS398	£2.76
74LS12	23p	74LS92	89p	74LS165	75p	74LS273	£2.44	74LS399	£2.30
74LS13	38p	74LS93	89p	74LS166	£2.26	74LS275	£2.50	74LS445	£1.50
74LS14	75p	74LS95	£1.16	74LS170	£2.88	74LS279	66p	74LS447	£1.44
74LS15	30p	74LS96	£1.16	74LS173	£1.05	74LS283	£1.92	74LS490	£1.80
74LS20	20p	74LS107	44p	74LS174	£1.06	74LS290	£1.28	74LS668	£1.82
74LS21	22p	74LS109	55p	74LS175	£1.10	74LS293	£1.28	74LS669	£1.82
74LS26	48p	74LS112	55p	74LS181	£3.98	74LS295	£1.85	74LS670	£2.48
74LS27	28p	74LS113	50p	74LS183	£2.98	74LS298	£1.68		
74LS28	48p	74LS114	50p	74LS190	£1.40	74LS324	£2.40		
74LS30	20p	74LS122	70p	74LS191	£1.40	74LS325	£2.90		
74LS32	27p	74LS123	70p	74LS192	£1.30	74LS326	£2.94		
74LS33	39p	74LS124	£1.80	74LS193	£1.30	74LS327	£2.86		
74LS37	39p	74LS125	60p	74LS194	£1.66	74LS347	£1.48		
74LS38	39p	74LS126	60p	74LS195	£1.36	74LS348	£1.86		
74LS40	28p	74LS132	95p	74LS196	£1.00	74LS352	£2.28		
74LS42	98p	74LS136	55p	74LS197	£1.40	74LS353	£2.28		
74LS47	90p	74LS138	85p	74LS221	96p	74LS365	65p		
74LS48	£1.20	74LS139	85p	74LS240	£2.36	74LS366	65p		
74LS49	£1.20	74LS145	£1.08	74LS241	£2.32	74LS367	65p		
74LS51	24p	74LS147	£1.70	74LS242	£2.32	74LS368	66p		
74LS54	28p	74LS148	£1.73	74LS243	£2.32	74LS373	£1.80		

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5.000 MHz	£3.23
5.0688 MHz	£3.23
5.120 MHz	£3.23
5.185 MHz	£3.23
6.000 MHz	£3.23
6.144 MHz	£3.23
6.400 MHz	£3.23
6.55360 MHz	£3.23
7.000 MHz	£3.23
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9.800 MHz	£3.92
10.000 MHz	£3.23
10.245 MHz	£3.23
10.700 MHz	£3.23
10.92 MHz	£3.92
11.000 MHz	£3.92
12.000 MHz	£3.92
14.0 MHz	£3.92
14.31818 MHz	£3.23
16.000 MHz	£3.92
18.000 MHz	£3.23
18.432 MHz	£3.23
20.000 MHz	£3.62
20.1134 MHz	£3.23
24.0 MHz	£3.92
26.690 MHz	£2.10
27.0 MHz	£3.92
27.145 MHz	£2.10
27.648 MHz	£3.92
38.6666 MHz	£3.23
48.000 MHz	£3.23
100.000 MHz	£3.23
116.000 MHz	£3.23

VEROBOARD
0.1" Pitch with copper strips

2½"×1" (pack of 5)	£1.01
2½"×3¾"	73p
2½"×5"	83p
2½"×17"	£2.51
3¾"×3¾"	83p
3¾"×5"	95p
3¾"×17"	£3.26
4.7"×17.9"	£4.28

0.1" Plainboard (no strips)

3¾"×2½"	52p
3¾"×5"	79p
3¾"×17.0"	£2.11
Terminal pins	£1.50/500
V-Q DIP board	£1.58
DIP breadboard	£3.98
Spot face cutter	£1.18
Pin insertion tool	£1.82

SOLDERCON PINS
100 50p   1000 £3.95

DIL SOCKETS
8/14/16 pin 10p/12p/13p
18/20/22 pin 18p/20p/25p
24/28/40 pin 30p/40p/50p
24 pin Textool lever type zero insertion force £7.00

EDGE CONNECTORS
43 way, 0.1" pitch, wire wrap, polarizing slot pin 37
Single sided (1×42) £3.11
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TIMER ICs
NE555/556 29p/49p

OP-AMPS (All Mini dips)

CA 3130E	84p
CA 3140E	35p
UA 741 (Texas)	22p

LED DISPLAYS

DL-704E	99p
DL 727E/728E	£2.00
DL-747E/750E	£1.80
FND 500/560	£1.20

LIQUID CRYSTAL DISPLAY
4×0.5" Digits 40 pin DIL £9.75

CLOCK CHIPS

AY-5-1224A	£2.60
MK 50253	£5.50
MK 50366	£6.50

SIX DECADE COUNTERS

MK 50395/6/7	£9.90
MK 50398/9	£7.50

SWITCH MODE PSUs

AC 5221S 5V/10A	£69.90
AC 9221S 5V/5A, 12V/1A, −12V/1A, −5V/0.1A	£86.80
AC 5421S 5V/20A	£99.20
AC 9421S 5V/10A 12V/2A −12V/2A −5V/0.1A	£126.50

OPEN CARD SWITCH MODE PSU
FULLY ASSEMBLED P C B CARD 197 x 108 x 52mm Outputs +5V 6A −5V/0 5A, +12V/1A −12V 1A
Type AC9251 £79.80

FLOPPY DISK CONTROLLER BOARD

This is used in conjunction with 'Kemitron' Z80 boards to interface to twin single density S/S 8" floppy disks. It is not available as a bare board, but only built and tested. Regrettably Kemitron do not supply circuit diagram £165.00

To run CP/M on the system a serial interface (e g SIO board) to some sort of VDU or terminal is required, and 48K of RAM (e g three MXD-2 boards). The MZB-3 board has facilities for 'power on jump' and a 'boot prom' to load the CP/M operating system from the disk.

Boot PROM (2708)	£19.95
CP/M (8" floppy disk)	£89.00

8" FLOPPY DISK DRIVES
DRE Model 7100 **£350.00**

60 KEY ASCII KEYBOARD

High quality. Capacitive switches, metal mounting frame £49.70

T.V. MONITOR P.C.B. for OEM users

This is an assembled P.C.B. size 130 x 190mm, which you add to your own 12"/14" black and white C.R.T. (90 degree, 20mm dia neck), to obtain a T.V. monitor at modest cost. (Regrettably we cannot supply the C.R.T. at present.)

Preset controls, contrast, brightness, etc., are included, and the only inputs needed are 15 Volts ± 10% AC at 1.5 Amps and 1 Volt pk-pk composite video input.

Supplied with circuit diagram £33.50

KEYBOARD CASES

405 x 210mm. Panel size 330 x 188mm	£10.14
510 x 340mm. Panel size 430 x 115mm	£26.22

DOT MATRIX PRINTER

This is about the same price as for example the Nascom Imp, but has many features only previously found in models costing hundreds of pounds more:

Standard interfaces (not 'extras') RS-232, 20mA, IEE 488, Centronics I/O. 15 baud rates to 9600. 100 characters per second. 64, 72, 80, 96, 120 or 132 characters per line, rear, bottom or front paper loading, friction or tractor feed, can accept user defined characters, can also print graphics under program control, has 'self-test' facility. Supplied with mains cable and full operator's manual.

Base 2 Model 800 £325.00

QUME DAISYWHEEL PRINTER

High quality printer for use with word processing packages running under CP/M. 45 characters per second. RS 232 interface. (Check stock position before ordering.)

Qume Sprint 5 Model 45/RO £1505.00
Also available on lease.

QUME SUPPLIES AND ACCESSORIES

Forms Tractor	£110.00
Standard Printwheels	£6.60
Word Processing Printwheels	£6.80
Ribbons (in packs of 12)	
Medium Inked Fabric Black	£27.60
Multi Strike Black	£27.60
Single Strike Black	£40.56

EUROCARD 19" CARD FRAME

Kit of 2 end plates + angles, 2 front and 2 rear tie bars, 4 guide location strips £28.64

Accessories

Card guides (pack of 10)	£1.53
Eurocard Plug (64 way DIN 41612)	£2.22
Eurocard Socket (64 way DIN 41612)	£3.39
Connector mounting strips (pair)	£3.27
Case conversion kit	£19.80
(or fit into separate 3U 19" D-type case)	£32.58

MICROPROCESSORS

6502

6502	£6.95
6520/21	£4.95
6522	£6.95
6532	£8.25

Z80

Z80A-CPU	£7.93
Z80A-P10	£5.75
Z80A-CTC	£5.75

6800

6800 MPU	£5.95
6802 MPU	£0.95
6809	£19.95
6810 (128 × 8 RAM)	£3.25
68A10 (128 × 8 RAM)	£3.75
6820, 6821 PIA	£3.50
6845	£22.30
6850 ACIA	£4.85
MC6880	£2.64

SC/MP II RAM I/O

SC/MP II (4MHz)	£10
INS 8154 RAM I/O	£9.40
INS 8255 I/O	£4.75

CMOS

COSMAC CDP 1802CE	£6.50
COSMAC CDP 1802E	£10.85
CDP 1864	£7.25

STATICS (Mostly 450nS)

2102—1K x 1	£1.20
2111—256 x 4	£2.25
2112—256 x 4	£2.25
2114/4045—1K x 4	£2.25
8 x 2114	£15.36
2114L—1K x 4	£1.99
4118—1K x 8	£8.95

DYNAMICS

4116 16K 200nS	£1.99
8 x 4116	£15.36

1UV ERASABLES

5204 (512 x 8)	£9.95
2708 1K x 8	£3.43
2716/2516 2K x 8 single 5v	£4.98
2532 4K x 8 (5v)	£14.95

5204/2708/2516 Programming Service £7.50/£7.50/£15.00 each prom. (Price does not include prom. We accept handwritten/typed source code — must be hexadecimal)

PROM WASHING SERVICE
50p each prom

UV PROM ERASER

UV140	£61.20
UV141	£77.70
EPROMPT	£33.00

INTERFACE

81LS96/6/7/8	£1.40
1488 (RS232)	90p
75491 LED driver	50p
75492	92p
ZN425	£3.95
8T26/8T28	£2.84
IL74	48p
AY-3-8910	£8.50
FD 1771	£29.00

CRT Controller: Uarts

AY-5-1013	£4.00
AY-5-1013A	£4.70
AY-3-1014A	£5.00
AY-3-1015	£5.00
6402	£4.50
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MK 2302	£15.20
RO-3-2513 (5v Uppercase)	£4.75
DM 8678 CAB	£14.27
AY-5-2376	£7.00

SOFTWARE
To suit Z80 Tiny Basic
Moonlander Game Cassette £1.00
Listing £1.00
Noughts and Crosses Cassette £1.00
Listing £1.00

FIRMWARE

ZMON for Z80 (1 x 2708)	£14.95
2K Tiny BASIC for Z80 (2 x 2708)	£19.95
4K NIBL for SC/MP (4 x 2708)	£49.95
4K NIBL-MON for SC/MP (4 x 2708)	£40.95
1K Various, for SC/MP (1 x 2708)	£14.95

(Descriptive leaflet available on above. Ref SW4, 5)

1K Elektor Junior (1x2708)	£19.95
1½K ELBUG (3×5204)	£35.00
ETIBUG 1 (1×5204)	£14.95
ETIBUG 2 (1×5204)	£14.95
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UM1233 E36 Wide bandwidth, computer VDU type £4.70
UM1286 E36 Combined wide bandwidth vision modulator with intercarrier sound, high performance £8.25

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7805	75p
7905	£1.00
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78H05	£5.81

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Ideal for use in otherwise 5V only systems, to obtain +12V, −12V, or dual ± 12V power for ASCII keyboards, RS-232 interfaces, dynamic RAMs etc. All types need +5V input.
Size of each module (excluding pins) 34 x 28 x 10mm.
Type ADIP-12A10 +12V output. (25-84mA) £4.95
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Type ADID-12A10 ± 12V dual output. 2 x (12-42mA) £5.25

READER'S DESIGNS

CARAVAN LIGHTS CHECKER

A project that will pay for itself in the first ticket from the police that you don't collect. Submitted by Graham Packer of Soutergate.

Many ETI readers, besides boring the pants off their neighbours with dreary electronics, are just as anti-social when it comes to cluttering up the highways with their sluggish caravans. Now that they (and their caravans) are in hibernation until summer, the time is at hand to reach for soldering iron and component catalogue and make amends.

Most caravans receive their power supply and lighting signals by way of a multiway plug and socket, terminating on a 'choc-block' terminal strip under the front seat/bed. This is where the 'guts' of the project goes. The cable is merely chopped and the large plastic box inserted. The display unit can be mounted anywhere that is visible from the driving mirror and double sided tape (the thick foamy kind) may be used to hold it on the wardrobe or side of the kitchen unit.

For once, no complicated electronics; just the most basic of electromagnetic devices, the relay, albeit in its more refined form of the reed insert. These reeds, originally developed for electronic telephone exchanges, need about 20 to 50 ampere turns to pull them in. The current drawn by a caravan sidelight, brakelight or indicator lamp can be found by calculation (or just asking people) and the correct number of turns wound around the reed.

Reed inserts may be obtained from a number of sources and be of dubious vintage. Therefore, it's best to wind on 40 or 50 turns of 22 swg insulated wire and check them out first with the test circuit shown.

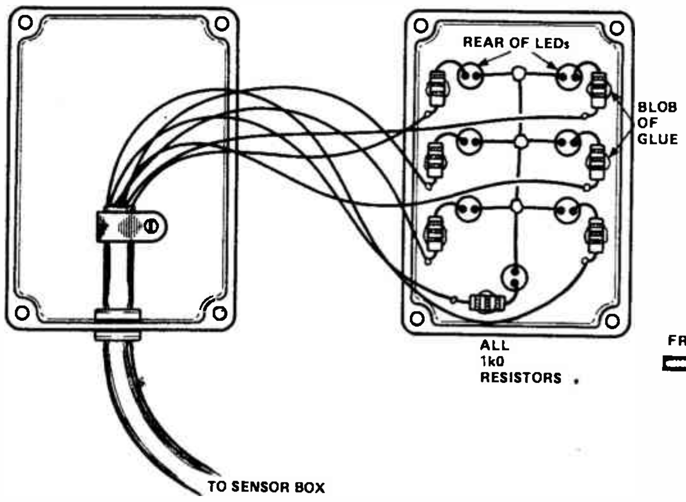
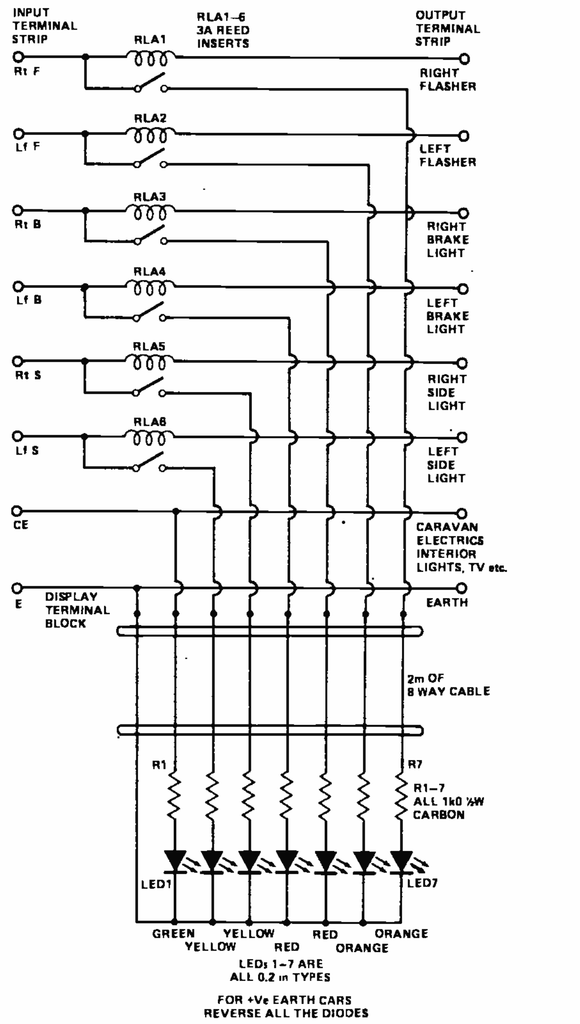


Fig. 1 Construction details of the display box.



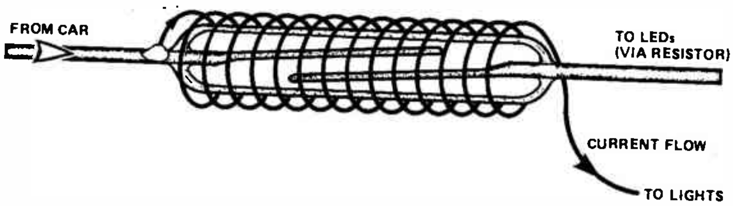


Fig. 2 Circuit diagram with relay assembly/wiring details.

Fig. 3 Construction details of the sensor box.

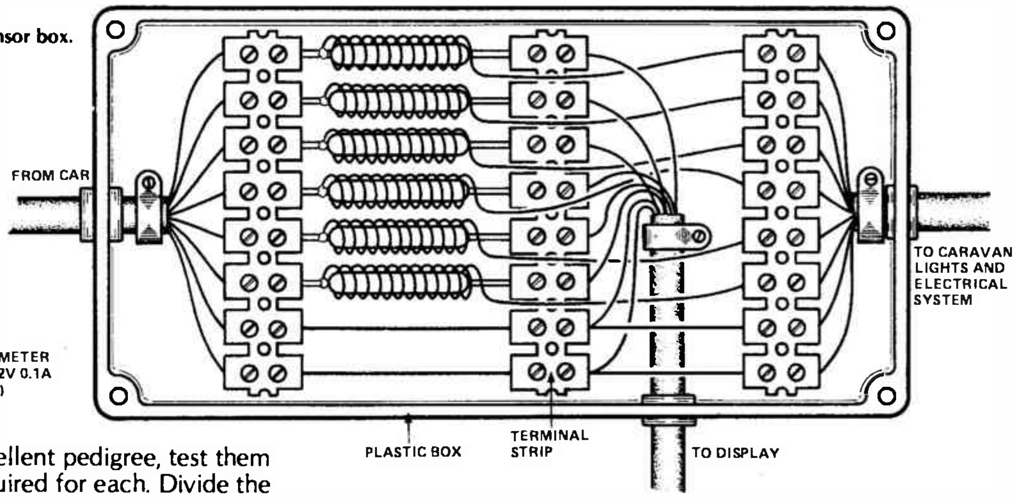
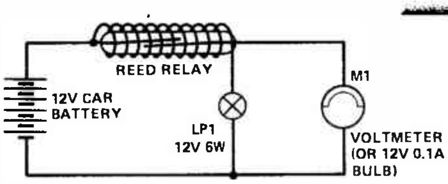


Fig. 4 This simple circuit can be used to check out reed relays.



If the reeds do not have an excellent pedigree, test them and decide how many turns are required for each. Divide the ampere turns by the current to be drawn and there's the number you need. Add 25% for luck. As a rule of thumb, 6 W sidelights need about 40 turns in two or three layers, or 20 turns if they are fore and aft. You could put separate current sensors in each line and make your caravan look like a mobile Blackpool Illuminations! Brake and indicator lights need only 12 turns.

Solder one end of a length of 20 swg insulated wire to one end of a reed and wind carefully along its entire length. Be careful not to break the glass as it will slice into your fingers with the greatest of ease. Hold the reed in your left hand with the loose end of wire pulled taut by your little finger and apply cyanoacrylate (Superglue). Two days later it should be possible to remove the completed current sensing relay from your hand!

Install the reeds between the two choc-blocks as shown in the diagram by holding the terminal blocks on a flat surface to ensure that no twisting action takes place when the assembly is finally installed in its box. Cyanoacrylate may now be used to mount the complete assembly in its box. Complete the wiring and install in your beloved behemoth.

The green 'power-on-to-the-caravan' light only consumes 15-20 mA and as long as the caravan is being pulled daily (as it would be on holiday) the overnight drain is negligible.

A complete kit of parts, including solder and superglue is available from Packer Communications, Bridge End Barn, Soutergate, Cumbria LA17 7TW for £12.75 including post and VAT.

ETI

ETIPRINTS

ETIPRINTS offer you the easy way to produce high quality printed circuit boards. Each ETIPRINTS sheet contains a set of etch resistant rub down transfers of the printed circuit board designs for several of our projects.

ETIPRINTS are made from our original artwork ensuring a neat and accurate board. We thought ETIPRINTS were such a good idea that we have patented the system (patent numbers 1445171 and 1445172).

PARTS LIST

040A	ETI 80 VCO/VCLFO	Feb 80
040B	ETI 80 PSU Tuning Fork Hi-Lo Filter Coin Toss	Feb 80
041A	Audiophile Driver Amp VCA Signal Tracer Heater Controller Main Board Electromyogram	Mar 80
041B	ETI 80 VCM Heater Controller Sensor	Mar 80
046A	ETI 80 Dual VCA 100 W Power Amplifier	Aug 80
046B	Capacitance Meter US Alarm BGM 100 W Amplifier Logic Tester 100 W Power Amp	Aug 80
047A	Digital Test Meter	Sep 80
047B	Vocoder Internal Excitation Speed Control DTM Switching Board RIAA Preamp	Sep 80
047C	ETI 80 Envelope Shaper TV Sound Survival	Sep 80
048A	Sustain/Fuzz Box Flash Trigger FM Radio Control Receiver: (Top side) (Bottom side) FM Radio Control Transmitter	Oct 80
048B	Vocoder Slew Rate Control Vocoder Output Amp Vocoder Input Amp Vocoder PSU Vocoder LED PPM Display	Oct 80
048C	Cassette Interface ETI 80 Monitor Amp	Oct 80
049	AF Generator Multi-Option Board Space Invasion PSU	Nov 80

BUYLINES

Sheets for Sep 79, Dec 79, Jan 80 and April - July 80 are temporarily out of stock. Earlier ETIPRINT sheets are available.

Send a cheque for PO (payable to ETI) for £1.20 per sheet with details of the project for which you require an ETIPRINT, and the month and year of publication to:

ETIPRINTS,
ETI,
145 Charing Cross Road,
London WC2H 0EE.

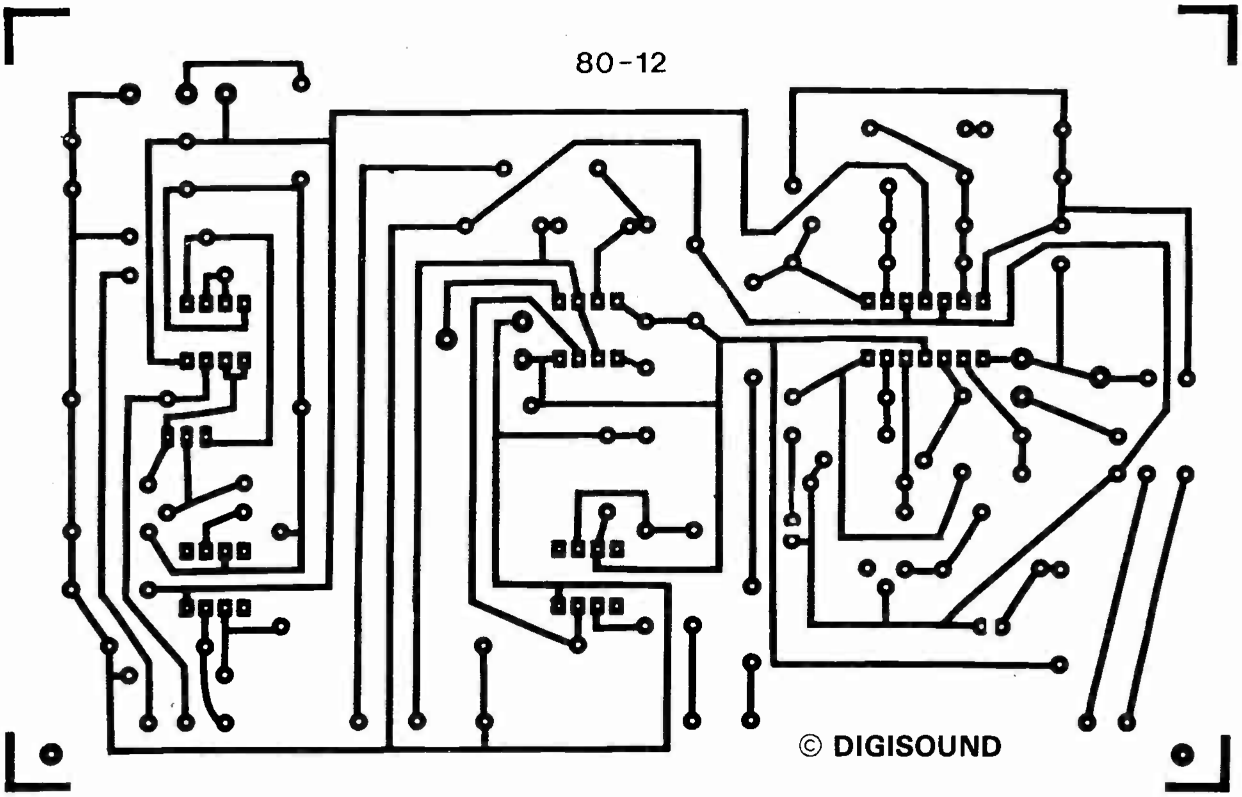
HOW IT WORKS

Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

ETIPRINTS

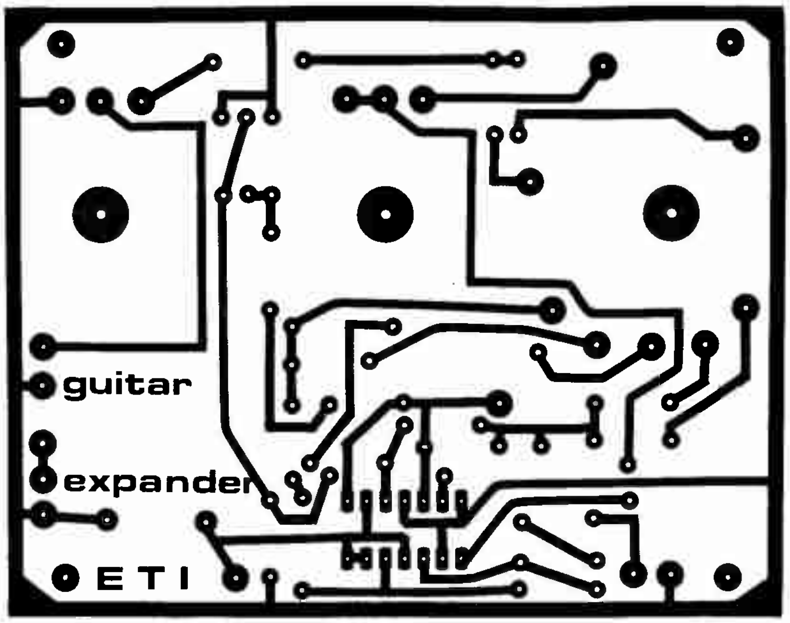
PCB FOIL PATTERNS

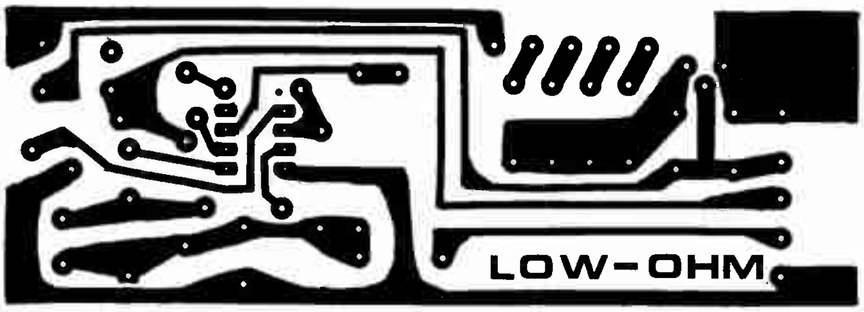
Please note that the foil pattern for the VCSA is too large to go into the magazine. A large SAE will secure a photocopy.

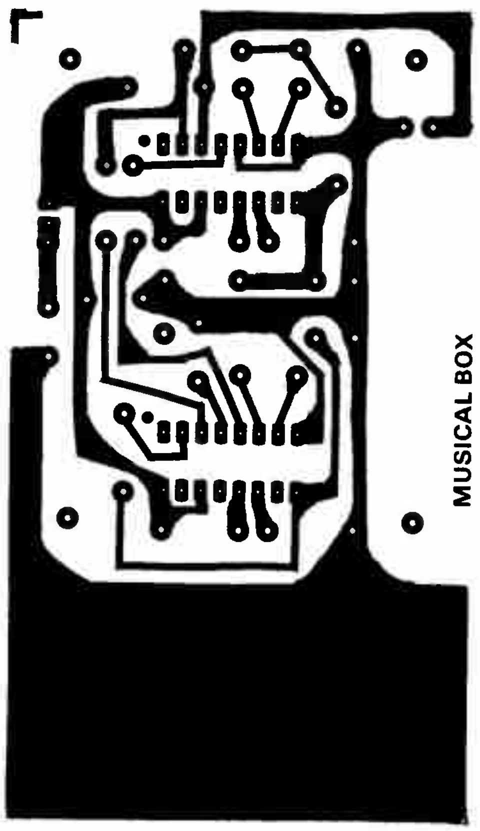


Above: Foil pattern for this month's Project 80 module. Note that Digisound hold the copyright on this board and firms may not reproduce the PCBs for sale.

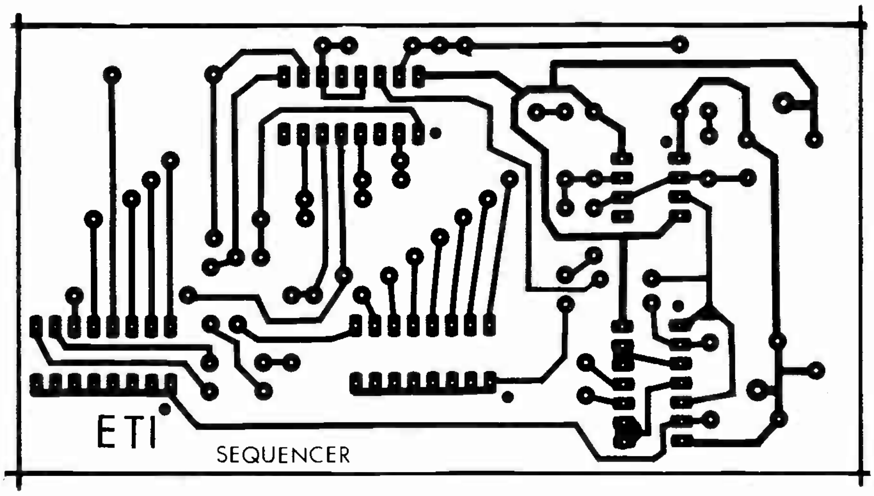
Right: Foil pattern for the guitar expander.



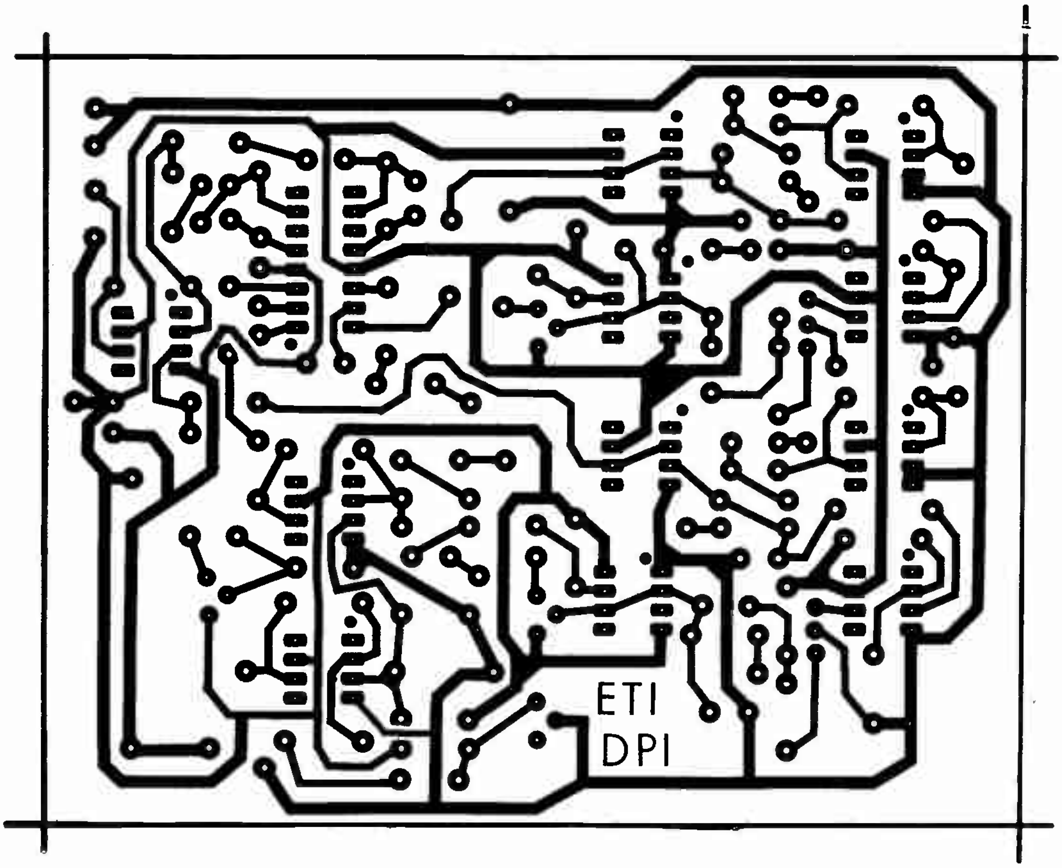




Above: The Low-ohm Meter foil pattern.
Right: Musical Box PCB — this has been designed to fit into the specified case.



Above and below: The two foil patterns for the ETI Drum Machine.



CHROMATHEQUE 5000 5 CHANNEL LIGHTING EFFECTS SYSTEM

Panel size 19.0" x 3.5".
Depth 7.3"

COMPLETE KIT ONLY £49.50 + VAT!

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward.

Kit includes fully finished metalwork, fibreglass PCB controls, wire, etc. — Complete right down to the last nut and bolt!

MPA 200 100 WATT (rms into 8Ω) MIXER/AMPLIFIER

COMPLETE KIT ONLY £49.90 + VAT!

MATCHES THE CHROMATHEQUE 5000 PERFECTLY!

Panel size 19" x 3.5". Depth 7.3"

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features an adaptable input mixer which accepts a wide range of sources such as a microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward.
The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.

SP2-200 2-CHANNEL 100W AMPLIFIER

NEW!

COMPLETE KIT ONLY £64.90 + VAT!

Panel size 19.0" x 3.5". Depth 7.3"

The power amplifier section of the MPA 200 has proved not only very economical but very rugged and reliable too. This new design uses two of these amplifier sections powered by separate power supplies fed from a common toroidal transformer. Input sensitivity is 775mV.
Power output is 100 rms into 8 ohms from both channels simultaneously. The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. – complete down to the last nut and bolt!

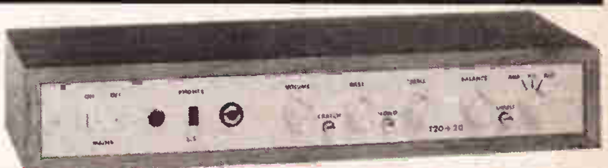
POWERTRAN

SYNTHESIZER KITS ON PAGE 8. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER.

All kits also available as separate packs (e.g. PCB, component sets, hardware sets, etc.). Prices in our FREE CATALOGUE.

DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £85.00 + VAT

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring while distortion is less than 0.01%.



T20 + 20 20W STEREO AMPLIFIER £33.10 + VAT

This kit, based upon a design published in Practical Wireless, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers. A 30 watt version of this kit (T30+30) is also available for £38.40+VAT. MATCHING TUNERS — See our FREE CATALOGUE!

Above 2 kits are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cable, nuts, bolts, etc. and full instructions — in fact everything!

BLACK HOLE CHORALIZER

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments, offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a "spacey" feel to the sound achieved by delaying the input signal and mixing it back with the original. Notches (HOLES), introduced in the frequency response, move up and down as the time delay is modulated by the chorus sweep generator. An optional double chorus mode allows exciting antiphase effects to be added. The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity, has high signal/noise ratio obtained by an audio compander and is mains powered — no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure.

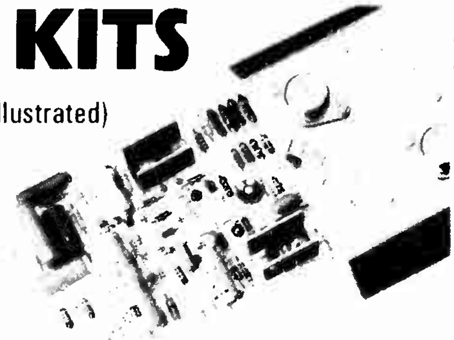
COMPLETE KIT ONLY £49.80 + VAT (single delay line system)

De Luxe version (dual delay line system) also available for **£59.80** + VAT

Cabinet size 10.0" x 8.5" x 2.5" (rear) 1.8" (front)

HIGH POWER MODULE KITS

125 WATT MODEL £10.50 plus £1.15 p&p (Illustrated)
200 WATT MODEL £14.95 plus £1.15 p&p



SPECIFICATIONS

Max. Output power	125 watt RMS
Operating voltage (DC)	50-80 Max.
Loads	4-16 ohms
Frequency response measured at 100 watts	25Hz-20KHz
Sensitivity for 100 watts	400mV @ 47K
Typical T.H.D. @ 50 watts 4 ohms load	0.1%
Dimensions	205 x 90 and 190 x 36 mm

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

ACCESSORIES

Suitable LS coupling electrolytic for 125W model **£1.00** plus 25p p&p

Suitable LS coupling electrolytic for 200W model **£1.25** plus 25p p&p

Suitable Mains Power Supply Unit for 125W model **£7.50** plus £3.15 p&p

Suitable Twin Transformer Power Supply for 200W model **£13.95** plus £4.00 p&p

MULLARD LP1183 STEREO PREAMP

FREE!

Original listed price over £5.00. Suitable for ceramic and auxiliary inputs, when you purchase 2 power module kits.

PRACTICAL ELECTRONICS CAR RADIO KIT (Constructors pack 7)

2 WAVE BAND MW LW
- Easy to build
- 5 push button tuning
- Modern styling design
- All new unused components
- 6 watt output
- Ready etched & punched P.C.B.
- Incorporates suppression circuits
- Now with tape input sock

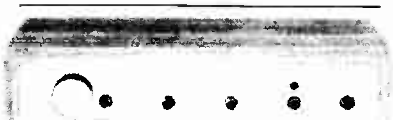
All the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue. Features: Pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone control, the other for manual tuning, each set on wood simulated fascia.

The P.E. Traveller has a 6 watts output, neg ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit. The radio fits easily in or under dashboards.

Complete with instructions **£10.50** plus £2.00 p&p

CONSTRUCTORS PACK 7A

Suitable stainless steel fully retractable locking aerial and speaker (approx. 6" x 4") is available as a kit complete **£1.95** per pack p&p £1.15



30 + 30 WATT STEREO AMPLIFIER BUILT AND TESTED

Viscount IV unit in teak simulate cabinet silver finished rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape and auxiliary. Rear panel features fuse holder DIN speaker and input socket. 30 + 30 watts RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers. Size 14¾" x 10" approx.

READY TO PLAY **£32.90** plus £3.80 p&p

HI FI STEREO AMPLIFIER MODULES

- Mullard LP1183 built preamplifier suitable for ceramic and auxiliary inputs £1.95 plus 70p p&p
- Mullard LP1184 built preamplifier suitable for magnetic/ceramic and auxiliary inputs £4.95 plus 80p p&p
- Matching I.C. 10 + 10 Stereo Power amplifier kit £3.95 plus £1.15 p&p
- Matching power supply kit with transformer £3.00 plus £1.96 p&p
- Matching set of 4 slider controls complete with knobs for bass, treble and volumes. £1.70 plus 80p p&p
- Complete with application notes

£14.95 plus £2.90 p&p

10+10 WATT STEREO AMPLIFIER KIT

- Featuring latest SGS/ATES TDA 2006 10 watt output I.C.'s with in-built thermal and short circuit protection.
- Mullard Stereo Preamplifier module
- Attractive black vinyl finish cabinet. Size 9" x 8⅜" x 3⅝" approx
- Converts to a 20 watt Disco amplifier

To complete you just supply connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 20 watt mono disc amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre amp module plus power amplifier assembly kit and mains power supply. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs and contrasting ready made black vinyl finish cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit.

SPECIFICATIONS

Suitable for 4 to 8 ohms speakers

Frequency responce	40Hz — 20KHz
Input Sensitivity	P.U. 150mV Aux. 200mV Mic. 1.5mV
Tone controls	Bass ± 12db @ 60Hz
	Treble ± 12db @ 10KHz
Distortion	·1% typically @ 4 watts
Mains supply	220/250 volts 50Hz

BSR chassis record deck with manual set down and return, complete with stereo ceramic cartridge **£8.50** plus £3.15 p&p when purchased with amplifier. Available separately **£10.50** plus £3.16 p&p

8" SPEAKER KIT 2 8" approx. twin cone domestic use speakers **£4.75** per stereo pair plus £1.70 p&p when purchased with amplifier. Available separately **£6.75** plus £1.70 p&p

STEREO MAGNETIC PRE-AMP CONVERSION KIT. All components including P.C.B. to convert your ceramic input on the 10+10 amp to magnetic **£2.00** when purchased with kit featured above **£4.00** separately inc. p&p

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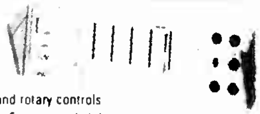
STEREO DISCO PREAMPLIFIER

matching above modules, suitable for twin deck mixing with P.F.L. output and Mic/Tape input.
Ready built, ready to play with circuit diagram and application notes to suit our power module kits. **£21.95** plus £1.72 p&p

100 WATT MONO DISCO AMPLIFIER



Brushed aluminium fascia and rotary controls. Size approx 14" x 4" x 10¾". Five vertical slide controls, master volume, tape leverl, mic level, deck level, PLUS INTER DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre fade level controls (PRL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak **£76.00** plus £4.60 p&p

50 WATT MONO DISCO AMPLIFIER

Size approx 13⅛" x 5¼" x 6¾". 50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.

£30.60 plus £3.68 p&p

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

£12.25 OUR PRICE plus £3.16 p&p. Size approx 13" x 11"

PHILLIPS RECORD PLAYER DECK GC037

Size approx 15¼" x 12¼"

Hi Fi record player deck, 2 speed, damped cueing, auto shut-off, belt drive with floating sub chassis to minimise acoustic feedback. Complete with GP401 stereo magnetic cartridge—*LIMITED STOCK*. UNBEATABLE OFFER AT **£27.50** complete plus £3.16 p&p

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NEXT MONTH. NEXT MONTH. NEXT MONTH. NEXT MONTH. NEXT MONTH.

Hobby Electronics

Look for the April issue. You can't afford to miss it!

Anatomy Of The Space-Shuttle

A special HE report on the forthcoming NASA Space-Shuttle launch. We investigate what the technical problems have been, why it's overdue, and give you a timetable running up to the launch and beyond

Tremolo

Just the effect you want for your guitar to complement the Fuzzbox in the March issue, although it will work with any electronic musical instrument. Simple-to-build, even simpler-to-use yet it won't burn a hole in your pocket

Russian Roulette

A novelty game designed to eliminate the players — without any mess whatsoever

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- STOP - PROMOTING THE UNITED NATION'S INTERNATIONAL YEAR OF
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ANY ELECTRONIC AID - SOLID-STATE, COMPUTER PROGRAM, EVEN VALVE
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WIN - STOP
---- STOP PRESS ---- STOP PRESS---- STOP PRESS ---- STOP PRESS ----

High Fidelity Comes To HE

Announcing a special audio project for HE: a hi-fi, high-power amplifier system which you can tailor according to your budget by making use of our special-offer kits. We start with the pre-amplifier in the April issue. This pre-amp requires *no wiring* except for the leads to the power supply! You can use it with your own amplifier too

Windscreen Washer Alarm

For the motorist who's fed up with cleaning his windscreen by hand because his washer bottle has run dry. As soon as the fluid drops below a predetermined level a 're-fill me' alarm is displayed

Plus:

News, views and info on CB, circuits, recent developments in electronics — everything for the electronics enthusiast and hobbyist — things you can't afford to miss. Get It!

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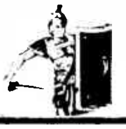

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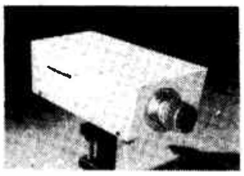

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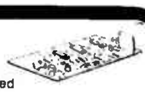

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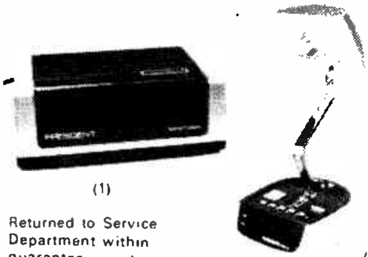

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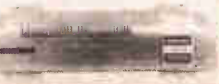

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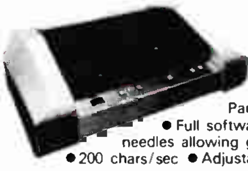

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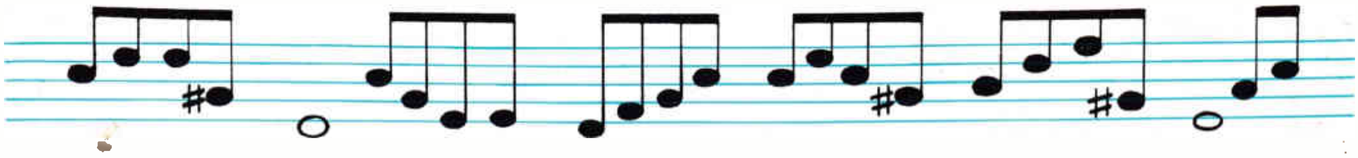

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