

# electronics today

ISSN. 0142-7229

INTERNATIONAL

MAY 1981 65p

## REMOTE CONTROL YOUR HOME!

Everything from heaters to dimmers at a distance

Over  
**100**  
pages



**SYNTHESIZER  
SEQUENCER  
PROJECT**  
Over  
1000  
note  
storage!



- Moving Coils - What state the art?
- Temperature Controlled Soldering Iron

**MICROPROCESSORS. . . .AUDIO.**

# TRANSCENDENT POLYSYNTH

By brilliant design work and the use of high technology components the Polysynth brings to the reach of the home constructor a machine whose versatility and range of sounds is matched only by ready built equipment costing thousands of pounds. Designed by synthesizer expert Tim Orr and being featured in this issue of Electronics Today International, this latest addition to the famous Transcendent family is a 4 octave (transposable over 7½ octaves) polyphonic synthesizer with internally up to 4 voices making it possible to play simultaneously up to 4 notes. Whereas conventional synthesizers handle only one at a time.

The basic instrument is supplied with 1 voice and up to 3 more may be plugged in. A further 4 voices may be added by connecting to an expander unit, the metalwork and woodwork of which is designed for side by side matching with the main instrument. Each voice is a

complete synthesizer in itself with 2 VCOs, 2 ADSRs, a VCA and a VCF (requiring only control voltages and a power supply, the voice boards are also suitable for modular systems). One of these voices is automatically allocated to a key as it is operated. There are separate tuning controls for each VCO of each voice. All other controls are common to all the voices for ease of control and to ensure consistency between the voices.

Although using very advanced electronics the kit is mechanically very simple with minimal wiring, most of which is with ribbon cable connectors. All controls are PCB mounted and the voice boards fit with PCB mounted plugs and sockets. The kit includes fully finished metalwork, solid teak cabinet, professional quality components (resistors 2% metal oxide or metal film of 0.5% and 0.1%), nuts, bolts, etc.

## EXPANDABLE POLYPHONIC SYNTHESIZER



### COMPLETE KIT

ONLY

£320 + VAT

(Single voice)

Plug in extra

Voices — Kit price £52 + VAT  
(£48 + VAT if ordered with kit)

Cabinet size 31.1" x 19.6" x 7.6" rear 3.4" front

### Kit also available as separate packs

	Price	Pack	Price	Pack	Price	
ADSR IC CEM 3310	£4.00	Pack	£9.50	POLY 14	PCB for VOICE controls	£6.80
VCO IC CEM 3340	£6.00	POLY 1	£8.20	POLY 15	Pots, switches, diodes, Cs for VOICE PCB	£4.80
0.1% 25 ppm M.F. Res	£0.50	POLY 2	£32.25	POLY 16	PCB for plug in voice	£8.20
0.5% 25 ppm M.F. Res	£0.25	POLY 3	£12.00	POLY 17	Rs, Cs, presets, connectors for one voice	£16.30
30 ppm multilayer ceramic cap	£0.50	POLY 4	£17.25	POLY 18	ICs, IC skts, diodes for one voice	£27.50
ICs and details of all packs in our		POLY 5	£10.50	POLY 19	Transformer 0 120 240, 17.0 17 0 7 7	£6.30
<b>FREE CATALOGUE</b>		POLY 6	£31.30	POLY 20	Pitch bend control	£3.90
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		POLY 8	£14.10	POLY 22	Ribbon cable, ribbon cable connectors, mains cable	£8.45
		POLY 9	£18.80	POLY 23	Fully finished metalwork and fixing parts	£25.60
		POLY 10	£9.30	POLY 24	Solid teak cabinet	£25.80
		POLY 11	£11.80		Total cost for individually purchased packs for single voice instrument	£365.15
		POLY 12			<b>Complete kit for 4 voice expander including connectors</b>	<b>£295.00</b>
		POLY 13			<b>All prices VAT exclusive.</b>	

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# electronics today

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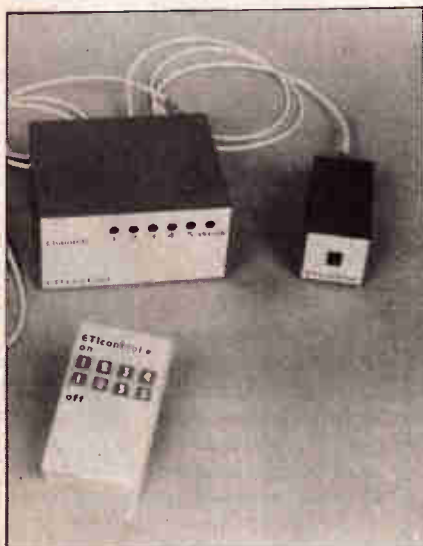
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# New! Sinclair ZX81 Personal Computer. Kit: £49.<sup>95</sup> complete

Reach advanced computer comprehension in a few absorbing hours

1980 saw a genuine breakthrough – the Sinclair ZX80, world's first complete personal computer for under £100. At £99.95, the ZX80 offered a specification unchallenged at the price.

Over 50,000 were sold, and the ZX80 won virtually universal praise from computer professionals.

Now the Sinclair lead is increased: for just £69.95, the new Sinclair ZX81 offers even more advanced computer facilities at an even lower price. And the ZX81 kit means an even bigger saving. At £49.95 it costs almost 40% less than the ZX80 kit!

### Lower price: higher capability

With the ZX81, it's just as simple to teach yourself computing, but the ZX81 packs even greater working capability than the ZX80.

It uses the same micro-processor, but incorporates a new, more powerful 8KBASICROM – the 'trained intelligence' of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays.

And the ZX81 incorporates other operation refinements – the facility to load and save named programs on cassette, for example, or to select a program off a cassette through the keyboard.

### Higher specification, lower price – how's it done?

Quite simply, by design. The ZX80 reduced the chips in a working computer from 40 or so, to 21. The ZX81 reduces the 21 to 4!

The secret lies in a totally new master chip. Designed by Sinclair and custom-built in Britain, this unique chip replaces 18 chips from the ZX80!

*Proven micro-processor, new 8KBASIC ROM, RAM – and unique new master chip.*

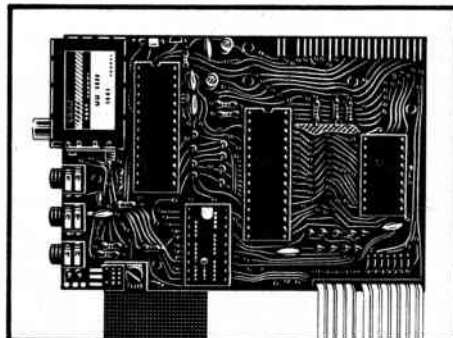
**Built:**  
**£69.<sup>95</sup>**  
complete



### Kit or built – it's up to you!

The picture shows dramatically how easy the ZX81 kit is to build: just four chips to assemble (plus, of course the other discrete components) – a few hours' work with a fine-tipped soldering iron. And you may already have a suitable mains adaptor – 600 mA at 9 V DC nominal unregulated (supplied with built version).

Kit and built versions come complete with all leads to connect to your TV (colour or black and white) and cassette recorder.



### New Sinclair teach-yourself BASIC manual

Every ZX81 comes with a comprehensive, specially-written manual – a complete course in BASIC programming, from first principles to complex programs. You need no prior knowledge – children from 12 upwards soon become familiar with computer operation.



```

KN IIR I*N THEN GO TO 6
X=1 TO N
B(X)=11(X)
J=X
J=0
J=J+1
Y=N OR J=N THEN GO TO 4B
T=J+1
OT A(J)>A(T) THEN GO TO
P=A(J)
B(J)=A(T)
B(T)=P
K=J-1
<<1 THEN GO TO 1B

```

## If you own a Sinclair ZX80...

The new 8K BASIC ROM used in the Sinclair ZX81 is available to ZX80 owners as a drop-in replacement chip. (Complete with new keyboard template and operating manual.)

With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 - including the ability to drive the Sinclair ZX Printer.

## Coming soon - the ZX Printer.

Designed exclusively for use with the ZX81 (and ZX80 with 8K BASIC ROM), the printer offers full alphanumerics across 32 columns, and highly sophisticated graphics. Special features include COPY, which prints out exactly what is on the whole TV screen without the need for further instructions. The ZX Printer will be available in Summer 1981, at around £50 - watch this space!



## 16K-BYTE RAM pack for massive add-on memory.

Designed as a complete module to fit your Sinclair ZX80 or ZX81, the RAM pack simply plugs into the existing expansion port at the rear of the computer to multiply your data/program storage by 16!

Use it for long and complex programs or as a personal database. Yet it costs as little as half the price of competitive additional memory.



### How to order your ZX81

BY PHONE - Access or Barclaycard holders can call 01-200 0200 for personal attention 24 hours a day, every day.

BY FREEPOST - use the no-stamp-needed coupon below. You can pay by cheque, postal order, Access or Barclaycard.

EITHER WAY - please allow up to 28 days for delivery. And there's a 14-day money-back option, of course. We want you to be satisfied beyond doubt - and we have no doubt that you will be.

To: Sinclair Research Ltd, FREEPOST 7, Cambridge, CB2 1YY.

Qty	Item	Code	Item price £	Total £
	Sinclair ZX81 Personal Computer kit(s). Price includes ZX81 BASIC manual, excludes mains adaptor.	12	49.95	
	Ready-assembled Sinclair ZX81 Personal Computer(s). Price includes ZX81 BASIC manual and mains adaptor.	11	69.95	
	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	10	8.95	
	16K-BYTE RAM pack(s).	18	49.95	
	8K BASICROM to fit ZX80.	17	19.95	
	Post and Packing.			2.95
				<b>TOTAL £</b>

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Please print.

Name: Mr/Mrs/Miss

Address

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ET105

### New, improved specification

- Z80A micro-processor - new faster version of the famous Z80 chip, widely recognised as the best ever made.

- Unique 'one-touch' key word entry: the ZX81 eliminates a great deal of tiresome typing. Key words (RUN, LIST, PRINT, etc.) have their own single-key entry.

- Unique syntax-check and report codes identify programming errors immediately.

- Full range of mathematical and scientific functions accurate to eight decimal places.

- Graph-drawing and animated-display facilities.

- Multi-dimensional string and numerical arrays.

- Up to 26 FOR/NEXT loops.

- Randomise function - useful for games as well as serious applications.

- Cassette LOAD and SAVE with named programs.

- 1K-byte RAM expandable to 16K bytes with Sinclair RAM pack.

- Able to drive the new Sinclair printer (not available yet - but coming soon!)

- Advanced 4-chip design: micro-processor, ROM, RAM, plus master chip - unique, custom-built chip replacing 18 ZX80 chips.

# Sinclair ZX81

**Sinclair Research Ltd,**  
6 Kings Parade, Cambridge, Cambs.,  
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Reg. no: 214 4630 00

ET1 MAY 1981





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Combox FW610 Charger for HP7, HP11, HP2			

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2N 5222	.10	BC 172	.06	BC 416A	.05	BAX 13	.05
AC 126	.15	BC 172C	.06	BC 517	.12	BAY 93	.02
AC 127	.15	BC 173	.05	BC 71	.05	BB 105B	.10
AC 132	.05	BC 174B	.05	BC 72	.09	BY 126	.14
AC 152	.15	BC 178B	.14	BD 138	.10	CV 7641	.05
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CD4012	£0.20	CD4022B	£0.78	CD4047B	£1.02	CD4068	£0.30	CD4086	£0.90	CD4522	£1.10

SN7400	£0.19	SN7420	£0.15	SN7445	£0.91	SN7460	£0.15	SN7496	£0.20	SN74164	£0.91
SN7401	£0.19	SN7423	£0.19	SN7446	£0.24	SN7472	£0.20	SN74107	£0.20	SN74165	£0.91
SN7403	£0.19	SN7426	£0.21	SN7447	£0.24	SN7484	£0.51	SN74121	£0.20	SN74174	£0.60
SN7404	£0.15	SN7432	£0.21	SN7448	£0.30	SN7490	£0.25	SN74141	£0.24	SN74182	£0.60
SN7410	£0.19	SN7440	£0.15	SN7450	£0.19	SN7491	£0.35	SN74145	£0.77	SN74190	£0.60
SN7412	£0.15	SN7441	£0.30	SN7453	£0.15	SN7492	£0.20	SN74155	£0.50	SN74192	£0.91
SN7414	£0.55	SN7442	£0.20	SN7454	£0.15	SN7493	£0.20	SN74157	£0.70	SN74197	£0.60

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SIZE	SINGLE SIDE	DOUBLE SIDE
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KIT FOR UV EXPOSURE UNIT FOR DEVELOPING FOTO BOARDS  
COMPLETE WITH BOX & GLASS SCREEN 228 x 152mm £34.50  
OR WITHOUT BOX £19.50

ALL PRICES EXCLUSIVE OF VAT



# DIGEST

## Visionary Idea

That world-famous character Uncle Clive Sinclair has struck again. This time Sinclair Research Ltd has developed a new flat-screen pocket-size television which should be available by the middle of next year. Its announcement follows a five year development project costing £1 million and partly backed by the National Research and Development Council. The investment for manufacturing what will initially be a pocket black-and-white TV with FM radio will be around the £5 million mark, supported by industry grants from the Scottish Economic Planning Department who will provide £1.5 million plus a regional development grant of £1.1 million, making 22% of the total capital employed. (Perhaps Sinclair's catch-phrase should be 'your wish will be granted?') Sinclair's contribution will be funded from profits derived from its equally well-known personal computer business. Sinclair have managed to achieve a number of interesting breakthroughs with their flat screen TV, not least perfec-

ting a new method of vacuum-forming glassware, a volume reduction of 2½ times over a conventional CRT, and a power requirement reduction five times better than previously achieved. Impressive huh? Manufacture of the tube has been sub-contracted to Timex who will produce it in Dundee and expect to employ an extra 1,000 people by 1985.

The cathode ray tube measures approximately 4 x 2 x ¼ inches and is assembled from two sheets of glass, a flat front plate and a vacuum-formed backing plate. The phosphor screen is coated on the interior of the backing plate and is viewed through the front face from the same side that the electrons strike. As a result, the brightness is more than double that of a conventional CRT with the same beam energy. The electron gun is set to one side of the screen with its axis parallel to the screen. Two sets of electrostatic deflection plates in the gun assembly provide horizontal and vertical scanning and a third set between the phosphor screen and front face bends the electron beam



towards the screen. The tube assembly lends itself to low-cost mass production and has significantly fewer components than a conventional CRT. There will be many applications for this new tube; doubtless to say Sinclair will consider linking it to his personal computer, and the basic tube can be

modified for projection TV systems. A full colour three-tube system is being carefully considered with the electronics and optics able to fit into a shoe-box-sized unit projecting onto a wall-mounted screen. The initial TV/radio unit should retail for about £50. We ask ourselves 'is there anything this man can't do?'

## Mini-Movies

Matshita Electric of Japan have come up with a new mini colour video camera which contains the tape recorder as well. They think that it's such a good design that it should be made a world standard for miniature video. It uses metal

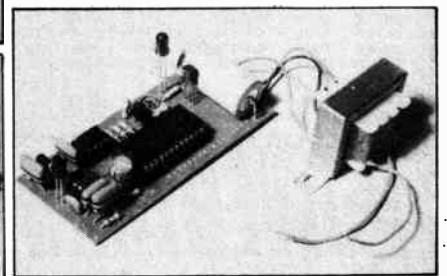
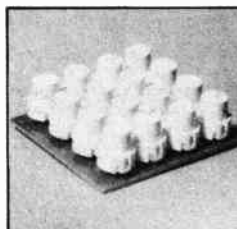
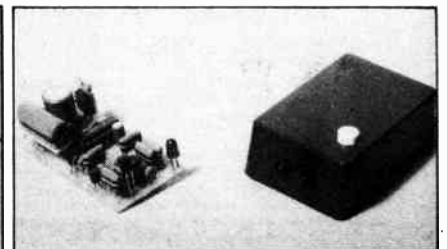
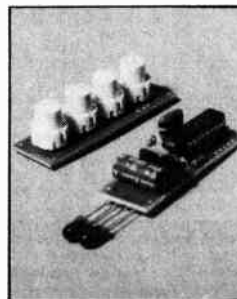
evaporated magnetic tapes which are actually slightly smaller than standard audio cassettes. The camera/recorder is almost as small as a conventional hand-held video camera; 229 mm (D) x 118 mm (H) x 67 mm (W) and weighs only 2.1 kg including batteries. The tape speed is 14.3 mm/S which is the slowest among systems of this kind. Matshita achieved the compactness of this device thanks to the development of the 'Cosvicon' ½ inch colour image pick-up tube coupled with extensive use of LSI in the circuitry. For further details on this camera contact: National Panasonic UK Ltd, 300-318 Bath Road, Slough, Berkshire, SL1 6JB.



## Kitting Out

TK Electronics, who specialise in electronic mini-kits for hobbyists, have extended their range to include some remote control kits. These include the MK6 Simple Infra-Red Transmitter (as featured in Kit Review last month), the MK7 Infra-Red Receiver, the MK8 Coded Infra-Red Transmitter and the MK12 16-channel Receiver. The MK6 and MK7 consist of a small hand-held, battery operated transmitter and a small mains powered receiver with a triac output capable of switching mains loads of up to 500 W. The MK8

can transmit up to 32 different commands depending on the keyboard used. The MK12 is a mains-powered unit with 16 CMOS outputs (0 to 15 V) which may be interfaced with logic, or used to drive relays or triacs for power switching. By changing the value of one resistor in the MK8 kit and adjusting the present on the MK12, simultaneous operation to two or more receivers in the same area can be achieved. Prices are: MK6 — £4.20, MK7 — £9.00, MK8 — £5.90, MK12 — £11.95 plus 40p postage and 15% VAT. TK Electronics, 11 Boston Road, London W7 3SJ.



# TRANSCENDENT 2000

## COMPLETE KIT ONLY £168.50 + VAT!

Designed by consultant Tim Orr (formerly synthesizer designer for EMS Ltd) and featured as a construction 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 1/2% metal trim) 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 easily 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!



## SINGLE BOARD SYNTHESIZER



Cabinet size 24.6" x 15.7" x 4.8" (rear), 3.4" (Front).

# 1024 COMPOSER

THIS MONTH'S FRONT COVER FEATURE!  
COMPLETE KIT ONLY £89.50 + VAT!

# ETI VOCODER

COMPLETE KIT ONLY  
£195 + VAT!

KIT INCLUDES FREE FOOT CONTROL  
AND TEST OSCILLATOR



Panel size 19.0" x 5.25". Depth 12.2".

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 level 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 the unvoiced sounds of sibilants, etc. There is a slow 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" x 15.0" x 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 vibrato 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.



## Sticky Solution

From Devcon come two types of epoxy adhesives in handy 9oz bottle twin packs. A really useful aid for DIY and modelling, there is a choice of '5 Minute' or 'Slow Cure' adhesives. The five minutes type, as its name suggests, cures in 4 to 7 minutes and provides superfast bonding even with thin films and at low temperatures. It is clear, non-shrinking and has good chemical resistance, though is not suitable for long term immersion in water. The 'Slow Cure' epoxy is a tough adhesive setting in about 30 minutes, has a long working life and can be drilled, sanded or machined. For more information, Devcon is a division of ITW Ltd at Station Road, Theale, Reading, Berks, RG7 4AB.

## Testing, testing...

If you're still using neon screwdrivers and moving coil voltmeters, get with it and take a look at the two new additions to the Steinel range of voltage testers. The Mono Check is a single pole phase tester with great improvements over the conventional electrician's screwdriver. The internal resistance of the instrument is 10M and the current through the human body is reduced to a fraction of that required by neon testers. Under extreme conditions of insulation (for example, you're standing on a wooden ladder on an insulated floor) the tester will maintain as bright an indication as if it were directly earthed. The test range is 80-250 V AC relative to earth and the Mono Check remains safe at overloads six times this range. There is a function test switch located in the handle to confirm correct operation. The recommended retail price of the Mono Check is £3.80 plus VAT.

The Steinel range of two-pole voltage testers have a unique design; each instrument consists of two probe tips connected by a lead, with a solid state readout (LEDs or neons in the existing testers) built into one of the probes. This makes the testers inexpensive, reliable and practically unbreakable. The instruments are

## Home, Home on the...

The Design Council is currently exhibiting a range of products representing in all its glory the microelectronics revolution which now affects all our lives. The exhibition shows some 40 British-made microelectronics products which are available now or will be in the near future. These products are meant to

## DIY Sound

A new company called DIY Hi-Fi has just launched 'Cecilia', a pair of low cost DIY loudspeakers. They are of the bookshelf variety utilising the Pioneer TS 107 drive unit which was originally developed for in-car hi-fi systems. The speakers will cost around £35 to build and one of the contributing factors to this low cost is that there are no electrical components, such as crossovers etc, except for the drive units themselves which incorporate a strontium magnet and a compact dual cone giving a full extended frequency of 50-20,000 Hz! The finished speakers are extremely efficient, producing 91.5 db at 1 W/metre, power handling is 20 W maximum with a nominal impedance of 4 R which can be converted to 8 or 16 R. The finished size is 17" x 9" x 8½" deep. DIY Hi-Fi reckon you can easily build them in a weekend and they provide complete step-by-step, easy-to-follow instruction guides and full size blueprint plans for just £2.50 including postage and packing. DIY Hi-Fi, York House, Swan Street, West Malling, Kent.

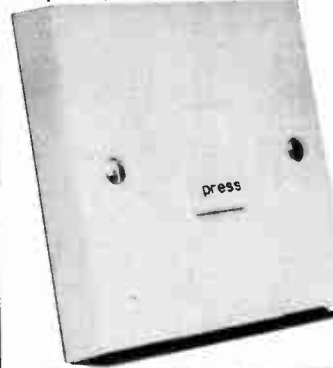
safe and simple to use; you can hang them on the wall (or round your neck) until you need them, then just place the probes on the test points and the readout operates automatically. On the simplest device this is just an indication of whether an AC or DC voltage greater than 4V5 is present, and DC polarity. Other instruments will display AC or DC voltages in bar form (eg 6, 12, 24, 110, 240 and 415 V), or allow continuity checks. We've been using these testers ourselves since November and think they're excellent, so it's good to see a new addition. The Digi-Check hand-held multimeter follows the same design philosophy but features a 3½ digit LCD display as the readout. The scale can be easily changed whilst using the instrument and if you find yourself in a position where you can't see the display (unlikely), then pressing a button on the probe latches the reading into memory. The ranges are 0.1 mV to 500 V DC, 10 mV to 500 V AC, and resistances from 0R1 to 20M. The Digi-Check is powered by four built-in NiCad batteries and there is an integral mains battery charger (no accessories required) which is overcharge-proof. The complete meter only weighs 250 g and has an RRP of £68.75 plus VAT. You can find Steinel at 288 Chester Road North, Sutton Coldfield, West Midlands B73 6RR.

make life easier — improving efficiency or simply for amusement. The exhibition is divided into different areas of the home, for example the kitchen includes the 'Sensamatic' tumble dryer and the Satchwell Sunvic 'HC1201' central heating controller. The playroom section is filled with electronics games and kits, like Rowtron's Home Entertainment Centre which is a microcomputer-based television games system. In the living-room there is a highly

sophisticated Chess Computer. In the sports and hobbies categories there is Paterson's digital thermometer and time signal for developing photographs, a car computer from Smith's Industries and at the 'front door' is a Yale Diplomat burglar alarm system. There are plenty more things to see at the Microelectronics Come Home exhibition which will be at the Scottish Design Centre from 30th March to 30th May.

## Lights Out

MK Electric have recently brought out a new logic time delay switch. It is an ideal way to provide lighting economically in buildings where stairways, landings and corridors only need intermittent lighting. At the heart of the device is an oscillator with a variable pulse frequency. When the built-in

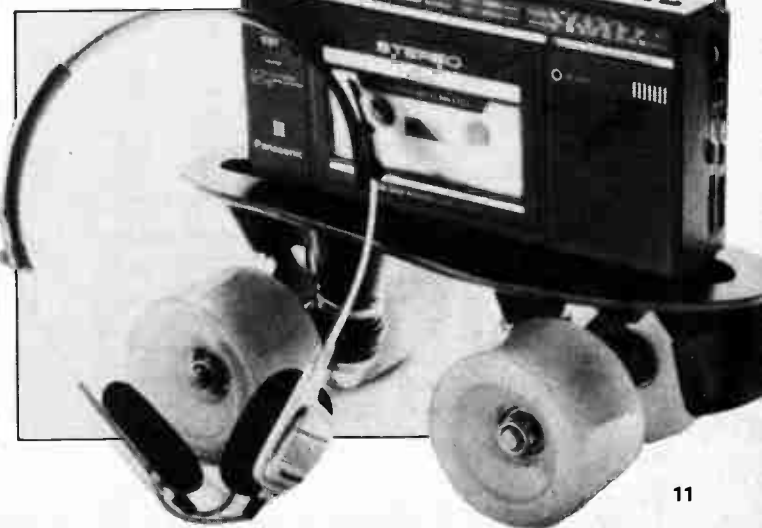


counter has recorded a set number of pulses, the switch is turned off. For a short delay period, the oscillator frequency is increased, resulting in a shorter counting period. The delay adjustment screw is on the back of the switch which is set during installation for a time delay of between two and 15 minutes. It cannot be altered once set. The triac is protected by a fuse located at the front of the switch, but this can be locked to prevent unauthorised removal. The Logic Time Delay Switch can be installed for one-way, two-way or multi-way operation, with the delay switch as the master unit and standard logic press switches or architrave switches as extension units. There is also an override facility provided, useful when maintenance work or routine cleaning is carried out. A built-in neon indicator glows through the face-plate for easy location. The switch has a 400 W rating, for tungsten lighting only. For further details contact MK Electric Ltd, Shrubbery Road, Edmonton, London N9 0PB.

## Is It A Bird? Is It A Plane?

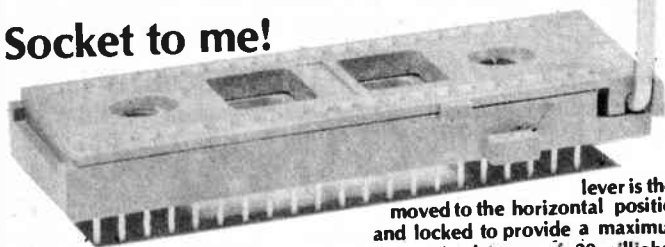
Not entirely unexpected after the Sony Stowaway's runaway success (along with the offerings of its many competitors), comes the first of a new breed of 'music on the move' ideas. It is a miniature stereo cassette/radio from Panasonic — the RX 2700. It is a pocket-sized unit which includes a compact FM/AM radio and cassette recorder producing 550 mW power output. It has a built-in speaker as well as stereo

headphones and is able to record from its own radio in either stereo or mono, or can record in mono from its built-in microphone — useful for dictation. Among its other features are LED indicators, two-step tone control, one-touch recording, auto-stop, pause control and variable sound monitor. For the mere sum of £133.50 you too can have this versatile little device along with a carrying case and hip/shoulder strap. It is available now from Panasonic dealers. This is not likely to be the last of the miniature stereo devices we are likely to see, so keep watching these pages!





## Socket to me!



A range of Lever Actuated Zero Insertion Force sockets has been recently launched by Winslow International. The design is space saving — giving a height above the PCB of only 0.283 inches. When the lever is lifted to the upright position the socket will accept the IC without any force being applied to it. The

lever is then moved to the horizontal position and locked to provide a maximum contact resistance of 20 milliohms at 10 mA. The socket is manufactured from Glass Reinforced PBT Resin and contact plating is 75 microinches of gold over hard nickel. It is available in 24, 28, 40 and 64 contact versions. More details are available from Winslow Component Systems Ltd, 71 Tunnel Road, Tunbridge Wells, Kent TN1 2BX.

## A Case In Point

Lascar Electronics are offering a FREE custom moulded handheld instrument case worth over £1 to any enthusiast building their LCD meter kit, which they claim to be the first of a new generation of DPMs. The meter gives a battery life of at least 10 times that of existing types. LCD watch manufacturing techniques have been used to reduce the depth to a minimum. The 0.6 inch digits can be read to a distance of 10 m. The unit also incorporates a digital hold facility, auto-zero, auto-polarity, programmable decimal points and a

200 mV full scale deflection. Display backlighting is a customer option. The meter is supplied with brackets for front or rear panel mounting. The custom moulded case accepts the DPM, a PP3 battery and allows space for the customer's own PCB (the data sheet on the meter includes 10 small easy-to-build handheld instruments). The total cost of the meter is £19.95 plus 50p postage and packing and £3.06 VAT. The offer of the free case is valid until the end of December this year. For further information contact Lascar Electronics at Unit 1, Thomasin Road, Burnt Mills, Basildon, Essex SS13 1LH.

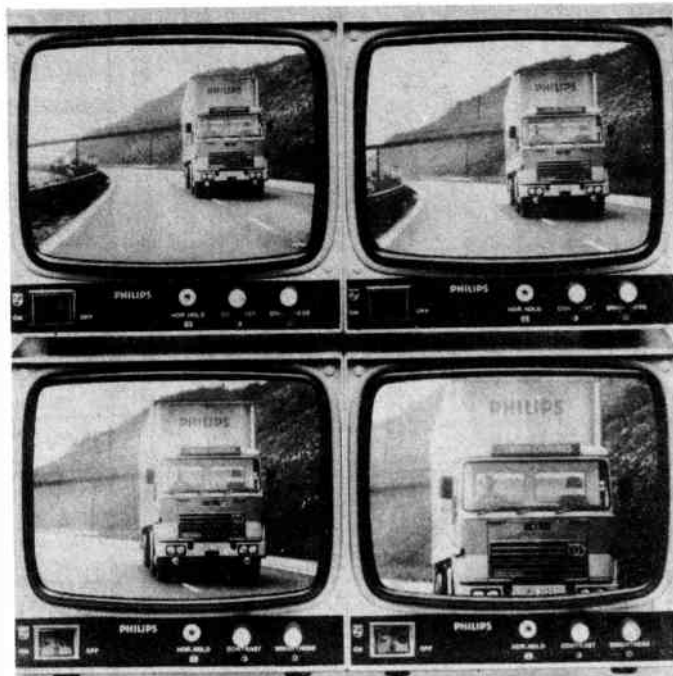
## Phone Around

Now that British Telecom has taken over the communications network for the Post Office, some ex-

citing new innovations are taking place, not the least of which is the yellow telephone box idea. Enough of the controversy though, let's get on with the real story. British Telecom has placed an order worth £10 million for the Herald electronic business telephone system. With this new system Britain can no longer be accused of being inefficient and old-fashioned in its approach to telecommunication by comparison with other countries. Herald is the most advanced small business system in the world. Based on a micro-processor and purpose designed large-scale integrated circuits, the Herald offers a unique range of programmable facilities. It can be arranged to function as a multi-line exchange, as a key system, as an automatic call distribution system or as a satellite to a large PABX. It is easy to install and maintain and is low-cost. The terminal is available in either standard or de-luxe models with a compact Central Control designed to blend into the office environment. Unfortunately the company hasn't mentioned whether the standard colour is British Telecom yellow! Buzby, you've got a lot to answer for!



ETI MAY 1981



## Dial-a-Picture

Still pictures can now be sent over any distance for the cost of a single phone call with the Philips Slowscan system. The system is ideal for cheap remote observations of buildings, industrial processes and motorways where it is not feasible to install high quality video circuits for real-time pictures. The application for this system is already in evidence on the M4 motorway. A CCTV camera is located at the Chepstow interchange, viewing the approach road. Still pictures, updated every 8.5 S, are displayed on monitors situated 17 miles away in the Police

Control Centre at Cwmbran, providing the Police with information on motorway conditions. The system has the facility for selecting up to four pre-set camera positions, and should the operator require closer examination of an incident, he can switch the Slowscan transmission system from a low definition/high speed scan of 8.5 S to a high definition/low speed scan of 17 to 35 S. The system comes from Pye Business Communications, Cromwell Road, Cambridge, CB1 3HE. This division of Philips will be re-named the Communication and Control Division of Philips Business Systems after 1st April this year.

## Swimming Around?

The Casio W-100 series of watches are able to function up to a depth of 100 m and feature a 12-digit display. The integrated LCD shows full information simultaneously — hours, minutes, seconds, AM/PM (or 24 hour clock), day, month and date. Even when operating the secondary functions such as countdown alarm and stopwatch the W-100 still displays the current hour and minutes in an offset position. It is also capable of a daily alarm and half-hourly time signal. The Casio W series is a range that offers a choice of bracelet or case styles. The W-100 itself has a resin case and strap and costs £22.95. The W-150C features a stainless steel case with black resin strap at £27.95. Top of the range is the W-150 with full stainless steel case and strap at £32.50. (All these are recommended retail prices and this type of product is usually sold at lower prices.) Fur-

ther information from: Casio Electronics Co. Ltd, 28 Scrutton Street, London EC2A 4TY.



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2111	2.32	8T95	1.80
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4118	14.95	81L S96	1.30
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6011	4.95	8228	4.20
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6522	7.95	8257	10.95
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6545	17.50	8678	12.95
6576	14.95	8602	2.20
6800	7.95	9C364	10.95
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6852	5.95	Z8000	120.00
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**SOFTWARE**

**CP/M** DISK WITH /MAN MANUAL Available on 8" IBM format & 5 1/4 for TUSCAN & TRITON

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LS00	13	LS366	85
LS01	13	LS367	85
LS02	15	LS368	85
LS03	15	LS373	180
LS04	20	LS374	180
LS05	23	LS375	180
LS08	23	LS377	180
LS09	23	LS378	185
LS10	20	LS379	215
LS11	32	LS386	85
LS12	32	LS390	140
LS13	40	LS393	140
LS14	75	LS395	210
LS15	40	LS396	180
LS20	24	LS398	275
LS21	32	LS399	230
LS22	40	LS445	140
LS26	46	LS447	185
LS27	48	LS490	180
LS28	48	LS668	105
LS30	24	LS669	105
LS32	30	LS670	275
LS33	39		
LS37	39	4000	18
LS38	39	4001	18
LS40	28	4002	24
LS42	80	4006	22
LS47	85	4007	22
LS48	120	4008	40
LS49	125	4010	40
LS51	25	4011	24
LS54	30	4012	24
LS55	70	4013	24
LS63	150	4014	46
LS72	40	4015	85
LS74	40	4016	42
LS75	48	4018	28
LS76	46	4019	48
LS78	46	4020	82
LS83	105	4021	105
LS85	105	4022	95
LS86	45	4023	25
LS90	80	4024	75
LS91	125	4025	25
LS93	75	4026	100
LS95	115	4027	48
LS96	180	4028	82
LS107	45	4029	105
LS109	75	4030	80
LS110	80	4033	175
LS113	65	4034	210
LS114	49	4035	125
LS122	70	4040	105
LS123	95	4041	80
LS124	80	4042	80
LS125	80	4043	80
LS126	80	4044	85
LS132	95	4046	130
LS133	65	4047	95
LS136	60	4049	45
LS138	70	4050	48
LS145	175	4051	48
LS148	175	4052	80
LS151	95	4053	80
LS153	95	4054	130
LS155	95	4055	135
LS157	78	4058	28
LS158	85	4059	30
LS160	120	4070	25
LS161	98	4071	25
LS162	110	4072	25
LS163	100	4073	25
LS164	115	4075	25
LS165	155	4076	25
LS166	175	4078	30
LS168	210	4081	28
LS169	210	4093	125
LS170	285	4502	125
LS173	107	4507	99
LS174	147	4508	325
LS175	110	4510	99
LS181	295	4511	150
LS190	120	4512	65
LS191	120	4514	195
LS192	125	4515	289
LS193	125	4516	105
LS194	125	4518	125
LS196	125	4519	70
LS196	120	4520	115
LS202	345	4521	250
LS203	225	4522	150
LS240	225	4526	150
LS241	225	4527	180
LS242	222	4528	120
LS243	232		
LS244	225		
LS245	360		
LS247	135	T03	+ve
LS248	135	7805	145
LS249	135	7812	145
LS251	130	7815	145
LS252	130	7818	145
LS257	115	-ve	
LS258	115	7905	220
LS259	180	7912	220
LS261	450	T0220	plast
LS266	180	7805	80
LS273	180	7812	80
LS275	320	7815	80
LS279	88	7818	80
LS280	250	7824	85
LS283	180	7905	85
LS290	130	7912	85
LS293	130	7915	85
LS296	215	7918	85
LS298	215		
LS299	420		
LS324	200		
LS325	320		
LS326	330		
LS327	315		
LS352	185		
LS353	185		
LS355	85		

**CMOS**

4000	18
4001	18
4002	24
4006	22
4007	22
4008	40
4010	40
4011	24
4012	24
4013	24
4014	46
4015	85
4016	42
4018	28
4019	48
4020	82
4021	105
4022	95
4023	25
4024	75
4025	25
4026	100
4027	48
4028	82
4029	105
4030	80
4033	175
4034	210
4035	125
4040	105
4041	80
4042	80
4043	80
4044	85
4046	130
4047	95
4049	45
4050	48
4051	48
4052	80
4053	80
4054	130
4055	135
4058	28
4059	30
4070	25
4071	25
4072	25
4073	25
4075	25
4076	25
4078	30
4081	28
4093	125
4502	125
4507	99
4508	325
4510	99
4511	150
4512	65
4514	195
4515	289
4516	105
4518	125
4519	70
4520	115
4521	250
4522	150
4526	150
4527	180
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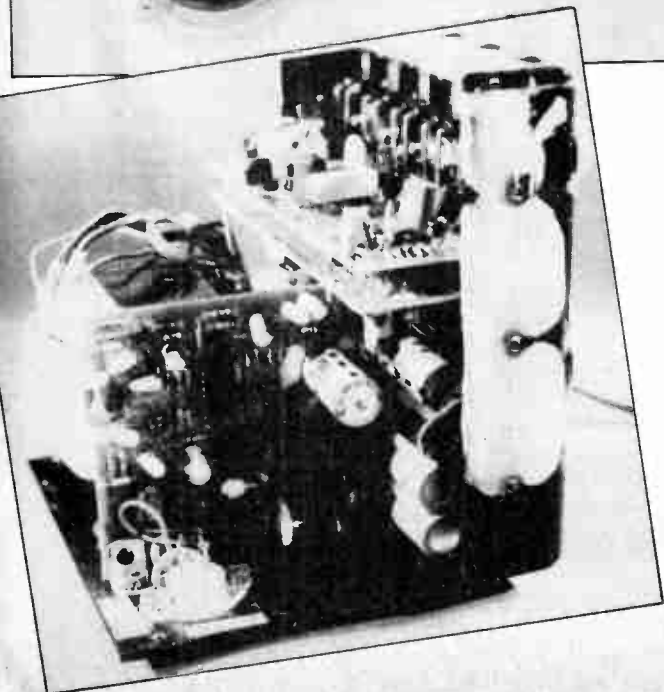
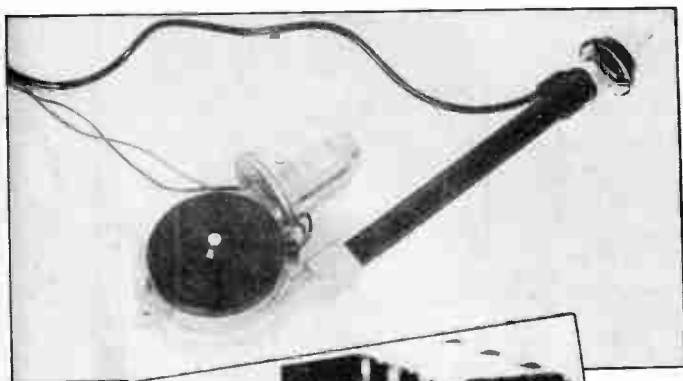
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## CARVER MAGNETIC FIELD AMP

An ETI exclusive. Despite what our friends across the Atlantic would call a low profile situation, we've been able to obtain details of Bob Carver's latest brainchild, the M-400 magnetic field amplifier. Would you believe a 7 inch cube that can push 200 W into an 8 ohm load? Neither did we until we read this article by Stan Curtis.



## VOLTAGE CONTROLLED AUDIO

Continuing our current theme of remote-control ing everything (almost), we look at a range of Mullard ICs, intended for use in hi-fi systems, that allow DC control of just about all the functions you can think of. In this article Keith Brindley examines two members of the family; applications circuits and suitable PCBs are included so you can try them out for yourself.

## TECH TIPS SPECIAL

Always one of our most popular features, Tech Tips gets the star treatment this month with extra pages of our readers' circuits. Essential for experimenters.

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



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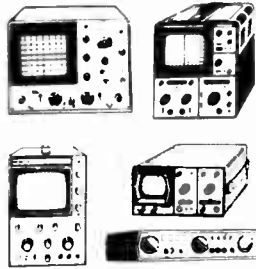
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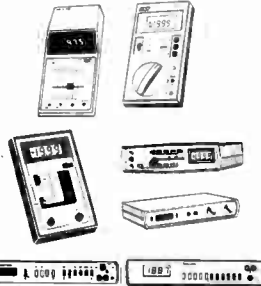


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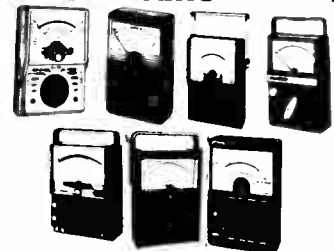
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# DESIGNER'S NOTEBOOK

The CMOS family contains many useful ICs, and in this month's extended Notebook, Ray Marston takes an in-depth look at the 4066B quad bilateral switch.

The 4066B CMOS IC is described in the manufacturer's literature as a 'quad bilateral switch', a pretty fair description since the device contains four independent electronic switches, each capable of passing signals in either direction and being controlled (turned on or off) by a single high-impedance terminal. The switches have a very high off impedance, an on impedance of about 90  $\Omega$ , and can be used to switch both analogue and digital signals. The ICs typically cost a mere 50 pence each, not bad for four independent SPST switches.

## Basic 4066B Circuits

Figure 1 shows the outline and pin notations of the 4066B quad bilateral switch, which can be used with any supply voltage in the range 3 to 18 V. Note that, since the switches are of the bilateral type, either switch terminal can be used as the input or output.

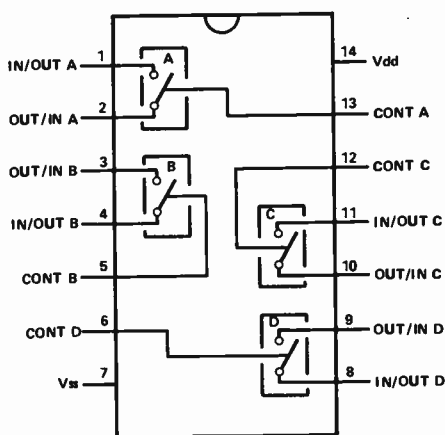


Fig. 1 Outline and pin notations of the 4066B quad bilateral switch.

Figure 2a shows the basic way of using the bilateral switch; the switch can be turned off (open circuit) by taking the control terminal to  $V_{SS}$  or turned on by taking the control terminal to  $V_{DD}$ . In digital switching applications (Fig. 2b) the IC can be used with a single-ended supply, with  $V_{SS}$  at 0 V and  $V_{DD}$  at the desired positive supply. In analogue switching applications (Fig. 2c), a split power supply (either true or effective) must be used, with the positive rail to  $V_{DD}$  and the negative to  $V_{SS}$ ; in this case, of course, the maximum supply limits are restricted to  $\pm 9$  V. Typically, the bilateral switch introduces less than 0.5% of signal distortion when used in the analogue mode.

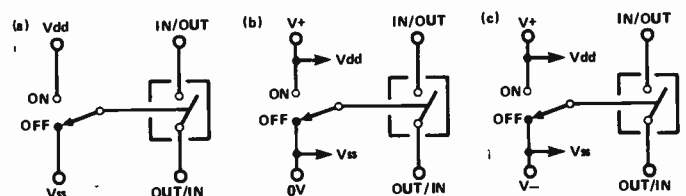


Fig. 2 (a) The basic bilateral switch is turned off by taking the control terminal to  $V_{SS}$  and turned on by taking the control to  $V_{DD}$ . (b) In digital switching applications,  $V_{DD}$  is  $V+$  and  $V_{SS}$  is 0 V. (c) In analogue switching applications where a split power supply is used,  $V_{DD}$  must go to  $V+$  and  $V_{SS}$  to  $V-$ .

Certain simple precautions must be observed when using the 4066B. First, the switch signals must in no circumstances be allowed to rise above the  $V_{DD}$  voltage or fall below the  $V_{SS}$  voltage. Each unused switch in the 4066B package must be disabled (see Fig. 3) either by taking its control terminal to  $V_{DD}$  or  $V_{SS}$  (as most convenient), or by taking all three terminals to  $V_{SS}$ .

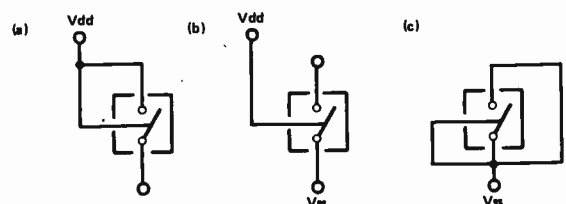


Fig. 3 Unused bilateral switches must be disabled, either by taking the control terminal to  $V_{DD}$  and one of the switch terminals to  $V_{DD}$  (a) or  $V_{SS}$  (b), or by taking all three terminals to  $V_{SS}$ .

Figure 4 shows how the 4066B can be used to implement the four basic switching functions of SPST, SPDT, DPST and DPDT. Figure 4a shows the SPST connections, which we have already discussed. The SPDT function is implemented by wiring an inverter stage (a 4001 or 4011, etc) between the IC1a and IC1b control terminals as shown. The DPST switch (Fig. 4c) is simply two SPST switches sharing a common control terminal, and the DPDT switch (Fig. 4d) is two SPDT switches sharing a common inverter stage in the control line.

Note that the basic switching functions of Fig. 4 can be expanded or combined in any desired way by simply adding extra switches/4066B-packages, as appropriate. Thus, a 10-pole double-throw switch can, for example, be made by using five of the Fig. 4d circuits and joining their control inputs together. ➔

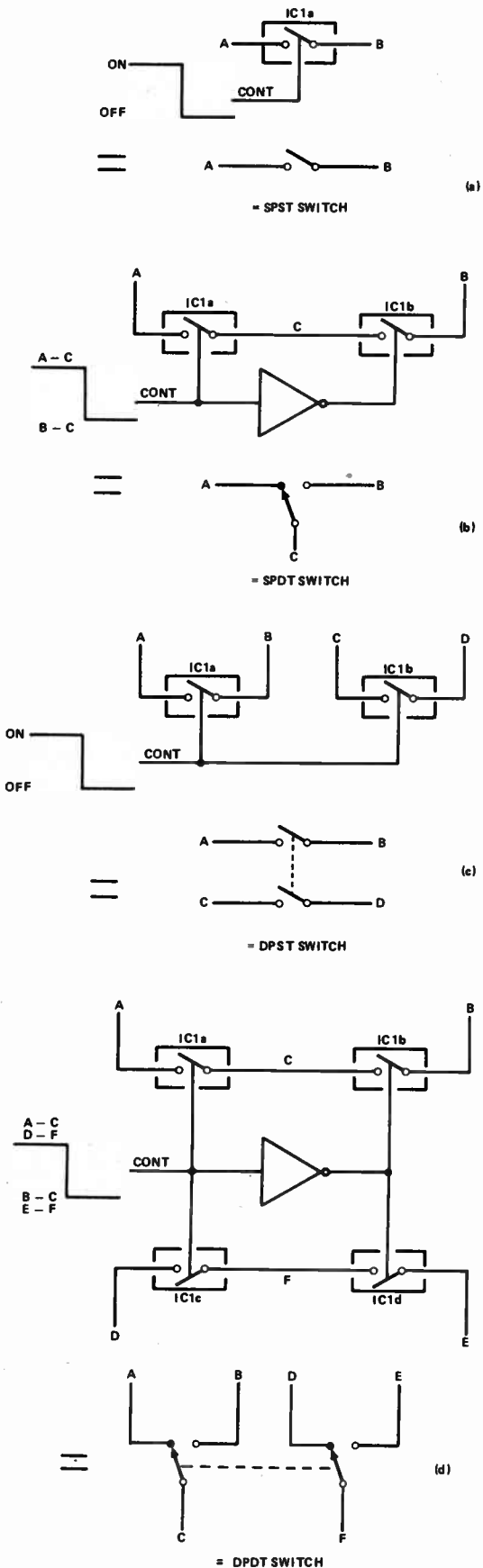


Fig. 4 Using the 4066B to implement the four basic switching functions.

## Six Latching Circuits

Figure 5 shows how a 4066B switch can be used as a simple but very useful press-button activated latch; the LED is merely used to indicate the state of the latch and can be replaced with a short circuit if preferred. Circuit operation is easily understood.

Suppose initially that the latch is off (switch open). In this case the output, and hence the control bias applied via R2, will be zero, so the switch will maintain its off state. If PB1 is now momentarily closed the control voltage will go high and turn the switch on, thus driving the output high and maintaining the control drive high (switch on) once PB1 is released. This new state will be maintained until PB2 is closed, at which point the switch will latch into the off state again. R1 is used in the circuit to ensure that a supply short will not occur if both buttons are pressed at the same time; with R1 in the position shown, the switch will turn off if both buttons are pressed at once; if R1 is moved to the low side of PB2, the switch will turn on if both buttons are pressed at once.

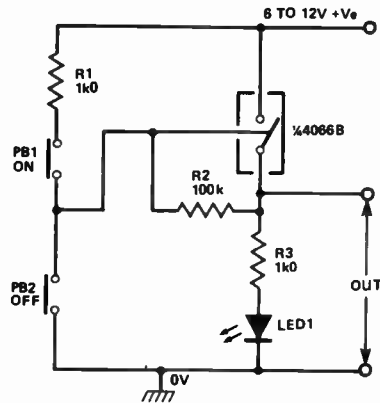


Fig. 5 Push-button latch using the 4066B.

The Fig. 5 circuit has a couple of interesting characteristics. First, the control bias resistor can be given any desired value up to practical limits. Figure 6, for example, shows how the value can be increased to 10M to make a latching touch switch that can be activated by placing a finger across the upper or lower set of touch contacts. R1 and C1 are used to suppress hum signals and ensure positive switching.

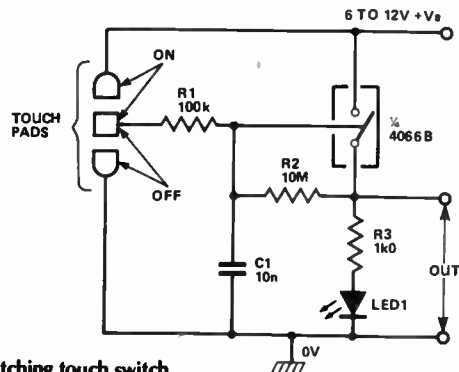


Fig. 6 A latching touch switch.

Another useful feature is that, since the on resistance of the switch is only 90 R or so, the voltage loss across the switch can be quite low (90 mV at 1 mA): in practice, the on current should be limited to 10 mA maximum. Figure 7 shows how this low-loss effect can be exploited to make a push-button power switch that can be used to connect or disconnect the power supply to a piece of electronic equipment (amplifier, test gear, etc).

When the switch is off, Q1 is cut off and the circuit consumes a typical standby current of less than 1 uA. When the

switch is on, Q1 acts as a voltage follower with its base tied to the positive line via IC1a, so the output voltage is high. The actual voltage drop between the output and the supply is equal to the IC1a drop plus the base-emitter drop of Q1 and typically ranges from 600 to 800 mV. The available output current depends on the gain and current rating of Q1, but currents of a few hundred milliamps are readily available from a single transistor.

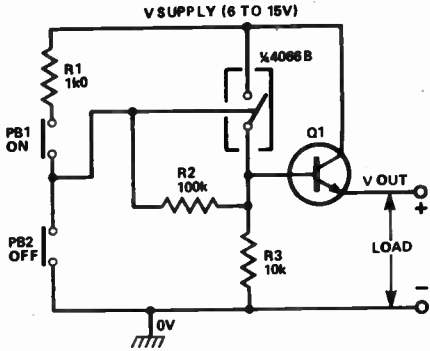


Fig. 7 This push-button-activated power switch can be used to replace a conventional slide or toggle switch.

A slightly more efficient version of the push-button power switch is shown in Fig. 8. In this case the load is wired between the collector of Q1 and the positive supply rail. The voltage drop in this circuit is determined only by the saturation characteristics of Q1 and may typically be in the range 200 to 600 mV.

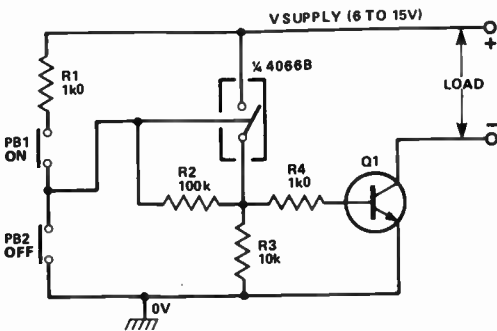


Fig. 8 An alternative version of the push-button power switch.

Figure 9 shows how the above circuit can be modified for use as a 'close-to-activate' burglar, panic or fire alarm, in which Q1 output feeds directly to a heavy duty 'alarm' relay which, in turn, actuates an external bell or siren. Any number of normally-open sensors/switches can be wired in parallel in the 'PB' positions. The circuit consumes only a microamp or so when in the 'ready' or off mode.

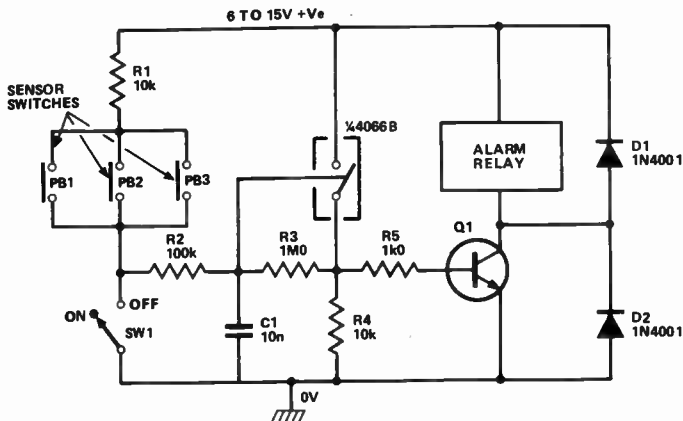


Fig. 9 A close-to-activate burglar/panic/fire alarm.

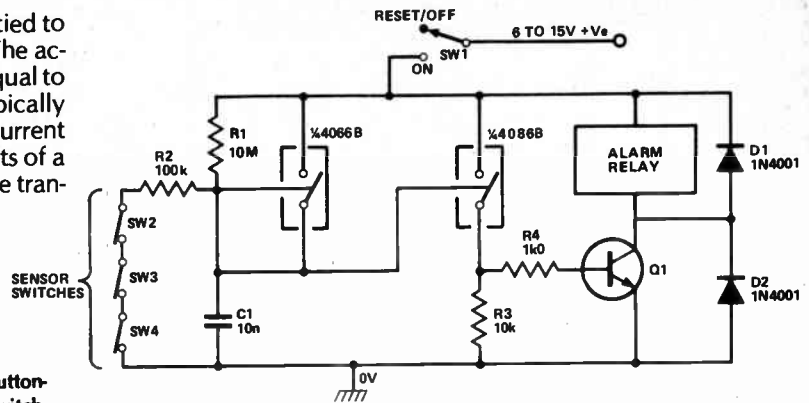


Fig. 10 A break-to-activate burglar alarm.

Finally, Fig. 10 shows how a pair of 4066B switches can be used to make a break-to-activate burglar alarm in which any number of normally-closed sensor switches can be wired in series and which typically consumes a standby current of only 1 uA or so. Here, if any of the switches open, the control terminals of IC1a and IC1b are pulled high by R1 and cause both switches to close; IC1a then shorts out R1, ensuring that the switches will not turn off again when the sensor switches close. Simultaneously IC1b activates the alarm relay via Q1. Note that, once this alarm circuit has been activated, it can only be turned off again by resetting the sensor switches and momentarily breaking the supply connections via SW1.

## Digital Control

The 4066B can be used to digitally control or vary resistance, capacitance, impedance, amplifier gain or oscillator frequency in any desired number of discrete steps. Figure 11 shows how the four switches of a single 4066B can be used to vary the effective value of a resistance in 16 digitally-controlled steps of 10k each. In practice, of course, the step magnitudes can be given any desired value (determined by the value of the smallest resistor) so long as the four resistors are kept in the ratio 1-2-4-8.

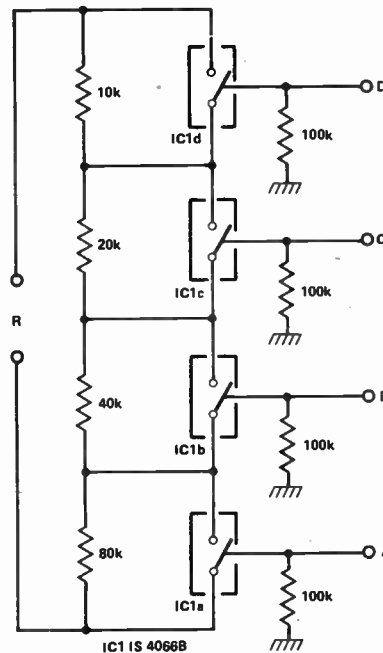
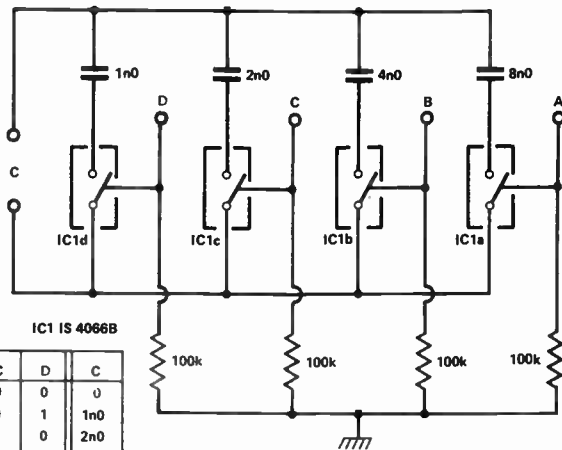


Fig. 11 This circuit gives 16-step digital control of resistance. R can be varied from zero to 150k in steps of 10k.

A	B	C	D	R
0	0	0	0	150k
0	0	0	1	140k
0	0	1	0	130k
0	0	1	1	120k
0	1	0	0	110k
0	1	0	1	100k
0	1	1	0	90k
0	1	1	1	80k
1	0	0	0	70k
1	0	0	1	60k
1	0	1	0	50k
1	0	1	1	40k
1	1	0	0	30k
1	1	0	1	20k
1	1	1	0	10k
1	1	1	1	0



A	B	C	D	C
0	0	0	0	0
0	0	0	1	1n0
0	0	1	0	2n0
0	0	1	1	3n0
0	1	0	0	4n0
0	1	0	1	5n0
0	1	1	0	6n0
0	1	1	1	7n0
1	0	0	0	8n0
1	0	0	1	9n0
1	0	1	0	10n0
1	0	1	1	11n0
1	1	0	0	12n0
1	1	0	1	13n0
1	1	1	0	14n0
1	1	1	1	15n0

Fig. 12 A similar circuit to that of Fig. 11 gives 16-step digital control of capacitance. C can be varied from zero to 15n in steps of 1n0.

Figure 12 shows how four switches can be used to make a digitally-controlled capacitor that can be varied in sixteen steps of 1n0 each.

Note that in the Fig. 11 and 12 circuits the resistor/capacitor values can be controlled by operating the 4066B switches manually, or automatically using simple logic networks, microprocessors, up/down counters, and so on.

The circuits of Figs. 11 and 12 can be combined in a variety of ways to make digitally-controlled impedance and filter networks. Figure 13, for example, shows three different ways of using the circuits to make a digitally-controlled first-order low pass filter.

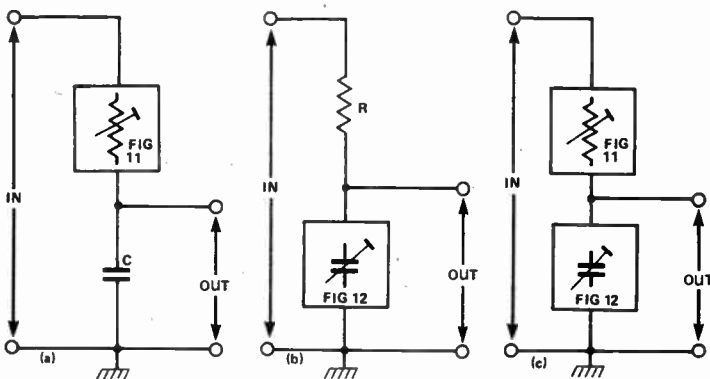
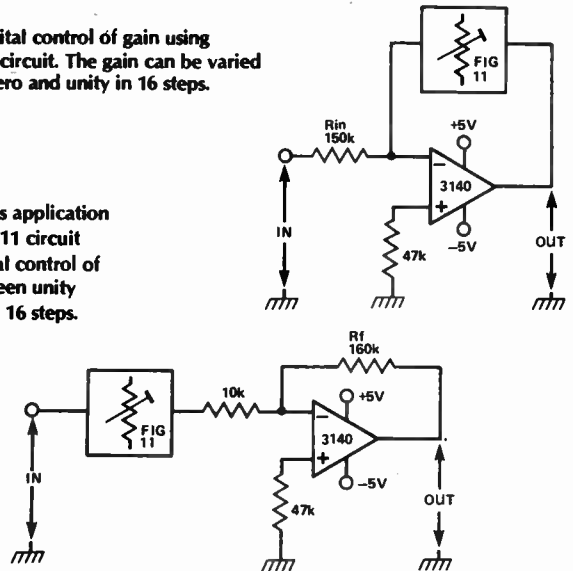


Fig. 13 Three ways of using the circuits of Fig. 11 and Fig. 12 to make a digitally-controlled first-order low pass filter.

Digital control of amplifier gain can be obtained by hooking the 'resistance' circuit of Fig. 11 into the feedback or input path of a standard op-amp inverting circuit, as shown in Figs. 14 and 15. The gain of such a circuit is equal to  $R_f/R_{IN}$ , where  $R_f$  is the feedback resistance and  $R_{IN}$  is the input resistance. Thus, in the Fig. 14 circuit, where the controlled resistance is in the feedback loop, the gain can be varied from zero to unity in 16 discrete steps of 'one fifteenth' each, ie giving a sequence of 0, 1/15, 2/15, 3/15, . . . ., 14/15, 15/15.

Fig. 14 Digital control of gain using the Fig. 11 circuit. The gain can be varied between zero and unity in 16 steps.

Fig. 15 This application of the Fig. 11 circuit gives digital control of gain between unity and x 16 in 16 steps.



In the Fig. 15 circuit, where the controlled resistance is in the input path, the gain can be varied from unity to x 16 in 16 steps, giving a gain sequence of 1, 2, 3, 4, 5, 6, . . . Note that in both of these circuits, the op-amp uses a split power supply so the 4066B control voltage must switch between the negative and positive supply rails.

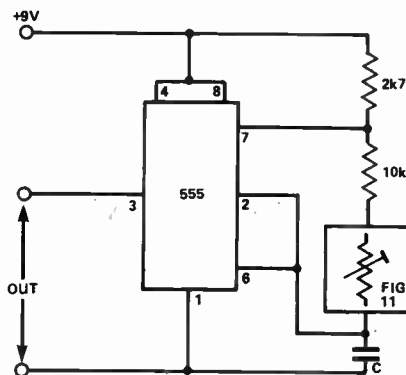


Fig. 16 Digital control of the frequency of a 555 astable. The frequency can be varied in 16 steps.

Figure 16 shows how the Fig. 11 circuit can be used to digitally control the frequency of an oscillator in 16 discrete steps. In this example the circuit is that of a 555 astable, but the general control principle can be applied equally well to many other types of oscillator circuit.

Figure 17 shows how a trio of 4066B switches can be used to implement digital control of the decade range selection of 555 astable. Here, only one of the switches must be turned on at any time. Naturally, the circuits of Figs. 16 and 17 can be combined to form a wide-range oscillator that can be digitally controlled by a computer, for example.

## Synthesized Multi-Gang Pots

The synthesizing principle is quite simple and is illustrated in Fig. 18, which shows the circuit of a synthesized four-gang 10k-100k rheostat for use at signal frequencies up to about 15 kHz.

Here, the 555 is used to generate a 50 kHz (nominal) rectangular waveform whose mark/space ratio can be varied from 11:1 to 1:11 by RV1, and this waveform is used to control the switching of the 4066B stages. All of the 4066B switches are fed with the same control waveform, and each switch is wired in series with a range resistor (RA, RB, etc), to form one gang of the 'rheostat' between the pairs of terminals, as shown.

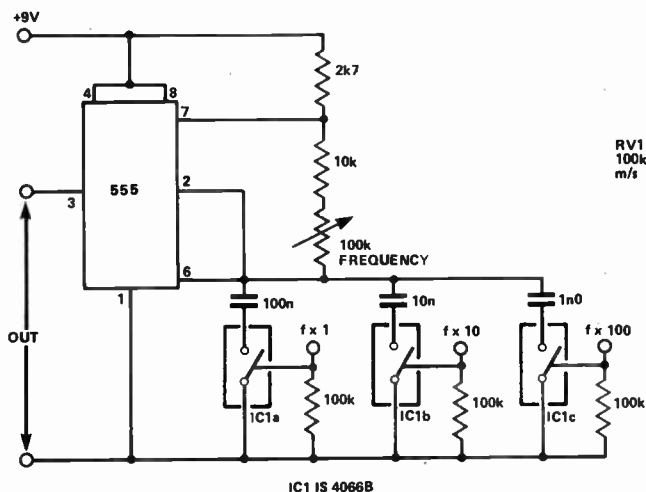


Fig. 17 Digital control of decade range switching of a 555 astable.

Remembering that the switching rate of this circuit is very fast (50 kHz) relative to the rheostat's maximum signal frequency (15 kHz), it can be seen that the mean or effective value of the 'rheostat' resistance can be varied with mark/space ratio control RV1. Thus, if IC2a is closed for 90% and open for 10% of each duty cycle (mark/space ratio of 9:1), the apparent (mean) value of the resistance will be 10% greater than RA, ie 10k. If the duty cycle is reduced to 50%, the apparent RA value will double, to 18k2. If the duty cycle is further decreased, so that IC2a is closed for only 10% of each duty cycle (mark/space ratio 1:9), the apparent value of RA will increase by a decade, to 91k. Thus, the apparent resistance of each 'gang' of the 'rheostat' can be

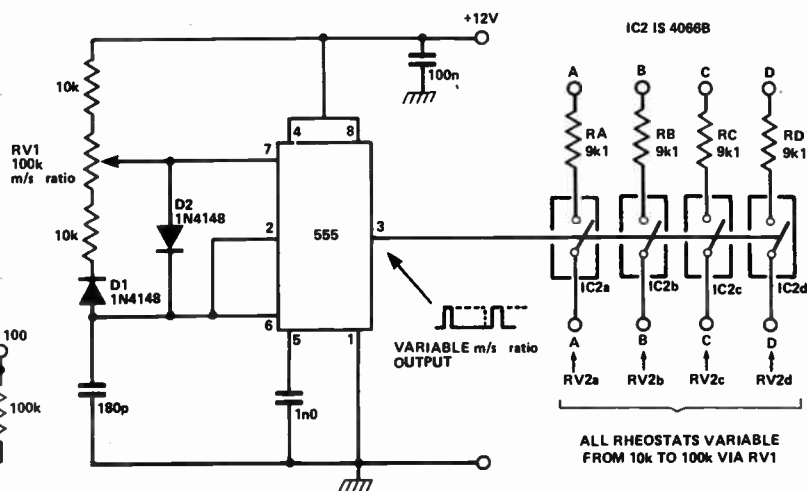


Fig. 18 Synthesized precision four-gang rheostat.

varied by RV1.

There are some important points to note about the Fig. 18 circuit. First, the circuit can be given any desired number of 'gangs' by simply adding an appropriate number of switch stages and range resistors. Since all switches are controlled by the same mark/space ratio waveform, perfect tracking is automatically assured. Individual gangs can be given different ranges, without affecting the tracking, by giving them different range resistor values. The sweep range and the law of the rheostat can be changed by changing the characteristics of the mark/space ratio generator.

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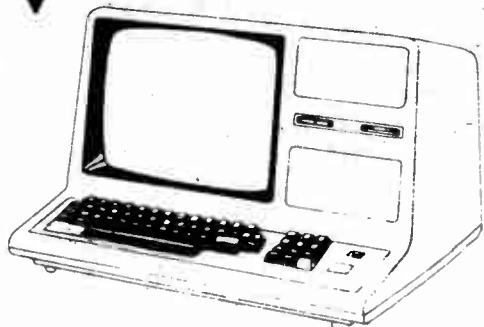
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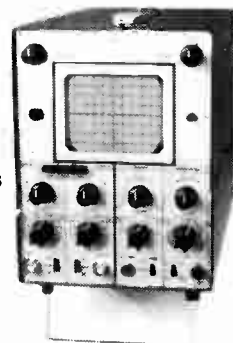
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TBA120S	1.00	SL1610P	1.60	HA11223	2.15	4000	0.18	4068	0.25	TTL	'N'	'LPSN'	TTL	'N'	'LPSN'	TTL	'N'	'LPSN'	8224	3.50	STD DOME TYPES			
L200	1.95	SL1611P	1.60	HA11225	1.45	4001	0.18	4069	0.25	7400	0.13	0.20	7454	0.20	0.30	74128	0.74	74194	1.05	8251	6.25	5mm RED	12p	
U27B	1.28	SL1612P	1.60	HA12002	1.45	4002	0.24	4070	0.30	7401	0.13	0.20	7455	0.30	0.30	74132	0.73	0.78	74196	1.34	8255	5.40	3mm RED	15p
U247B	1.28	SL1613P	1.89	HA12017	0.80	4007	0.30	4071	0.24	7402	0.14	0.20	7460	0.20	0.20	74136	0.40	0.40	74197	1.10	6800P	7.50	5mm RED	15p
U257B	1.28	SL1620P	2.17	HA12402	1.95	4008	0.80	4072	0.24	7403	0.14	0.20	7463	0.20	1.24	74141	0.75	0.72	74198	1.60	6810	5.95	2.5x5 RED	17p
U267B	1.28	SL1621P	2.17	HA12411	1.20	4008AE	0.80	4073	0.24	7404	0.14	0.20	7470	0.40	0.40	74141	0.75	0.72	74198	1.60	6820	7.45	5mm GRN	15p
LM301H	0.67	SL1623P	2.44	HA12412	1.55	4009	0.58	4075	0.25	7405	0.18	0.26	7472	0.30	0.30	74142	0.65	0.72	74199	1.60	6850	4.90	3mm GRN	15p
LM301N	0.30	SL624C	3.28	LF13741	0.33	4010	0.58	4076	0.90	7406	0.36	0.40	7474	0.35	0.35	74144	3.12	0.97	74279	0.88	6852	4.85	3mm GRN	15p
LM308TC	0.65	SL1625P	2.17	SN75660N	0.80	4011AE	0.24	4077	0.35	7407	0.38	0.40	7475	0.56	0.56	74145	3.12	0.97	74279	0.88	6880	5.95	2.5x5 RED	17p
LM324	0.64	SL1626P	2.44	FREQ. DISPLAY AND SYNTH. DEVICES		4011B	0.24	4078	0.30	7408	0.19	0.24	7476	0.41	0.45	74147	1.75	1.19	74293	1.32	MC2708	6.00	2.5x5 GRN	20p
LM339N	0.66	SL1630P	1.62	SAA1056	3.75	4016	0.52	4503	1.15	7412	0.27	0.32	7480	0.52	0.52	74150	0.99	0.97	74283	1.20	4027	5.78	5mm YL	16p
LM348N	1.86	SL1640P	1.89	SA11058	3.35	4017	0.80	4506	0.68	7413	0.32	0.32	7481	1.20	0.95	74151	0.95	0.95	74293	1.32	2114	6.50	5mm YL	15p
LF351N	0.49	SL1641P	1.89	SA11059	3.35	4018	0.60	4510	0.99	7414	0.51	0.51	7482	0.75	0.80	74153	0.70	0.80	74293	1.32	4027	5.78	5mm YL	16p
LF353N	0.76	TD2A002	1.25	SA11056	3.75	4016	0.52	4503	1.15	7412	0.27	0.32	7480	0.52	0.52	74150	0.99	0.97	74283	1.20	4027	5.78	5mm YL	16p
LM374N	3.75	ULN2242A	3.05	SA11058	3.35	4017	0.80	4506	0.68	7413	0.32	0.32	7481	1.20	0.95	74151	0.95	0.95	74293	1.32	2114	6.50	5mm YL	15p
LM380N-14	1.00	ULN2280B	1.00	SA11059	3.35	4018	0.60	4510	0.99	7414	0.51	0.51	7482	0.75	0.80	74153	0.70	0.80	74293	1.32	4027	5.78	5mm YL	16p
LM380N-B	1.00	CA3080E	0.70	11C900C	14.00	4020	0.60	4510	0.99	7414	0.51	0.51	7482	0.75	0.80	74153	0.70	0.80	74293	1.32	4027	5.78	5mm YL	16p
LM381N	1.81	CA3089E	1.84	LN1232	19.00	4021	0.82	4512	0.98	7415	0.30	0.40	7485	1.04	0.99	74154	1.30	1.10	74374	1.80	2511	7.54	5mm ORA	20p
ZNA199C	1.98	CA3090AO	3.35	LN1242	19.00	4022	0.96	4514	2.55	7417	0.30	0.30	7486	1.04	0.99	74154	1.30	1.10	74374	1.80	HM4716	4.00	5mm ORA	29p
NE544N	1.80	CA3123E	1.40	MSL2318	3.84	4023	0.25	4518	1.03	7420	0.19	0.24	7489	2.05	0.97	74156	0.80	0.70	74377	1.99	81LS97	1.25	2.5x5 ORA	24p
NE555N	0.30	CA3130E	0.80	MSM5523	11.30	4024	0.76	4520	1.09	7421	0.38	0.24	7490	0.42	0.90	74157	0.78	0.71	74393	1.40	5mm Infra Red	56p	IF Opto Cplr	1.51
NE556N	0.50	CA3130T	0.90	MSM5524	11.30	4025	0.25	4521	2.36	7423	0.27	0.24	7492	0.50	0.78	74159	2.10	1.30	74393	1.40	BPW41	1.51	5mm Clip	5p
NE560N	3.50	CA3140E	0.46	MSM5525	7.85	4026	1.80	4522	1.49	7425	0.27	0.27	7493	0.57	0.99	74160	0.99	1.30	74393	1.40	5mm Clip	5p		
NE562N	4.05	CA3189E	2.20	MSM5526	7.85	4028	0.79	4529	1.61	7427	0.32	0.35	7495	0.70	1.15	74162	0.99	0.98	74393	1.40	5mm Clip	5p		
NE564N	4.29	CA3240	1.27	MSM5527	9.75	4029	1.04	4539	1.28	7428	0.35	0.35	7496	0.58	1.20	74163	0.99	0.95	74393	1.40	5mm Clip	5p		
NE565N	1.60	MC3357P	2.85	MSM55271	9.75	4030	0.59	4549	3.50	7430	0.17	0.26	7497	1.85	0.45	74164	1.20	1.30	74393	1.40	5mm Clip	5p		
NE566N	1.60	LM3900N	0.60	MSL2312	3.94	4035	1.20	4554	2.73	7432	0.32	0.28	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
NE570N	3.85	LM3909N	0.68	SP8629	3.85	4040	0.98	4560	2.18	7437	0.40	0.28	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
SL624	3.28	MS3914N	2.80	SP8647	6.00	4042	0.85	4566	1.59	7438	0.33	0.35	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
TBA651	1.81	LM3915N	2.86	95H90CP	7.80	4043	0.85	4568	2.18	7440	0.20	0.28	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
uA709HC	0.64	K84400	0.80	HD10551	4.45	4043AE	0.93	4569	3.03	7441	0.74	0.74	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
uA709PC	0.66	K84402	0.60	HD40415	4.45	4044	0.94	4572	3.00	7442	0.70	0.99	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
uA710HC	0.45	K84412	1.95	HD12009	6.00	4046	1.30	4585	1.00	7443	1.15	1.15	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
uA710PC	0.59	K84413	1.95	HD44752	8.00	4047	0.85	4568	2.18	7440	0.20	0.28	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
uA741CH	0.66	K84417	1.89	MC145151	12.45	4049	0.99	4572	3.00	7442	0.70	0.99	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
uA741CN	0.27	K84420B	1.09	MC145156	8.75	4050	0.55	4572	3.00	7442	0.70	0.99	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
uA747CN	0.70	TD4A420	2.65			4051	0.78			7447			7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
uA748CN	0.36	KB4423	2.30	MISC		4052	0.79			7447			7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
uA753	2.44	KB4424	2.44	ICM7106CP	9.55	4053	0.52			7448	0.56	0.99	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
uA758	2.35	KB4431	1.95	ICM7107CP	9.55	4060	0.52			7449			7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip	5p		
TBA820M	0.78	KB4432	1.95	ICM7216BP	19.50	4063	1.18			7451	0.20	0.25	7497	1.85	0.45	74165	1.20	1.45	74393	1.40	5mm Clip			

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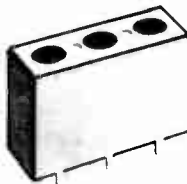
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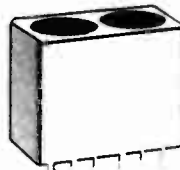
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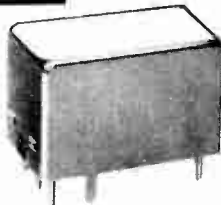


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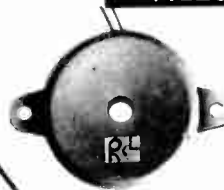
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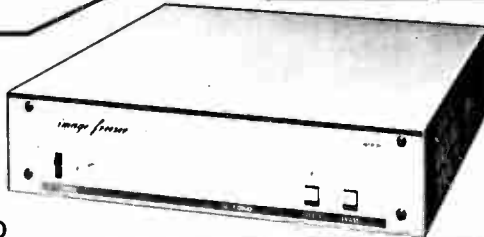
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It is something of an anachronism that in this day of high technology, we should still use solder to join the pieces of our electronic puzzles. And it isn't due to lack of choice: conductive polymers, force-fit, ultrasonics, wire-wrapping, clamp mass or unit terminators and even microweld have all been tried and are very useful in some specialised areas. But the fact remains that soldering is one of the most reliable and versatile ways of making an electrical and mechanical joint with a minimum of cost and time.

The ETI Microstation has been designed to make the process even more reliable and versatile. Its main purpose is melting the solder and locally heating the parts to be joined. It must do so:

- Whatever the thermal mass of these parts;
- In a very short time (before the heat has diffused into and damaged the electronic component or lifted the PCB track — a good rule of thumb is less than 3 S)
- Without overheating the solder (the flux burns and an oxide layer is formed, making it extremely difficult to wet the component).

The key words here are 'thermal mass' and electronic components vary wildly in this respect. Because of this, one usually ends up with three or even four irons in the tool box.

Thermomechanically-controlled irons (magnetic Curie point or thermocouple-switched) can be an improvement, but they are not adjustable and the switching of the heating element creates current spikes that can be very nasty to MOS and other sensitive devices. In addition, they are usually bulky and slow-reacting.

Electronically-controlled soldering stations with adjustable temperature are an improvement; the trouble with many of them is the relatively low maximum output power. The trouble with *all* of them is the price! Practically all electronic stations use a special heating element incorporating a temperature sensor. Unfortunately, this increases the



maintenance costs as well.

As a last criticism, on practically all models the tip is invariably too far from the handle and does not allow a precise work control.

The Microstation is based on a very low voltage heating element-bit initially introduced on portable, battery-powered irons. It has a very low thermal mass and no thermal resistance between element and bit, allowing a very fast-reacting temperature regulation. In addition, the low voltage operation makes it completely harmless to sensitive integrated circuits.

The temperature sensing is performed by measuring the resistance of the heating element itself (by including it in a Wheatstone bridge configuration) and therefore does not require any complicated thermal sensors.

The low working voltage of the element (2V5) implies a high current consumption at maximum power (12 to 15 A). The only type of power supply that can effectively handle and control such currents is the switched mode step-down converter. This circuit accepts a high, unregulated voltage and generates a high current-low voltage output that can be easily controlled. The principle is to store packets of energy in an inductor and then discharge them into the load at a different voltage. The current tends to be constant, so the ratio of the times taken to store and release the energy are the same as the ratio between input and output voltage.

As the power-controlling transistors are either switched on or off, the theoretical efficiency of the circuit is 100%. In practice, the finite switching times mean that some power is dissipated, and the heatsink can become quite hot.

One of the most crucial parts of a switched mode supply is the storage inductance and many tomes have been written



Fig.1 Circuit diagram. Components above the dotted line are mounted either on the heatsink, case or in the actual soldering iron.

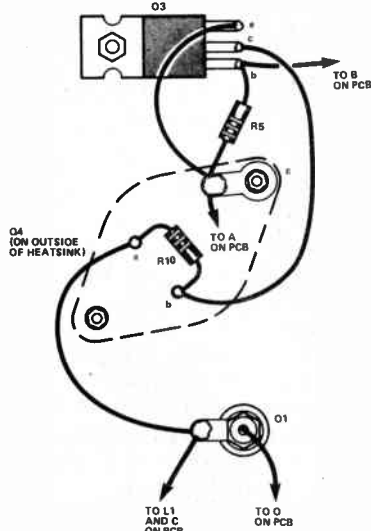
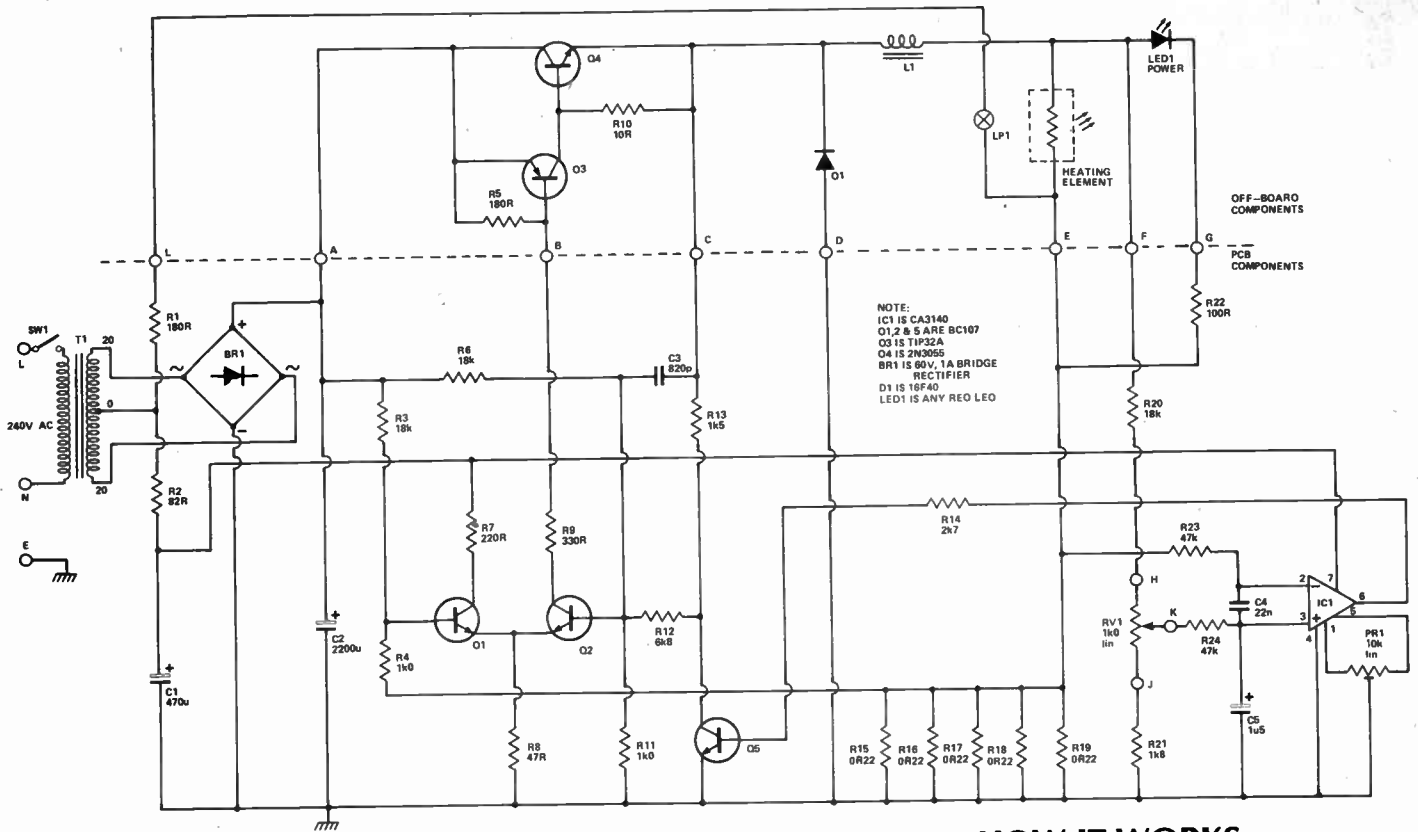


Fig.2 This drawing shows the off-board components as they should be mounted on the heatsink (seen from the inside of the case). The photograph on the last page may also help with construction.

about the pros and cons of different materials, magnetic polarisation and loss distribution. The basic problem is that core loss and size are proportional to the energy packet, but minimising them means increasing the switching frequency, and therefore the power semiconductor loss. This loss occurs during the transition period between the on and off states and is directly proportional to switching frequency. In practice, the core choice was mainly dictated by availability to the hobby market and many a beautiful formula had to stay in its book.

As mentioned earlier, no thermal sensor as such is used. The temperature is sensed by measuring the resistance of the heating element itself which is slightly temperature-sensitive. (It

## HOW IT WORKS

The circuit can be split into three main sections; power supply, main converter and temperature-sensing circuitry.

The supply rail for the main converter is standard, with the transformer output being full-wave rectified by BR1 and smoothed by C2. The op amp supply relies on the fact that the centre tap of the transformer is always at mid-voltage,  $V_{cc}/2$ , whatever the polarity of the incoming AC; it only needs to be filtered by R2/C1.

The circuitry of the main converter can be considered to be equivalent to an op amp, with the differential pair Q1, Q2 functioning as the inverting and non-inverting inputs respectively, and Q3, Q4 being the output stage. The circuit will oscillate at a high frequency, as follows. Assume Q4 is turning on, so that Q4 emitter is now at the supply voltage — this increase in voltage is coupled to the base of Q2 by C3 and R12-R13. C3 is included to improve the high frequency response. Q2 now conducts more heavily, tending to turn on Q3 (and hence Q4) still further and this regenerative action means that Q4 turns hard on. D1 will not conduct as it is reverse biased.

Current does not flow in the load immediately because of inductor L1; instead the current increases exponentially towards  $V_{cc}/R_{LOAD}$ . As the current flows through R15-19 it generates a voltage which is coupled to Q1 base via R4. As the load current increases, it reaches a point where the voltage on Q1 base exceeds that on Q2 base, and Q4 now begins to turn off. L1 again opposes this voltage change and lowers the voltage at Q4 emitter, a regenerative action that turns Q4 hard off. L1 forces Q4's emitter so low that D1 conducts and allows current to continue to flow through the load. The energy stored in the coil is discharged into the load and so the current through the heating element and R15-19 is decreasing. Thus the voltage on Q1 base eventually falls below that on Q2 base, turning Q4 on and starting the whole cycle again.

During each cycle, when Q4 conducts, the power output is  $V_{cc} \times I_{LOAD}$  but the power in the load is only  $V_{LOAD} \times I_{LOAD}$ . The difference is stored in L1 and delivered to the load when Q4 is blocked. The mean current output of Q4 is therefore much lower than the effective continuous load current.

Temperature control is achieved by using the Wheatstone bridge built around IC1. The heating element and R15-19 form one arm of the bridge, R20, RV1 and R21 form the other. The reference voltage from RV1 is compared with that across the inputs of IC1. The output of the op amp controls the oscillator feedback voltage by means of Q5.

varies between 0.155 and 0.22 R at 100°C and 400°C respectively.)

In practice, we don't even need to measure the temperature itself. By including the heating element into a Wheatstone bridge configuration, its resistance is continuously compared to the fixed resistors. Any change from the preset balance condition appears as an error signal that can be directly used to control the power input and therefore correct the temperature. The resulting temperature regulation is effective between 50°C and 500°C (as we discovered by melting a couple of heating elements during our trials), but for practical purposes, the temperature range was limited to 200°C-450°C, with a very good linearity.

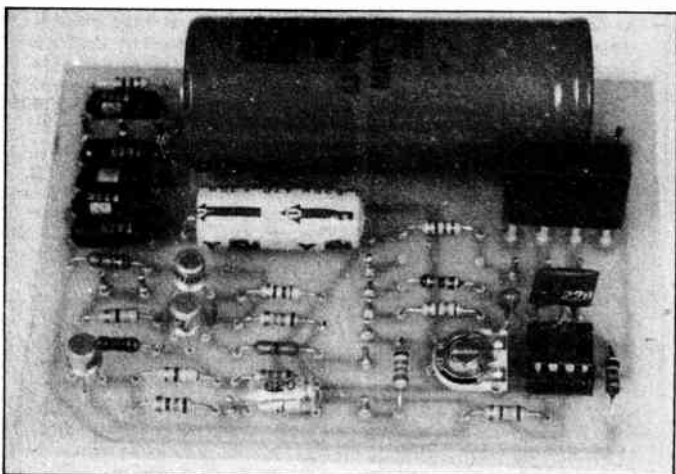
## Construction

The main point to remember throughout the construction of this project is the fact that the output currents can be very high indeed — more than 15 A peak. All current-bearing conductors (and that includes the output leads, the internal connections and the coil) must accept such currents without overheating. A 0.75 mm square cross-section wire seemed adequate. A well-ventilated enclosure is also recommended, a few holes in the bottom and the back can do wonders.

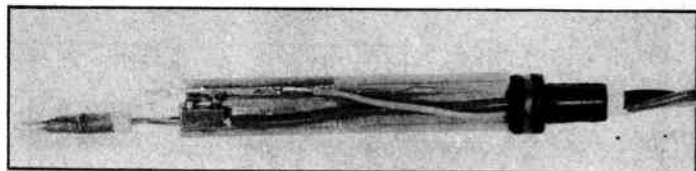
All power semiconductors (Q3, Q4 and D1) should be mounted on a 2.1°C/W heatsink (100 mm or 125 mm wide extrusion — see pictures). Make sure that each one is insulated with mica washers and thermal compound. The power semiconductors should be protected from electrical contact with the outside world by some form of cover on the heatsink and the whole thing mounted in a case that would not curl up at the sight of molten solder.

Coil L1 is made by winding 50 turns of 1 mm square enamelled copper wire onto a toroidal core. A bit of masking tape keeps things tidy, as you can see from the photograph.

The soldering iron itself is made from a small piece of double-sided PCB, press-fitted into a piece of aluminium tubing (100 mm by 14 mm). Screw connections from an ordinary terminal block are soldered at the right spacing onto the PCB. Although it can be replaced by some insulating material, note that the aluminium uniformly dissipates the heat coming from the element and allows a very comfortable grip at a small distance from the tip. A small magnet mounted on the side of the tubing is one of the quickest and most practical stands. The size of tubing even allows for mounting a small lamp inside the handle: very useful for precision work.



The PCB before interwiring.



The element and light bulb are mounted on a piece of double-sided PCB.

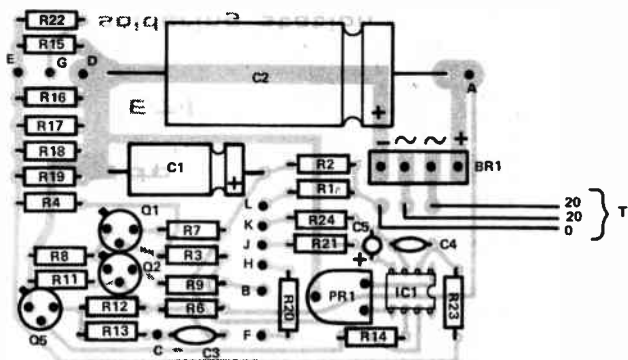


Fig.3 Component overlay for the PCB.

## PARTS LIST

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

R1	180R, 1 W
R2	82R
R3,6,20	18k
R4,11	1k0
R5	180R
R7	220R
R8	47R
R9	330R
R10	10R
R12	6k8
R13	1k5
R14	2k7
R15-19	0R22, 2W5 wirewound
R21	1k8
R22	100R
R23,24	47k

### Potentiometers

RV1	1k0 linear
PR1	10k miniature horizontal preset

### Capacitors

C1	470u 25 V axial electrolytic
C2	2200u 63 V axial electrolytic
C3	820p polystyrene
C4	22n ceramic
C5	1u5 35 V tantalum

### Semiconductors

IC1	CA3140
Q1,2,5	BC107
Q3	TIP32A
Q4	2N3055
BR1	60 V, 1 A bridge rectifier (in-line type)
D1	16F40
LED1	any red LED

### Miscellaneous

LP1	6 V, 60 mA bulb
SW1	mains switch
Transformer (20-0-20), toroidal core (see Buylines), heatsink (see text), case ref. BA1016, aluminium tube, magnet, sponge.	

# PROJECT : Soldering Iron

## Setting Up

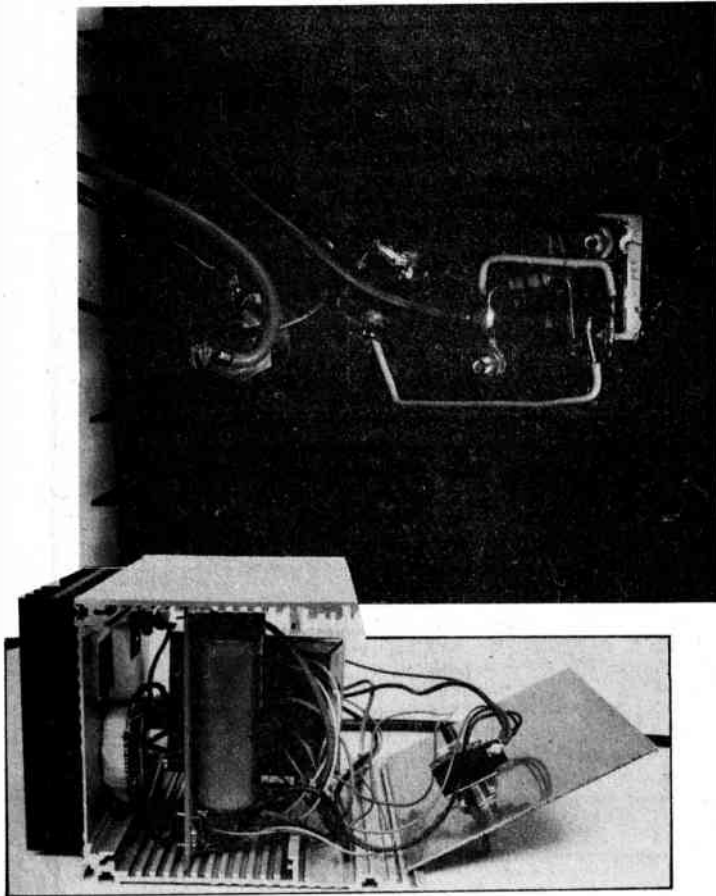
Once all connections are made, the converter section should function immediately — the setting-up procedure only applies to the thermal stabilisation circuitry. The op amp IC1 must be a true zero detector and for that, we must remove any offset voltage. To do so, short-circuit the two inputs (pins 2 and 3) and adjust PR1 until the output starts flickering on and off. Remove the short circuit and the Microstation is now ready for use.

## BUYLINES

One of the objectives that we set ourselves at the start of this project was to keep things simple. Although a whole new breed of components specially designed for switched mode supplies is slowly appearing, these are still very difficult to obtain from hobby suppliers. Most of the semiconductors we used are widely available types; D1 can be obtained from Electrovalue.

The toroidal core used for L1 can be obtained from Electro-Tech Components Ltd, 317 Edgware Road, London W2 — the order code is TMC3.

The case used for the prototype is a new model from West Hyde and the heating elements can be supplied by most distributors who sell cordless rechargeable irons, eg Marshall's, Electrovalue.



Top: This photograph shows the mounting details of the heatsink components. All these components must be completely insulated from the heatsink by mica washers.

Bottom: Internal view of the case after the interwiring has been completed. The PCB slides into the channels provided.

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	£4.71 (+£1.20 p.p. + 0.89 VAT)			£8.88 (+£1.80 p.p. + £1.60 VAT)	
1X010	6+6	2.50	5X012	12+12	6.66
1X011	9+9	1.66	5X013	15+15	5.33
1X012	12+12	1.25	5X014	18+18	4.44
1X013	15+15	1.00	5X015	22+22	3.63
1X014	18+18	0.83	5X016	25+25	3.20
1X015	22+22	0.68	5X017	30+30	2.66
1X016	25+25	0.60	5X018	35+35	2.28
1X017	30+30	0.50	5X028	110	1.45
			5X029	220	0.72
			5X030	240	0.66
<b>50VA</b>	80mm dia. x 35mm Weight 0.9 Kg		<b>225VA</b>	110mm dia. x 45mm Weight 2.2 Kg	
	£5.19 (+£1.30 p.p. + 0.97 VAT)			£10.59 (+£1.90 p.p. + £1.87 VAT)	
2X010	6+6	4.16	6X014	18+18	6.25
2X011	9+9	2.77	6X015	22+22	5.11
2X012	12+12	2.08	6X016	25+25	4.50
2X013	15+15	1.66	6X017	30+30	3.75
2X014	18+18	1.38	6X018	35+35	3.21
2X015	22+22	1.13	6X026	40+40	2.81
2X016	25+25	1.00	6X028	110	2.04
2X017	30+30	0.83	6X029	220	1.02
2X028	110	0.45	6X030	240	0.93
2X029	220	0.22			
2X030	240	0.20			
<b>80VA</b>	90mm dia. x 30mm Weight 1 Kg		<b>300VA</b>	110mm dia. x 50mm Weight 2.6 Kg	
	£5.76 (+£1.50 p.p. + £1.09 VAT)			£12.27 (+£2.00 p.p. + £2.14 VAT)	
3X010	6+6	6.64	7X016	25+25	6.00
3X011	9+9	4.44	7X017	30+30	5.00
3X012	12+12	3.33	7X018	35+35	4.28
3X013	15+15	2.66	7X026	40+40	3.75
3X014	18+18	2.22	7X028	45+45	3.33
3X015	22+22	1.81	7X029	110	2.72
3X016	25+25	1.60	7X030	220	1.36
3X017	30+30	1.33		240	1.25
3X028	110	0.72			
3X029	220	0.36			
3X030	240	0.33			
<b>120VA</b>	90mm dia. x 40mm Weight 1.2 Kg		<b>500VA</b>	140mm dia. x 60mm Weight 4 Kg	
	£6.72 (+£1.60 p.p. + £1.25 VAT)			£16.35 (£2.10 p.p. + £2.77 VAT)	
4X010	6+6	10.00	8X017	30+30	8.33
4X011	9+9	6.66	8X018	35+35	7.14
4X012	12+12	5.00	8X026	40+40	6.25
4X013	15+15	4.00	8X028	45+45	5.55
4X014	18+18	3.33	8X030	50+50	5.00
4X015	22+22	2.72		110	4.54
4X016	25+25	2.40		220	2.27
4X017	30+30	2.00		240	2.08
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74LS 10	0.20
74LS 11	0.21
74LS 12	0.21
74LS 13	0.41
74LS 14	0.71
74LS 15	0.21
74LS 20	0.20
74LS 21	0.21
74LS 22	0.21
74LS 26	0.27
74LS 27	0.21
74LS 28	0.25
74LS 30	0.20
74LS 32	0.20
74LS 33	0.25
74LS 37	0.25
74LS 38	0.25
74LS 40	0.20
74LS 42	0.56
74LS 47	0.58
74LS 49	0.86
74LS 51	0.20
74LS 54	0.21
74LS 55	0.21
74LS 73	0.30
74LS 74	0.27
74LS 75	0.42
74LS 76	0.30
74LS 83	0.76
74LS 86	0.26
74LS 90	0.52
74LS 91	1.13
74LS 92	0.56
74LS 93	0.55
74LS 95	0.68
74LS109	0.36
74LS112	0.36
74LS113	0.36
74LS114	0.36
74LS122	0.63
74LS123	0.81
74LS124	1.49
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74LS126	0.41
74LS132	0.71
74LS136	0.41
74LS138	0.56
74LS139	0.56

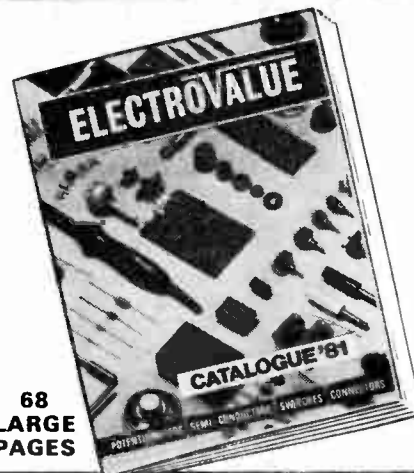
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74LS155	0.70
74LS156	0.70
74LS157	0.50
74LS158	0.56
74LS160	0.61
74LS161	0.61
74LS162	0.61
74LS163	0.61
74LS164	0.71
74LS174	1.06
74LS175	0.84
74LS181	2.10
74LS190	0.85
74LS191	0.85
74LS192	0.97
74LS193	0.97
74LS194	0.58
74LS195	0.58
74LS196	0.96
74LS197	0.96
74LS221	0.90
74LS240	1.41
74LS242	1.19
74LS243	1.19
74LS244	1.18
74LS245	1.69
74LS247	0.57
74LS248	1.05
74LS249	1.05
74LS251	0.64
74LS253	0.64
74LS258	0.56
74LS259	1.61
74LS273	1.37
74LS279	0.51
74LS283	0.63
74LS293	0.73
74LS366	0.54
74LS367	0.54
74LS368	0.54
74LS373	1.11
74LS374	0.70
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AC125	30	BC107C	12	BC174	15	BC550	14	BD201	80	BF165	50	BFR62	24	MPSA06	20	TIP30B	42	2N708	14	2N2715	22	2N3824	60
AC126	22	BC108	10	BC175	35	BC556	14	BD202	14	BF166	50	BFR79	26	MPSA55	26	TIP30C	44	2N711	30	2N2904A	26	2N3803	12
AC127	22	BC108A	11	BC177	14	BC557	13	BD201/202	M/P	BF167	24	BFR60	26	MPSA56	26	TIP31	38	2N717	30	2N2905	24	2N3804	12
AC128	22	BC108B	11	BC178	14	BC558	13	BD203	80	BF176	26	BFX29	25	OC19	85	TIP31A	40	2N718	25	2N2905A	24	2N3805	12
AC128K	37	BC108C	12	BC179	14	BC559	14	BD204	80	BF177	24	BFX30	25	OC20	85	TIP31B	42	2N719	25	2N2906	18	2N3806	12
AC132	28	BC109	10	BC180	12	BC560	14	BD205	80	BF178	24	BFX31	25	OC21	85	TIP31C	44	2N720	29	2N2906A	20	2N4059	14
AC141	28	BC109A	11	BC181	10	BCY31	80	BD203/204	M/P	BF179	25	BFX84	24	OC22	1.50	TIP32	38	2N727	29	2N2907	22	2N4060	14
AC141K	40	BC109B	11	BC182	10	BCY32	85	M/P	1.70	BF180	25	BFX85	24	OC23	1.50	TIP32A	40	2N733	29	2N2907A	22	2N4061	12
AC142	28	BC109C	12	BC182L	10	BCY33	80	BD205	80	BF181	25	BFX86	24	OC24	1.50	TIP32B	42	2N734	29	2N2908	22	2N4062	12
AC142K	40	BC113	18	BC163	10	BCY34	80	BD206	80	BF182	30	BFX87	28	OC25	1.00	TIP32C	44	2N914	20	2N2925	15	2N4062	12
AC176	24	BC114	17	BC164	10	BCY71	15	BD207	80	BF183	30	BFX88	28	OC26	1.00	TIP41A	44	2N918	30	2N2925	15	2N4062	12
AC176K	40	BC115	16	BC165	10	BCY72	15	BD208	80	BF184	22	BFX89	26	OC27	90	TIP41B	48	2N929	20	2N2926	15	2N4062	12
AC187	25	BC116	19	BC166	10	BCY73	15	BD209	80	BF185	22	BFX90	26	OC28	90	TIP41C	48	2N930	18	2N2927	20	2N4063	28
AC187K	40	BC116A	20	BC167	10	BCY74	15	BD210	80	BF186	28	BFX91	26	OC29	95	TIP42A	44	2N946	40	2N2928	20	2N4064	28
AC188	25	BC117	20	BC168	15	BCY75	15	BD211	80	BF187	28	BFX92	26	OC30	95	TIP42B	48	2N947	40	2N2929	20	2N4065	28
AC188K	40	BC118	17	BC207	11	BCY76	15	BD212	80	BF188	32	BFX93	26	OC31	95	TIP42C	48	2N948	40	2N2930	20	2N4066	28
AC1717	50	BC119	17	BC208	11	BCY77	15	BD213	80	BF189	32	BFX94	26	OC32	95	TIP2955	60	2N1302	25	2N3010	20	2N4288	28
AC1918	50	BC120	35	BC209	12	BD015	50	BD235	55	BF190	10	BIP19	38	OC33	95	TIP3055	50	2N1303	25	2N3011	20	2N4289	28
AC1918K	50	BC120	35	BC209	12	BD016	50	BD236	55	BF191	10	BIP20	38	OC34	24	TIP3055	50	2N1304	28	2N3012	22	2N4290	28
AC1919	50	BC126	25	BC212	10	BD017	50	BD237	55	BF192	12	BIP21	38	OC35	24	TIP3055	50	2N1305	28	2N3013	22	2N4291	28
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AD130	75	BC135	20	BC214	10	BD020	50	BD240	55	BF195	12	BIP24	38	OC38	24	TIP3055	50	2N1308	35	2N3016	22	2N4294	28
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AD142	85	BC137	20	BC225	26	BD022	50	BD242	55	BF197	12	BIP26	38	OC40	24	TIP3055	50	2N1310	35	2N3018	22	2N4296	28
AD143	85	BC138	28	BC226	36	M/P	80	BD243	55	BF198	12	BIP27	38	OC41	24	TIP3055	50	2N1311	35	2N3019	22	2N4297	28
AD149	70	BC139	32	BC237	13	BD033	40	BD244	55	BF199	12	BIP28	38	OC42	24	TIP3055	50	2N1312	35	2N3020	22	2N4298	28
AD161	40	BC140	25	BC238	14	BD034	40	BD245	55	BF200	30	BSX20	30	OC43	24	TIP3055	50	2N1313	35	2N3021	22	2N4299	28
AD162	40	BC141	25	BC239	15	BD035	40	BD246	55	BF201	30	BSX21	30	OC44	24	TIP3055	50	2N1314	35	2N3022	22	2N4300	28
AD161/162	M/P	BC142	25	BC251	15	BD036	40	BD247	55	BF202	30	BSX22	30	OC45	24	TIP3055	50	2N1315	35	2N3023	22	2N4301	28
AF114	30	BC143	25	BC251A	16	BD037	40	BD248	55	BF203	30	BSX23	30	OC46	24	TIP3055	50	2N1316	35	2N3024	22	2N4302	28
AF115	50	BC145	46	BC300	30	BD038	40	BD249	55	BF204	30	BSX24	30	OC47	24	TIP3055	50	2N1317	35	2N3025	22	2N4303	28
AF116	50	BC147	09	BC301	28	BD039/140	M/P	BD250	55	BF205	30	BSX25	30	OC48	24	TIP3055	50	2N1318	35	2N3026	22	2N4304	28
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AF124	50	BC150	20	BC304	28	BD042	55	BD253	55	BF208	30	BSX28	30	OC51	24	TIP3055	50	2N1321	35	2N3029	22	2N4307	28
AF125	50	BC151	22	BC307	13	BD043	55	BD254	55	BF209	30	BSX29	30	OC52	24	TIP3055	50	2N1322	35	2N3030	22	2N4308	28
AF126	50	BC152	22	BC327	12	BD044	55	BD255	55	BF210	30	BSX30	30	OC53	24	TIP3055	50	2N1323	35	2N3031	22	2N4309	28
AF127	50	BC153	25	BC328	13	BD045	55	BD256	55	BF211	30	BSX31	30	OC54	24	TIP3055	50	2N1324	35	2N3032	22	2N4310	28
AF139	50	BC157	10	BC337	13	BD046	55	BD257	55	BF212	30	BSX32	30	OC55	24	TIP3055	50	2N1325	35	2N3033	22	2N4311	28
AF139	50	BC157	10	BC338	13	BD047	55	BD258	55	BF213	30	BSX33	30	OC56	24	TIP3055	50	2N1326	35	2N3034	22	2N4312	28
AF139	50	BC157	10	BC339	13	BD048	55	BD259	55	BF214	30	BSX34	30	OC57	24	TIP3055	50	2N1327	35	2N3035	22	2N4313	28
AL102	1.80	BC158	10	BC384	14	BD049	55	BD260	55	BF215	30	BSX35	30	OC58	24	TIP3055	50	2N1328	35	2N3036	22	2N4314	28
AL103	1.80	BC159	10	BC440	30	BD050	55	BD261	55	BF216	30	BSX36	30	OC59	24	TIP3055	50	2N1329	35	2N3037	22	2N4315	28
ASV26	50	BC160	26	BC441	30	BD051	55	BD262	55	BF217	30	BSX37	30	OC60	24	TIP3055	50	2N1330	35	2N3038	22	2N4316	28
ASV27	50	BC161	36	BC460	32	BD052	55	BD263	55	BF218	30	BSX38	30	OC61	24	TIP3055	50	2N1331	35	2N3039	22	2N4317	28
ASV28	50	BC162	36	BC461	32	BD053	55	BD264	55	BF219	30	BSX39	30	OC62	24	TIP3055	50	2N1332	35	2N3040	22	2N4318	28
ASV29	50	BC163	36	BC462	32	BD054	55	BD265	55	BF220	30	BSX40	30	OC63	24	TIP3055	50	2N1333	35	2N3041	22	2N4319	28
AU104	1.90	BC169	10	BC478	20	BD055	55	BD266	55	BF221	30	BSX41	30	OC64	24	TIP3055	50	2N1334	35	2N3042	22	2N4320	28
AU110	1.90	BC169C	11	BC479	20	BD056	55	BD267	55	BF222	30	BSX42	30	OC65	24	TIP3055	50	2N1335	35	2N3043	22	2N4321	28
AU113	1.90	BC170	09	BC546	10	BD057	55	BD268	55	BF223	30	BSX43	30	OC66	24	TIP3055	50	2N1336	35	2N3044	22	2N4322	28
BC107	10	BC171	09	BC547	10	BD058	55	BD269	55	BF224	30	BSX44	30	OC67	24	TIP3055	50	2N1337	35	2N3045	22	2N4323	28
BC107A	11	BC172	09	BC548	10	BD059	55	BD270	55	BF225	30	BSX45	30	OC68	24	TIP3055	50	2N1338	35	2N3046	22	2N4324	28

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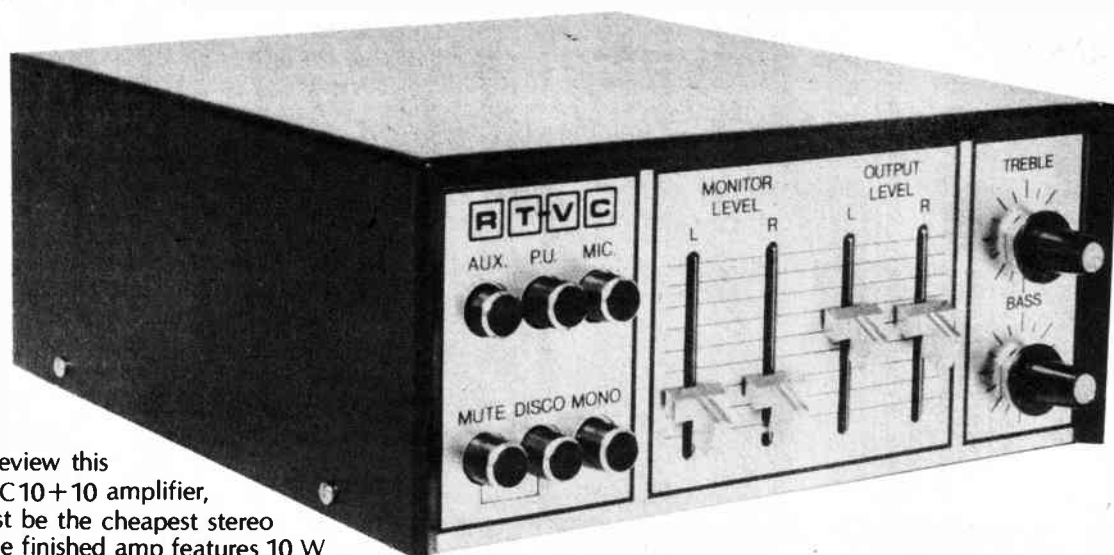
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AA119	08	BA104	07	BY176	75	OA79	10	74LS00	13	74LS78	48	74LS165	1.20	74LS279	85	200mA	IS200 100V	10	IN5408 1000V	25
AA120	08	BA105	07	BY206	75	OA85	10	74LS01	13	74LS79	48	74LS166	1.20	74LS280	2.40	IS200 50V	IS201 200V	11	6 Amp	
AA121	08	BA106	07	BY210	45	OA91	07	74LS02	18	74LS80	75	74LS167	1.80	74LS281	85	IS921 100V	IS202 600V	14	BYX38-300	45
AA122	09	BA107	08	BY211	45	OA91	07	74LS03	18	74LS81	75	74LS168	1.80	74LS282	85	IS922 150V	IS203 800V	16	BYX38-600	40
AA123	09	BA108	08	BY212	45	OA91	07	74LS04	15	74LS82	75	74LS169	1.80	74LS283	85	IS923 300V	IS204 1000V	20	BYX38-300R	45
AA124	09	BA109	0																	

# KIT REVIEW

Home-built amplifiers are very popular and this month Kit Review takes a look at one of the cheapest.



The subject of Kit Review this month is the RTVC IC 10+10 amplifier, which at £14.95 must be the cheapest stereo amplifier you can buy. The finished amp features 10 W RMS output per channel, three inputs (MIC, PU and AUX) and bass and treble tone controls. The volume of each channel is varied by independent slider pots on the front panel; the tape output level has similar controls. Push-buttons are provided for mute, mono and a 'disco' function, which converts the power amps to mono operation and the preamplifier to a two-channel mixer (so that two mono record decks, for example, may be faded in and out independently). A pre-punched chassis is included in the kit, with a black vinyl finish cover.

## Starting Out

As with any kit, the first thing to do is check that all the parts are present (they were) and read the instructions thoroughly. This caused my confidence in RTVC to flag slightly, as, despite their assurances, there are several errors. The colour code for a 1R0 resistor is brown-black-gold, not brown-black; 6k8 is blue-grey-red, not blue-grey-blue; and D2 is shown the wrong way round on the circuit diagram.

It is also disconcerting to discover that three holes in the chassis have to be redrilled because they're in the wrong place, and the power amp PCB has to be drilled. I would have thought that, on the whole, a kit like this is more likely to be bought by the beginner or less experienced constructor who is unlikely to own a PCB drill. I don't recommend using a domestic drill; I tried it with the first PCB I made myself and ended up with two halves. Slapped wrists, RTVC.

As well as a PCB drill, you might find a solder sucker handy as well. Two components on the preamp (a Mullard module) have to be removed and replaced with different values. Take care when you do this as the PCB tracks are thin and can lift off.

## Power Amp

Once the board had been drilled, the construction of the power amp presented no problems, except that the diodes are marked on the overlay with a '+'; I would have preferred to see

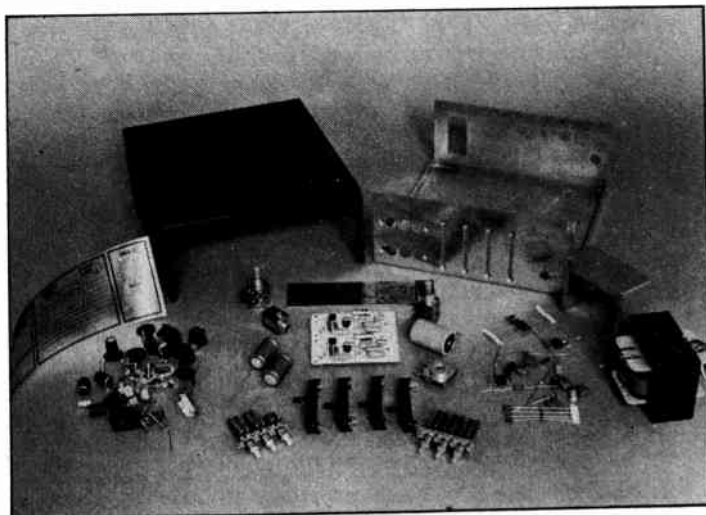
'anode' or 'cathode' which is less ambiguous. The overlay is a photographic one and fairly clear. Lengths of wire should now be soldered for all connections (except the inputs) as these solder directly to the foil side of the board, which is inaccessible once the board has been mounted. A good point about this kit is that power ICs are used which make construction a great deal easier than if power transistors were used.

## Preamp And Controls

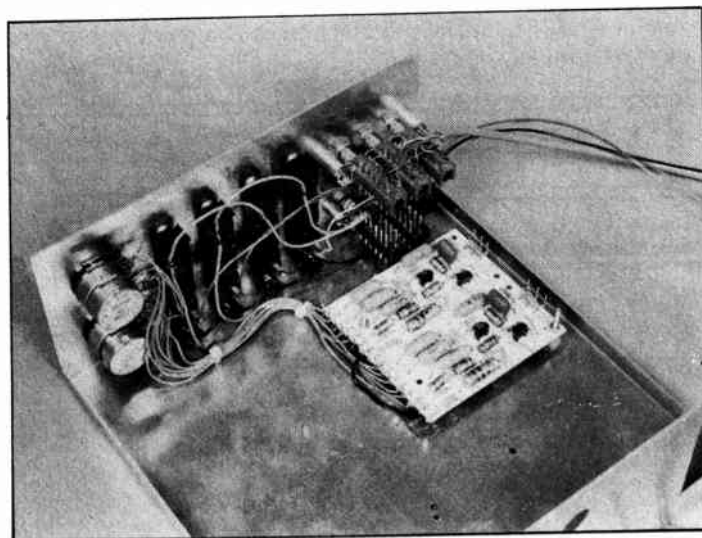
I found this part of the kit very tedious and fiddly. Being basically lazy I hate interwiring, and there's a lot of it in this kit. The best method is to fit the lower switch bank and the slider pots to the front panel first — interconnect them and solder generous lengths of wire where appropriate for connections elsewhere in the chassis. Note that some of the links between pins on the switches can be made on the underside as the pins go right through; otherwise things get a bit cramped. Then mount the top switch bank and the DIN input sockets on the rear panel and complete that part of the wiring. Finally, solder lengths of wire to all the rotary pot pins (including the two cross-connections) before mounting them on the front panel. Once they're in place you can complete all the connections to the preamp and fit cable ties to keep things neat. Wirestrippers are essential to prevent damage to your fingers and/or sanity.

## Rearguard Action

Before bolting the power amp to the chassis, the signal earth lead from the front panel switches should be cut to length and soldered to the copper side of the board. The board is held in place by the ICs which should *not* be insulated from the chassis — this acts both as a heatsink and the negative supply connection. The input connections from the switch bank can now be soldered directly to the leads of the input resistors. Fit-



This is what you get in the kit. What you *don't* get includes connecting wire, mains lead and a mains switch. The preamplifier is supplied as a ready-built module.



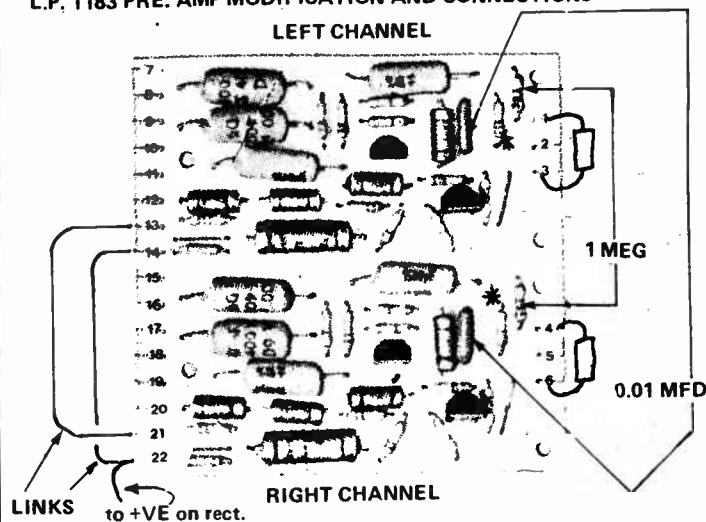
Halfway home and the worst is over. As you can see, the amount of interwiring required is extensive. The section shown corresponds to the instructions below.

ting the remaining rear panel sockets proved a trial of strength, as the retaining rings are very stiff! The photograph showing the output connections is a bit indistinct and reference to the main circuit diagram for clarification revealed another mistake — the pins on the headphone socket are incorrectly numbered. I finally solved the problem by assuming the wiring was symmetrical.

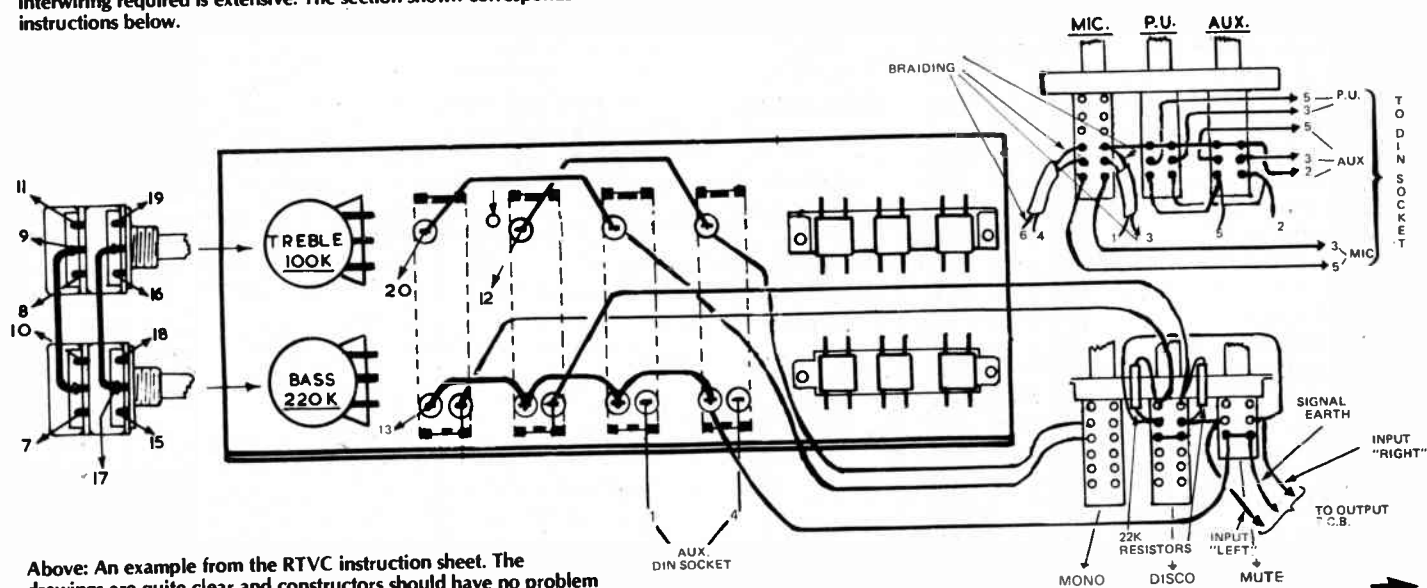
## Finishing Off

The final bits to fit are the fuseholder, rectifier, transformer and mains switch — you have to provide the latter yourself as RTVC describe it as optional. I would have thought it was essential. After making the power supply connections and completing the case construction the amp is ready to go. The instructions do not say anywhere that the mains earth lead should be bolted to the chassis — this is a serious omission considering the large amount of bare metal on the chassis.

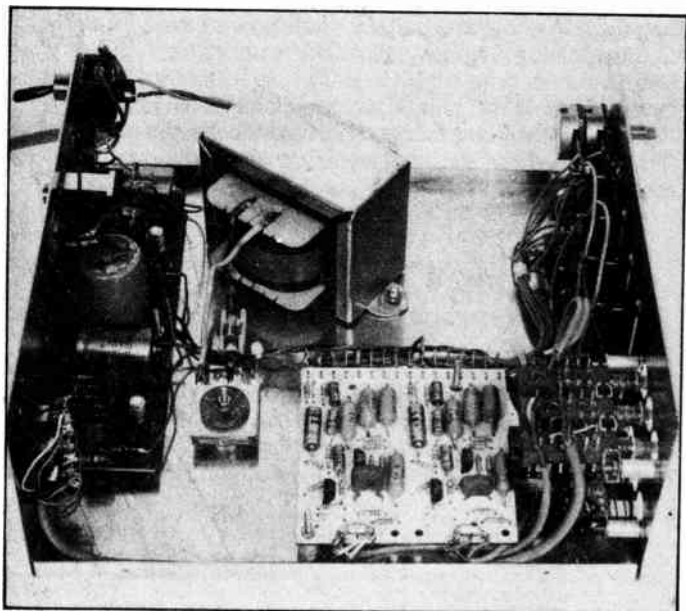
### L.P. 1183 PRE. AMP MODIFICATION AND CONNECTIONS



Above: Several component changes are required on the preamp module.



Above: An example from the RTVC instruction sheet. The drawings are quite clear and constructors should have no problem in following them.



Everything in place and ready for testing. All the sockets mount on the rear panel — three inputs, DIN loudspeaker sockets and a headphone socket. Inserting the headphones automatically mutes the speakers (provided you got the wiring right!). The power ICs bolt directly to the rear panel too, so that the chassis provides both heatsink and earth return; but make sure you connect the mains earth too.

## In Use

The amplifier worked perfectly first time; and even the office audiophile admitted that the kit represented good value for money. Some hum is evident when no signal is present but this is not noticeable when you're actually playing music. Having already built the '12+12' kit which this amplifier replaces, I feel that the new version offers a definite improvement in layout, appearance, ease of construction and sound quality. Although the kit took me eight hours to complete, this was partly due to double-checking the errors in the instructions and partly to deciding the best approach to adopt — I'm sure I could build a second one in half the time.

I have contacted RTVC regarding the errors and await their reply, which will be published in Digest next month.

## Conclusions

For the price involved this kit represents a good buy (I once built a homebrew power amp with tone controls from discrete components that cost me £20). However, the kit would probably appeal more to the beginner in electronics and so the errors in the instructions and the need to drill the PCB are definite minus points. As RTVC suggest in the instructions, having a friend who is familiar with electronics is a good idea if you should need any help.

PETER GREEN

## BUYLINES

10 + 10 Watt Stereo Amplifier Kit £14.95 plus £2.90 postage and packing. RTVC, 323 Edgware Road, London W2. Telephone: 01-723 8432.

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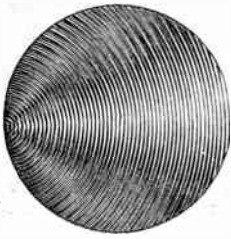
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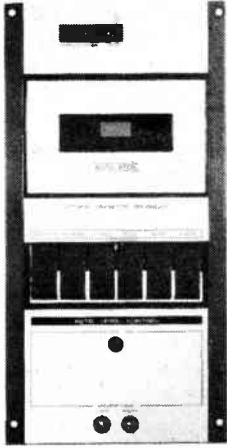
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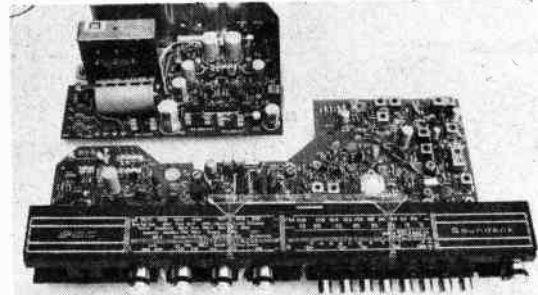


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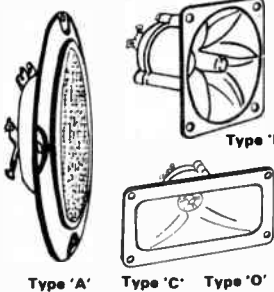
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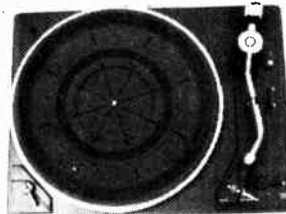
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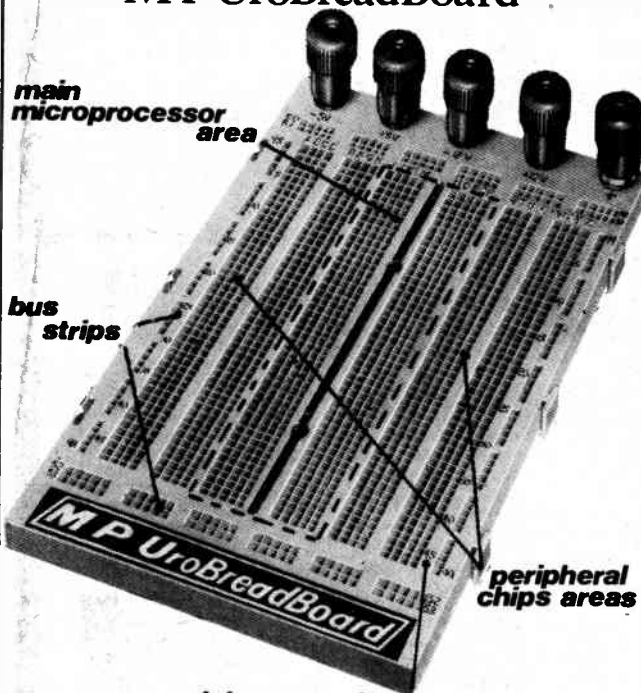
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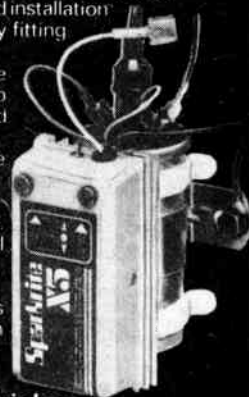
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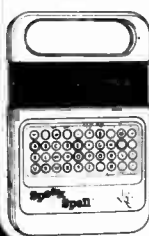
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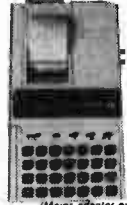
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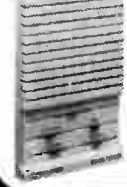


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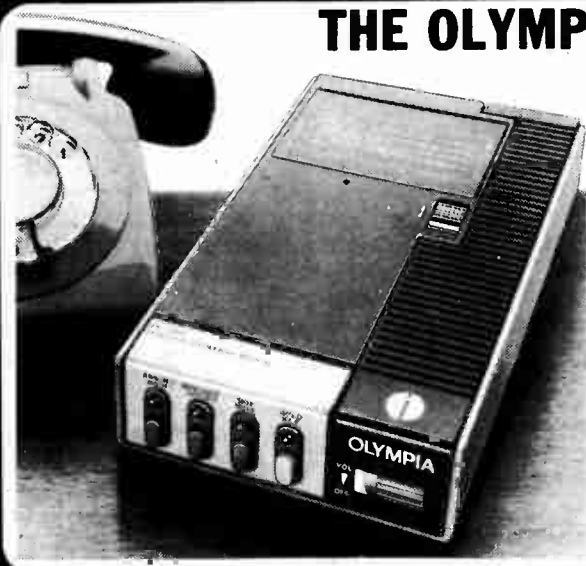


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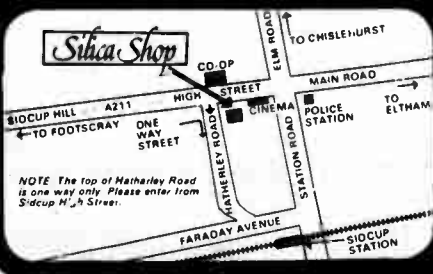
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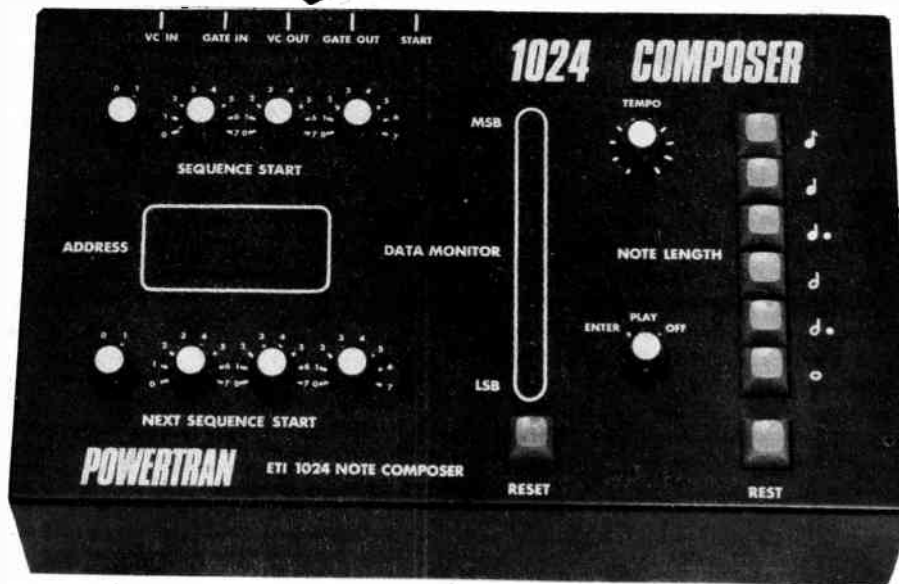
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# SYNTHESISER SEQUENCER



Treat your synth to this sequencer/composer and let it play sequences of up to 1024 notes. Design by Richard Becker of Powertran Electronics.

The 1024 composer is a machine which will repeatedly cause a synthesiser to play a pre-determined series of notes either as short sequences or a large composition of 1024 notes, ie several minutes long. The sequence can be of any number of notes from two to 1024. If the length is less than 1024 then the unused sections of the memory of the composer can be used for alternative sequences as there is full control over the starting and finishing points of the sequence. For example, 64 different 16-note sequences or 128 different eight-note sequences could be stored. The address of the note being played or entered is shown clearly on four seven-segment LED displays whilst the address at the beginning and end of the sequence selected are indicated by the position of the rotary switches which set them up.

The memory stores not only the pitch of the notes but also their length. There is a choice of six lengths ranging from half a beat to four beats. In addition, a rest or series of rests of one beat can be entered.

## Socket To Me

The composer is programmed from the synthesiser by plugging into the VOLTAGE CONTROL OUT and GATE OUT sockets. Transcendent 2000 owners needn't feel left out! You can easily add a couple of jack sockets to the rear panel of the 2000 and fit three bits of wire; VC OUT to IC6 pin 6, GATE OUT to IC4 pin 6 and common line to common line on the HI OUT socket. As for any other synths without these sockets, if the handbook mentions 1 V/octave (the standard) you will be able

to find the control voltage at the input of the VCO and the gate voltage at the input of the ADSR. The synth control voltage is converted to a digital code by an integrated A-to-D (analogue to digital) converter. An integrated D-to-A converter does the opposite on playback.

The outputs of the composer plug into the EXT VC IN and EX GATE IN sockets of the synth. Provision is made for the gate voltage to be of either polarity depending on the synth's requirement (the Transcendent 2000 requires a negative gate voltage). A synth usually sounds at its best when the filter is tracking with the VCO. If there is a control input for the VCF put the control voltage into here too. If there is no such socket it will be possible to find a suitable point on the VCF to inject the control voltage. On the Transcendent 2000 take VC IN to Q10 pin 12 via a 43k resistor.

## Musical Memories

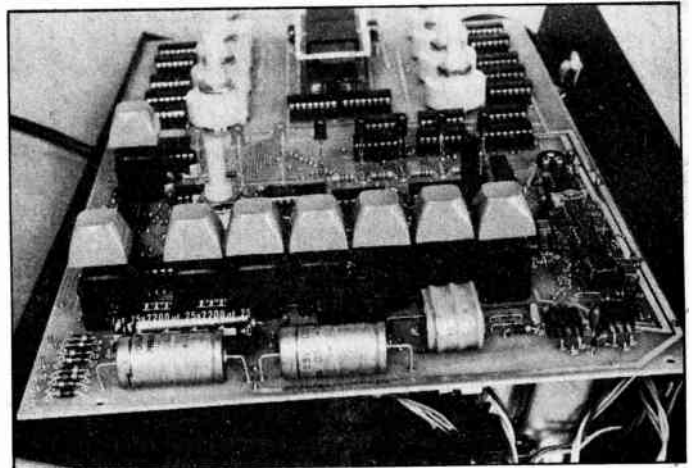
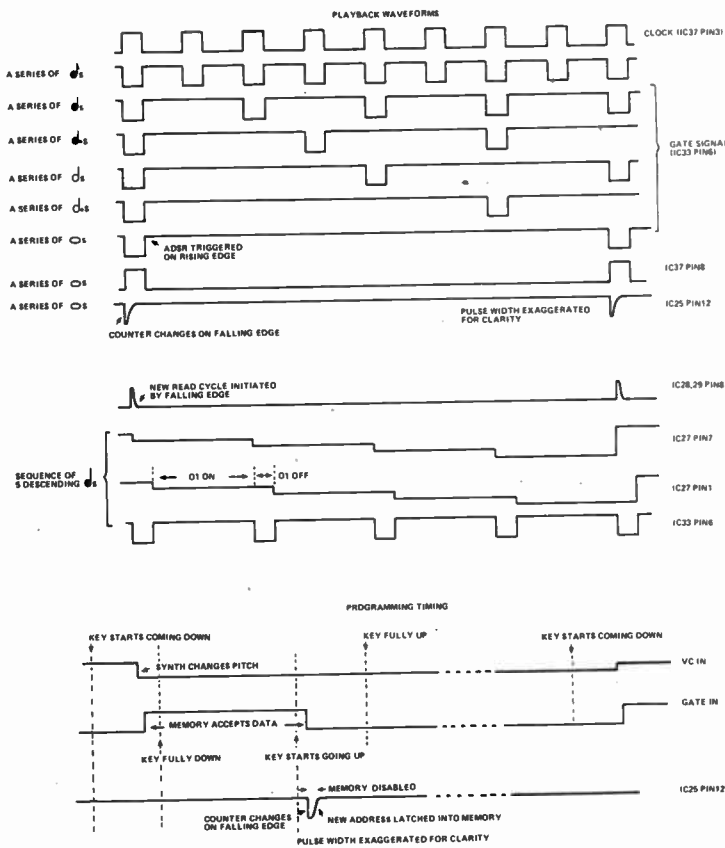
Now that we are plugged in, one of the note length switches is pressed. Pressing a key now programs in that note's pitch and length. To enter a rest, ie an interval with no note being played, press the rest switch followed by any key as many times as there are beats in the rest period.

It doesn't matter how long you take between entering notes. Go down to the pub in the middle of your composition if you like; it will still play back with perfect timing. What's more it doesn't matter if there's a power cut or anyone pulls out the plug while you're away. Hands up all those of you who have lost a painstakingly entered computer program that way! The com-

poser, though mains powered, has a trickle charged Nickel-Cadmium battery to supply the memory (which uses a pair of CMOS 4K synchronous RAMs) when there's no mains connected. After switch-off the memory will retain the data for months and will change only when reprogrammed. Should you find that you have entered a bum note — no hassle. Just advance the START-OF-SEQUENCE switches to the offending entry, press RESET, enter the correct note/note length combination. Take the address to where you left off, press RESET and carry on.

## Construction And Setting Up

The PCB is double-sided so start by linking the two sides with link pins, soldered to both sides, at the points indicated by black dots on the overlay. Now fit everything else except the displays. The tempo potentiometer is soldered to the side of the board which its pins enter. Mica washers are required under the 7915 and the 7815 to prevent shorting to the tracks. To fit the displays at the correct height above the board, stretch some 22 swg wire to stiffen it, cut 46 2" lengths and bend through 90° the last 3 mm of each one. Lay a 10 mm thick spacer bar across IC11-14 and lay the displays onto the spacer. Pass a wire through each hole in the displays and down into the PCB, solder the bent ends to the display, turn over the PCB, trim off the excess wire and solder in place. The photographs should make this clear.



Above and below: All the switches except the start switch mount directly on the PCB. The photograph below also shows the mounting details of the display.

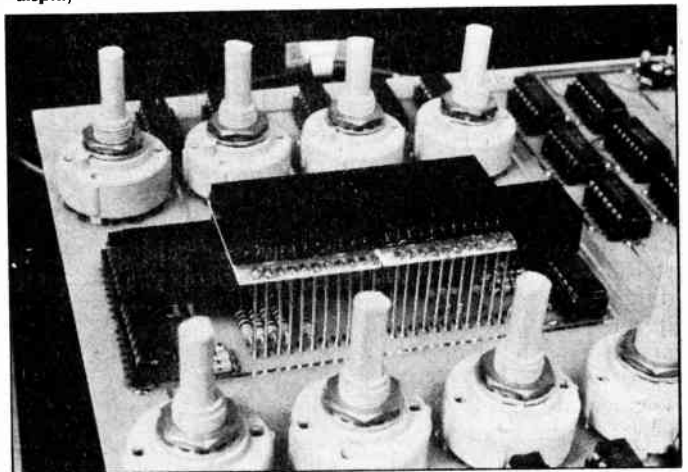
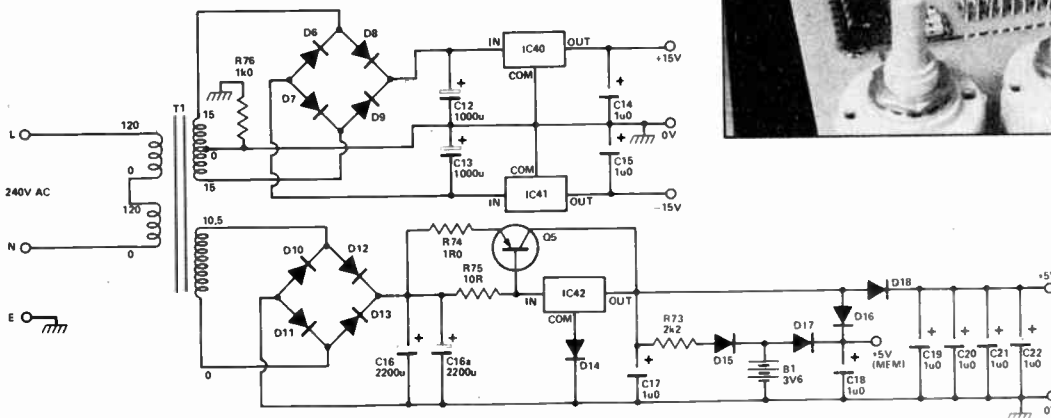


Fig.1 Waveforms at various points in the circuit during playback and programming.



NOTE  
IC40 IS 7815  
IC41 IS 7915  
IC42 IS 7805  
O5 IS TIP30A  
O6, 14, 18 ARE 1N4002  
D15-17 ARE 1N4148

Fig.2 Circuit diagram for the power supply. Note that R76 (not given in the Parts List) solders directly to the mains transformer. See Fig.4.

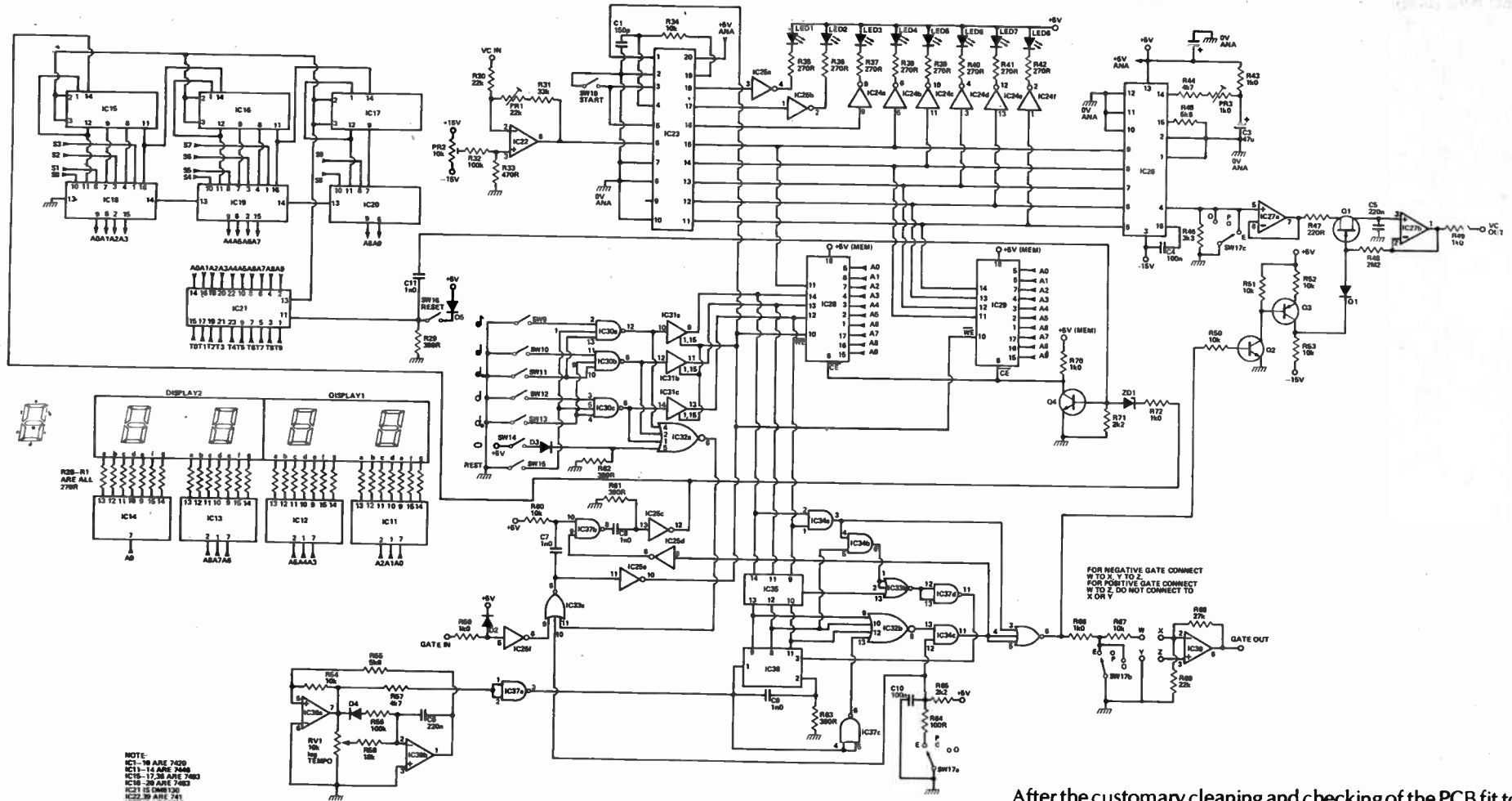


Fig.3 Circuit diagram of the composer. The binary encoding circuitry for the switches is shown below.

- NOTE:  
 IC1-18 ARE 7420  
 IC11-14 ARE 7448  
 IC15-17,20 ARE 7483  
 IC18-20 ARE 7483  
 IC21 IS 74180  
 IC22,29 ARE 741  
 IC23 IS 74138  
 IC24 IS 7414  
 IC25 IS 7414  
 IC26 IS 7414  
 IC27 IS 74138  
 IC28 IS 7414  
 IC29 IS 74138  
 IC30 IS 74138  
 IC31 IS 74138  
 IC32 IS 74138  
 IC33 IS 74138  
 IC34 IS 74138  
 IC35 IS 74138  
 IC36 IS 74138  
 IC37 IS 74138  
 IC38 IS 74138  
 O1 IS 8F24C  
 O2,4 ARE 8C182L  
 O3 IS 8C182L  
 O4 IS 8C182L  
 ZD1 IS 2V7 400- $\mu$ W ZENER  
 LED1-3 ARE TIL222  
 LED4-8 ARE TIL222  
 DISPLAY 2 ARE 80576  
 TTL MAY BE EITHER 74 SERIES  
 OR 74LS SERIES

## BUYLINES

A complete set of parts for this project including fully finished metalwork, nuts, bolts etc will be available from Powertran Electronics for £89.50 + VAT, post free. For delivery by Securicor add £2.50 (VAT inclusive). Powertran also supply separate parts eg. metalwork set, PCB etc - telephone Andover 64455 or write to: Powertran Electronics, Portway Industrial Estate, Andover, Hants, SP10 3NM.

After the customary cleaning and checking of the PCB fit to the cabinet, wire up the base/rear panel, set the presets to mid-way and plug in. Switch to ENTER, press a NOTE LENGTH switch and the START switch together with any key. This starts the ADC converting and is done at each switch-on. Press the top note of the keyboard together with any NOTE LENGTH switch and adjust the input offset null preset (PR2) until the red LEDs are all off, whilst the green LEDs (indicating the three least significant bits which are not stored) show either binary 3 (011), ie bottom two LEDs on, or binary 4 (100), ie the third one up on. The LEDs may flicker between these states. Next press the key two octaves down and adjust the gain control PR1 so that only the top two of the red LEDs are on whilst the green ones again show binary 3 or 4. This ensures that the ADC is halfway between changing the code given by the five most significant bits.

## HOW IT WORKS

The voltage control input (pitch data) is applied via IC22 to the A-to-D converter IC23 which produces an eight-bit binary code equivalent to the pitch voltage. C1 and R34, in conjunction with an internal Schmitt trigger, form the internal clock operating at a few hundred kilohertz. All eight bits are monitored by LEDs, driven by IC24 and IC25a and b, although only the five most significant bits are used. These go on a data bus connecting to the memory and the D-to-A converter IC26, the reference current for which enters pin 14. The quantized current from pin 4 generates a voltage across R46. Q1, C5, IC27b form a sample and hold circuit, controlled by the output gate signal. This permits a change in pitch only at the same time as the gate pulse starts. The output of IC26 changes a clock phase earlier.

IC1-10 encode the addresses set up on SW1-8 to the equivalent 10-bit binary codes. IC15-17 form a binary counter which is reset to all zeros at suitable times by the output of IC21. IC18-20 are binary adders which add the output of the counter to the output of IC1-5 to produce the address code for the memory. Thus when the counter is reset, the memory address is that set up by the START OF SEQUENCE switches SW1-4. The outputs of IC6-10 are compared with the memory address by the 10-bit comparator IC21 — a reset signal is generated when they are the same, so the sequence is finished and goes back to the start. The seven-segment displays are driven by the decoders IC11-14 which are connected to the memory address bus.

When entering data the counter is clocked by the gate pulse applied via IC25f, IC33a, IC37b, IC25c. Assuming the synth to be correctly adjusted with the pitch voltage changing *before* the gate signal is produced, the pitch voltage changes when a key goes down and the ADC generates the appropriate code. The gate signal then puts the memory into the write mode and enables the tri-state buffer IC31 and the ADC, entering the ADC data and the note length/rest data from IC30, IC31 into the memory. As the key is released the gate signal ceases, the memory is returned to the read mode and the buffer and ADC are disabled. The end of the gate signal results in a negative pulse from IC25c pin 12. On its negative going edge the counter adds one to the address. The pulse is also applied via Q4 to pin 8, the enable input of the memory, briefly disabling it. As pin 8 returns to 0 V the new address is latched in. The base of Q4 is also connected to the reset circuit so that the latched-in address is updated when the counter is reset.

IC38 is an asymmetric relaxation oscillator producing a 1:2 mark/space ratio pulse at IC37 pin 3, the negative edge of which clocks the divide-by-eight counter IC36. During playback the output of IC36 is compared with the note length/rest data by four bit comparator IC35. When there is equality IC35 pin 6 goes high and is applied to one of the two reset pins of IC36 via IC33b, IC37d. When the clock returns to high the other reset pin (pin 2) also goes high, resetting the counter. The counter therefore counts as far as the binary code from the memory, stays there for one phase of the clock and resets to zero. The all-zeros state of the counter is detected by IC32b, the output of which clocks the address counter. The clock (inverted) is applied to IC32 pin 13 to restrict its output to a single clock phase when the counter receives no reset ie when the note length is four beats and the memory reads out all zeros. The output of IC32b becomes the gate signal after passing through IC33c, which inhibits the gate when data '1X1' is detected by IC34a ie when there is a rest (101 programmed in). The counter is reset after two clock pulses by the output of IC34b. When there is a mains supply the logic receives 5 V via D18, the memory receives 5 V via D16 and the battery is charged via D15. D14 raises the output of IC42 from 5 V to about 5V6 to compensate for the drops across D16, D18. When there is no mains supply the logic is shut down but the memory still gets 3 V from the battery via D17. As the logic is all down Q4 turns off, disabling the memory so that only microamps are consumed.

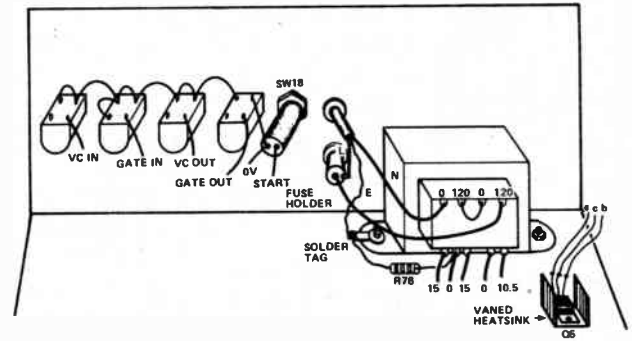
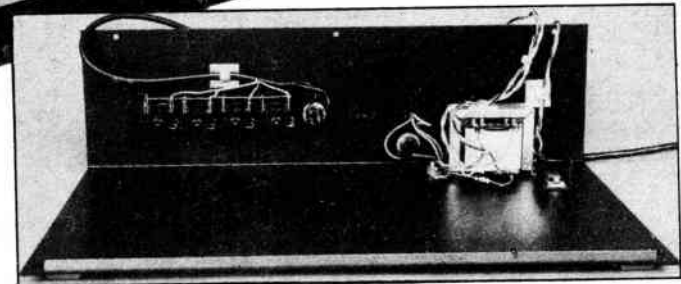
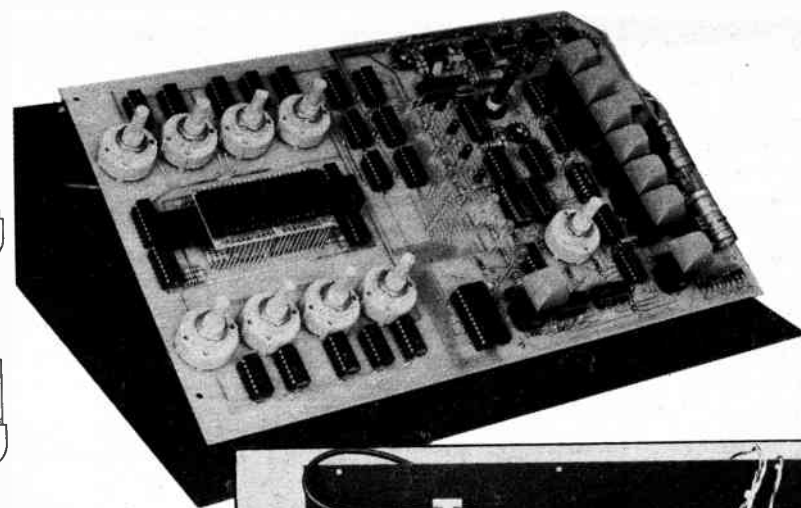
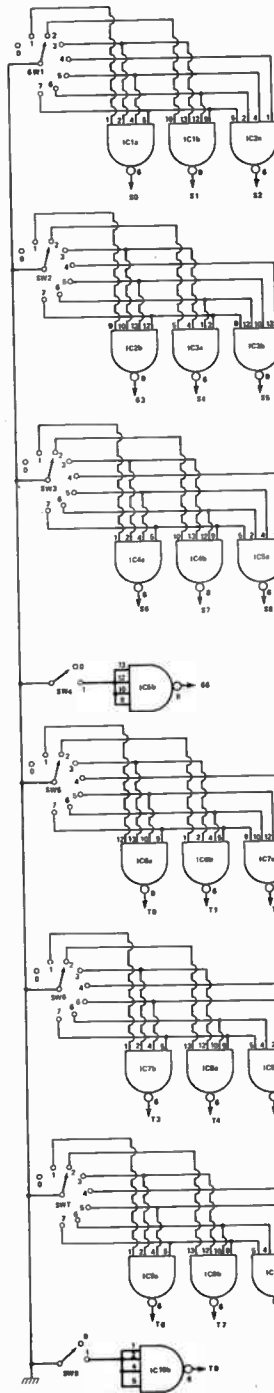


Fig.4 How to wire the off-board components.

Fig.5 (left) The switch encoder circuitry.

To confirm the correct encoding of each note, enter each one down the keyboard, switch to PLAY, press RESET and observe the red LEDs progressively showing a larger binary number.

Set the START OF NEXT SEQUENCE switches to 0003 and the START OF SEQUENCE switches to 0000, press RESET, enter the note two octaves down from the highest three times (any note length). Switch to PLAY with TEMPO halfway advanced and adjust PR3 for 2 V on VC OUT ie set the control voltage to 1 V/octave. Now you can bolt together the cabinet and start composing!

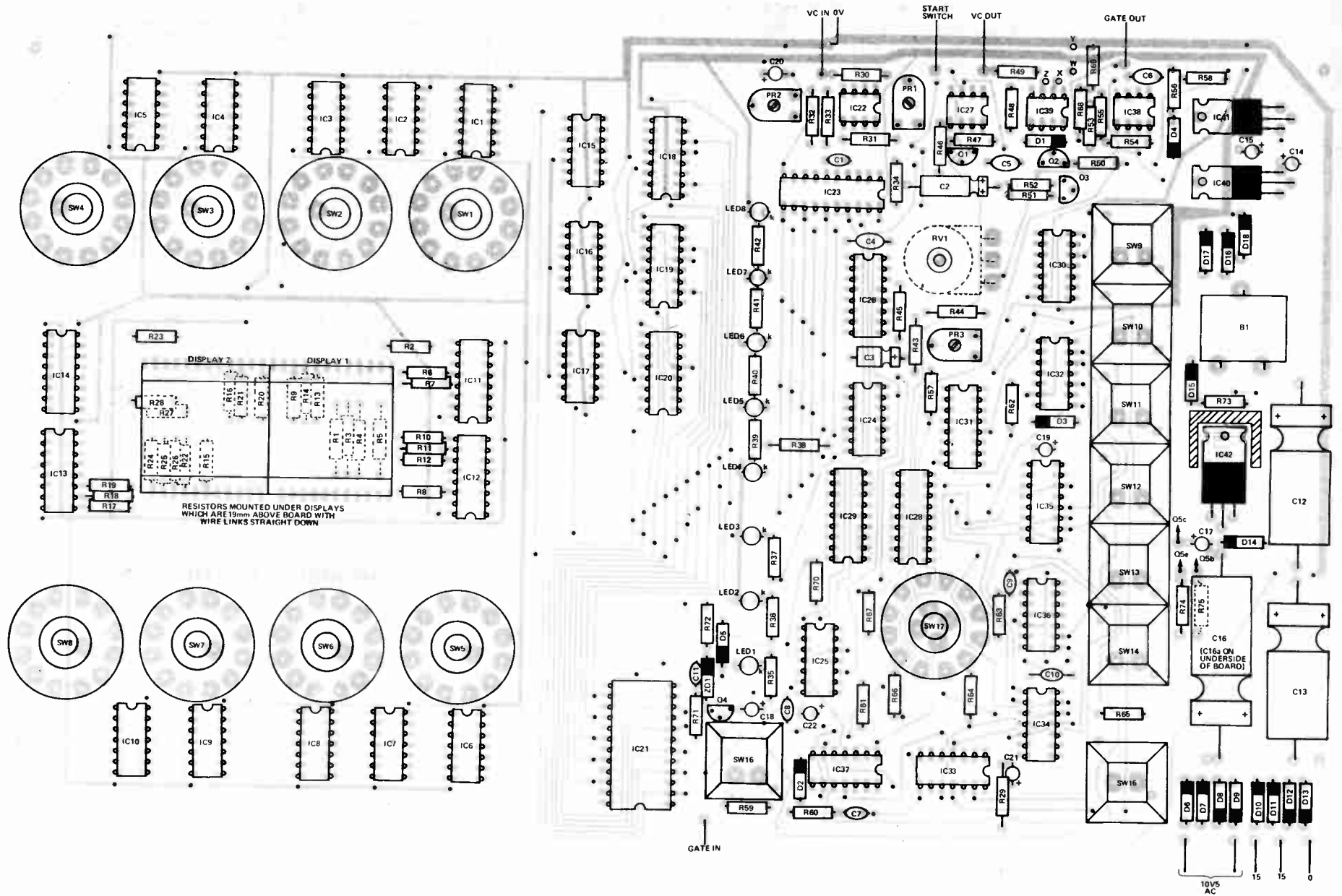


Fig.6 Overlay for the composer. The PCB is double-sided; note that this view is of the component side of the board and shows the copper tracks for that side. C16a is soldered underneath the board using the spare pads adjacent to C16.

ETI MAY 1981



## PARTS LIST

**Resistors (1/4 W 5% carbon film except where stated)**

R1-28, 35-42	270R
R29, 61, 62, 63	390R
R30	22k metal oxide
R31	33k metal oxide
R32	100k metal oxide
R33	470R metal oxide
R34, 50, 51, 52, 54, 60, 67	10k
R43	1k0 metal oxide
R44	4k7 metal oxide
R45	5k6 metal oxide
R46	3k3 metal oxide
R47	220R
R48	2M2
R49, 59, 66, 70, 72, R53	1k0
R53	47k
R55	5k6
R56	100k
R57	4k7
R58	18k
R64	100R
R65, 71, 73	2k2
R68	27k
R69	22k
R74	1R0
R75	10R
<b>Potentiometers</b>	
RV1	10k logarithmic
PR1	22k cermet preset

**PR2  
PR3**

**Capacitors**

C1	150p ceramic
C2	220u 10 V axial electrolytic
C3	47u 10 V axial electrolytic
C4, 10	100n polyester
C5, 6	220n polycarbonate
C7, 8, 9, 11	1n0 ceramic
C12, 13	1000u 25 V axial electrolytic
C14, 15, 17-22	1u0 tantalum
C16, 16a	2200u 25 V axial electrolytic

**Semiconductors**

IC1-10	7420
IC11-14	7446
IC15-17, 36	7493
IC18-20	7483
IC21	DM8130
IC22, 39	741
IC23	ADC0804
IC24	7404
IC25	7414
IC26	DAC0808
IC27	TL082 or LF353
IC28, 29	6514
IC30	7410
IC31	74LS367
IC32	7425

**10k miniature horizontal preset  
1k0 miniature horizontal preset**

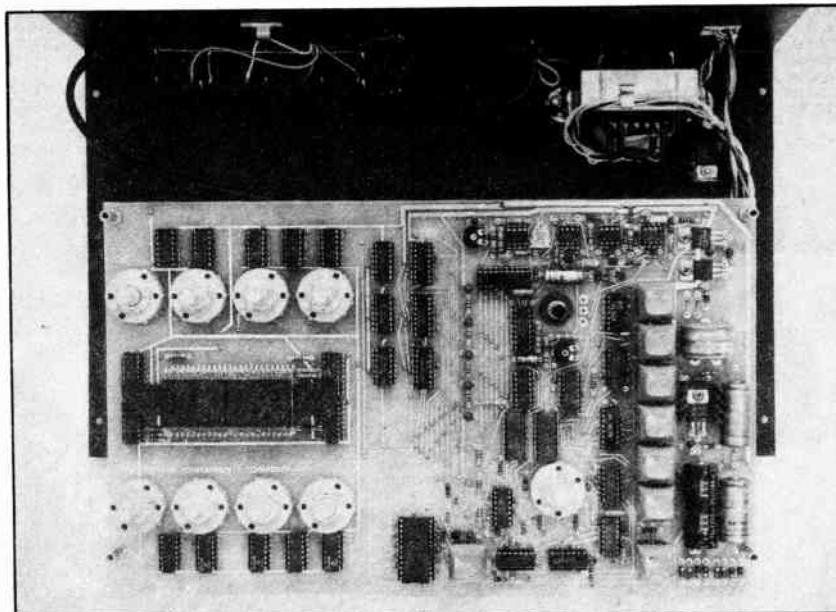
IC33	7427
IC34	7408
IC35	7485
IC37	74132
IC38	1458
IC40	7815
IC41	7915
IC42	7805
Q1	BF244C
Q2, 4	BC182L
Q3	BC212L
Q5	TIP30A
D1-5, 15-17	1N4148
D6-14, 18	1N4002
ZD1	2V7 400 mW
LED1-3	TIL222
LED4-8	TIL220
DISPLAY 1, 2	NSN784
TTL may be either 74 series or 74LS series	

**Switches**

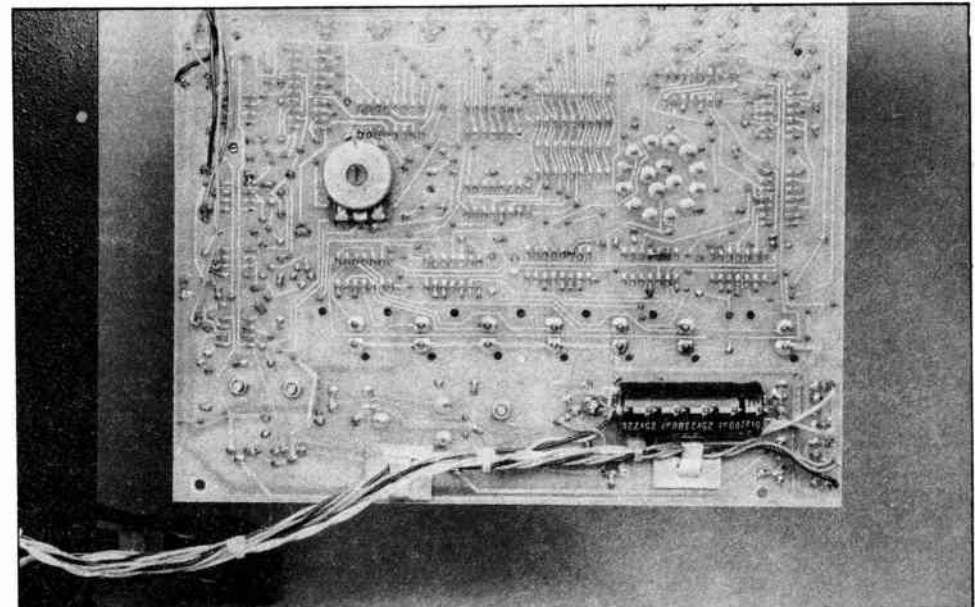
SW1-8	1-pole 12-way rotary with adjustable stop
SW9-16	keyboard 1-pole momentary make with 19 mm caps
SW17	4-pole 3-way rotary
SW18	panel-mounting momentary make

**Miscellaneous**

IC sockets, 3V6 Ni-Cd PCB-mounting battery, TV5 heatsink (2 off), transformer (secondaries 15-0-15 @ 100 mA, 10V5 @ 1 A), fuse holder, double-sided PCB, jack sockets (4 off), cabinet, spacers etc.



The complete PCB, with wiring finished and ready for fixing to the front panel.



Underside of the PCB showing RV1 and C16a in place.



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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

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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

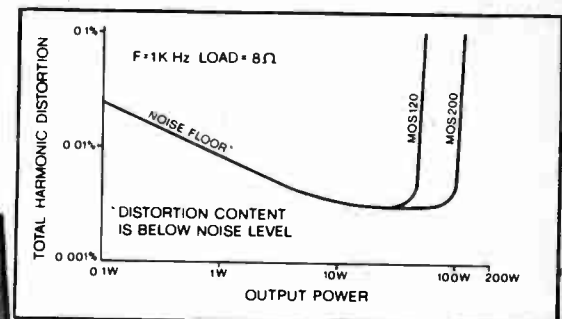


HY120

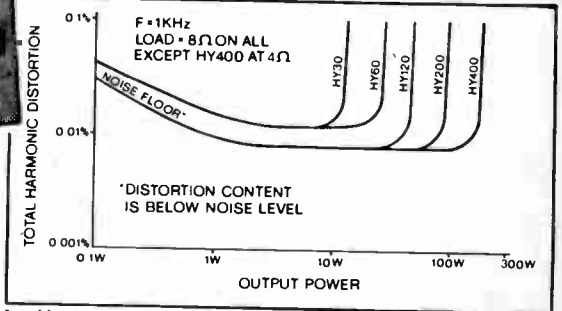


HY60

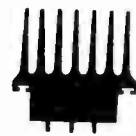
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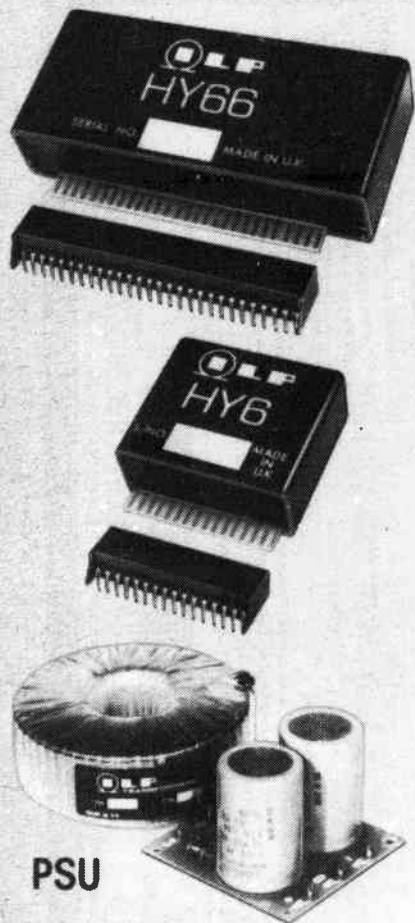
Load impedance both models 4Ω-∞ Input impedance both models 100KΩ  
4Ω-∞ Input sensitivity both models 500mV Frequency response both models 15Hz-100KHz - 3dB



Load impedance all models 4Ω-∞ Input impedance all models 100KΩ  
Input sensitivity all models 500mV Frequency response all models 15Hz-50KHz - 3dB



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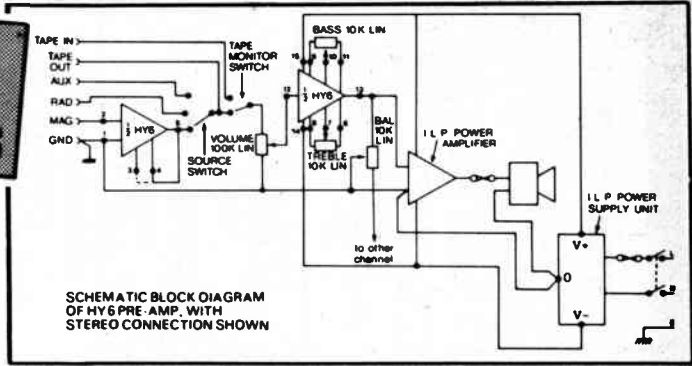


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- PSU65** for use with 1 MOS120 £13.32 + £2.00 VAT
- PSU70** for use with 1 or 2 HY120's £15.92 + £2.39 VAT
- PSU75** for use with 1 or 2 MOS120 £16.20 + £2.43 VAT
- PSU90** for use with 1 HY200 £16.20 + £2.43 VAT
- PSU95** for use with 1 MOS200 £16.32 + £2.45 VAT
- PSU180** for use with 1 HY400 or 2 HY200 £21.34 + £3.20 VAT
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# SONIC HOLOGRAPHY

**Hologram: a three-dimensional image. Sonic: pertaining to sound. Sonic Hologram, therefore, a three-dimensional sound image? Well almost! Ron Harris explains.**

**S**onic holography refers to a new principle of music reproduction being pioneered by Carver in their C4000 preamplifier. The aim is to more closely approach in the average room, the sound field found in a concert hall, using only the normal stereo pair of loudspeakers.

In operation the circuit's effect is to spread the sound image well beyond the speakers and add a marked 'depth' to the music. Such manipulation of the signal goes against the present trend in British hi-fi to exclude all controls except volume and input select. When examined closely this approach has just the faintest whiff of cowardice about it — rather than try and design a good compensation circuit it is easier to leave it out altogether.

It is also true that some of the best amplifiers around today follow this rationale — the Meridian and the Exposure for example — and are none the worse for doing so. However, all living rooms need equalisation to overcome their imperfections and some help is better than none. The ideal answer is probably a parametric equaliser which can be tuned to cancel the major system/room resonances and hence flatten the overall response closer to that ideal straight line.

## Control Lines

The 4000 is the exact opposite of the Meridian. It has controls for EVERYTHING. Tone controls are provided for each channel with variable turn-over frequencies, a most sensible and useful addition. An auto-correlator and an expander are also included with variable threshold for each. Between them they offer the experimenter a phenomenal increase in perceived signal-to-noise ratio — albeit at a small degradation in absolute sound quality.

**Right: The Carver C-4000 Sonic Holography Pre-amplifier. As you can see from the front panel there is no shortage of facilities. The set of six push-button set apart, beneath the logo, control the main circuits — including the Sonic Hologram. It is a nice ergonomic touch to have the Volume Control well separated from the rest as it makes it easier to 'find' in use.**

Inputs are provided for two tape decks — with full dubbing — two pickups, a tuner and an 'auxiliary'. Output level may be switch-matched to the particular power-amp in use.

The main feature is undoubtedly the Hologram Generator with its associated time-delay amps. Holographic reproduction can be obtained from the normal two speakers perfectly well, but for those wishing to enhance the effect still further, the time-delay feature is useful. We will return to this later, firstly let us consider how the basic hologram circuit operates.

## Binaural Beginnings

Most readers will have heard, or at least heard of, the binaural recording techniques, where music is captured on tape using a dummy head with microphones positioned in the 'ears'. When replayed on headphones, a remarkably accurate model of the original sound field is set up around the listener, ie it sounds very close to the hall in which the recording was made.

Reproduce a binaural record through loudspeakers, however, and the field is destroyed. Headphones work because they isolate each ear from the other channel completely. The right ear hears only the sound which reached that microphone in the dummy head.

The aim of Carver's Hologram circuitry is to attempt to simulate this isolation in a room using the loudspeakers. It does it by 'cross-feeding' each channel with an anti-phased version of the other. The left speaker thus receives a normal LH signal plus an added-in RH channel 'cancellation' signal.

In order to sound 'correct' to the ear, some compensation is required for the fact that the ears are different distances from the speakers and that the head throws a sound 'shadow', effectively altering the perceived frequency response as the sound passes around the head.

To properly isolate the ears, the signal from the LH speaker and the cancelling signal from the RH speaker must arrive at the



ear simultaneously and correctly equalised. Time delay is thus required and the listening zone will be relatively limited. Excessive movement will mean that the signals do not arrive in sync and little cancellation will occur.

## MIT Basics

A Ph.D candidate at MIT in America did some work on determining the amount of time delay needed in compensation and also the exact modifications required to the frequency response. Using a technique similar to binaural recording he took frequency response plots, etc from two tiny microphones placed in his ears.

From this emerged a figure of around 675 mS for the delay, and the complex frequency plot shown in Fig. 3. The closer a filter can be built to approximate this curve, the better will be the isolating effect and hence the sharper the holographic effect.

These plots were taken under anechoic conditions and things become considerably more complex under reflective conditions — the real world. Carver uses a 12 pole filter to shape response below 1 kHz and a second, five pole, filter for higher frequencies. The phasing problems must be horrendous. Time delay is achieved using wide-band FET amplifiers because they produce a better sound quality than IC CCD delay lines.

## Amplitude-To-Phase

One additional circuit was required in the final design, to allow for varying methods of 'multi-miking' records. This type of recording does not preserve the original sound field nearly as well as the simple 'crossed pair' techniques and to extract an effective hologram it is necessary to reorganise the amplitude variations in the signal into a particular, very complex, phase relationship. This is fed to the appropriate loudspeakers.

The C-4000 makes use of the fact that stereo positioning is entirely amplitude related, ie if a drum is louder on the left channel than on the right it will appear to emanate from a position closer to that speaker. This enables the preamp to place the sound laterally and the phase information already on the recording is then used to provide a 'depth' relationship.

A two position switch is provided on the preamp which is labelled 'normal' and 'theoretical'. Set to the former it optimises the playback for normal stereo multi-miked recordings and switching to the latter will allow better reproduction of 'natural' recordings ie 'cross-pair' etc.

## Practise

That's the theory then, but how does it do in practise? Very well actually. We tested the preamp as a 'normal' piece of hi-fi first of all and it exceeded its specifications comfortably on all counts.

Setting up the holographic generator is a little tricky, but use of the special test record from Carver greatly facilitated things. Once aligned, seating position is critical to around three feet laterally and about seven feet front to back. Outside this area the effect is greatly lessened but still present.

Playing a record and switching in the hologram proved to be an unnerving experience. The sound stage expands enormously and appears totally divorced from the speakers. On a classical piece the effect is simply of being nearer the orchestra with instruments appearing to be playing well outside the speakers!

On rock records, with all their attendant re-mixing, some quite startling things began to happen. The Pink Floyd's 'The Wall' and 'Dark Side' have to be heard to be believed. Live LPs reproduce brilliantly, giving a greatly enhanced 'presence' to the music, much closer to being there!

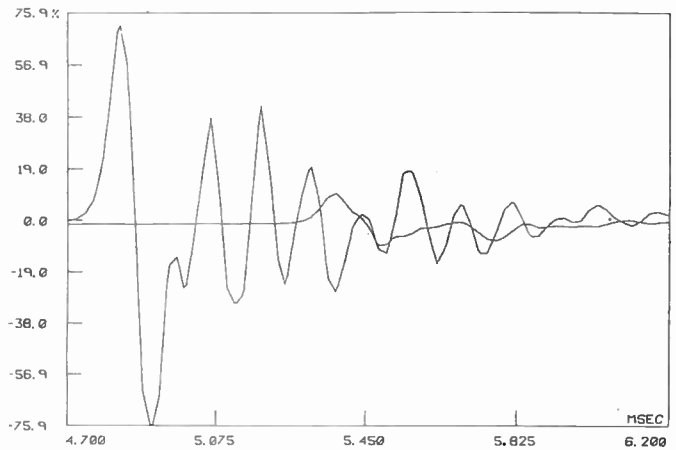


Fig. 1. The time difference between the two ears with a signal source placed at 60° to the left of the listener. The first large rise shows the left ear receiving the pulse, and 675 mS later the right ear hears the same signal, greatly attenuated by the head.

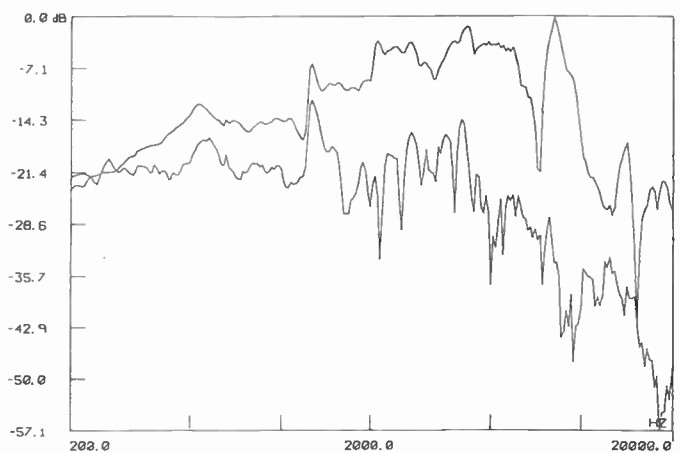


Fig. 2. Frequency response differences between the two ears hearing the same pulse from the same place as in Fig. 1. Below 200 Hz there is little difference as the head is too small to 'shadow' sound below this frequency.

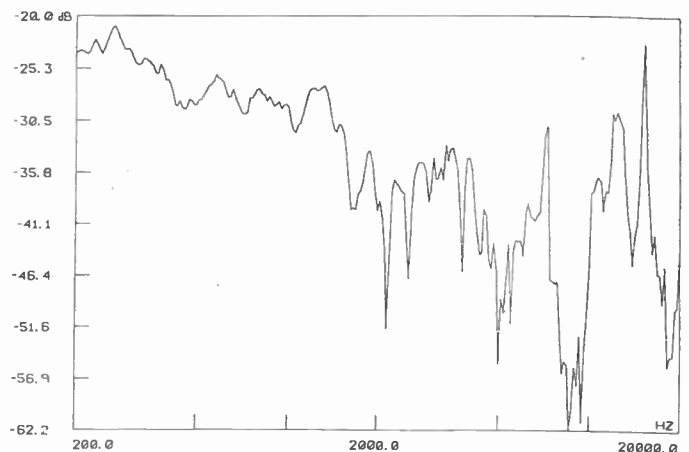
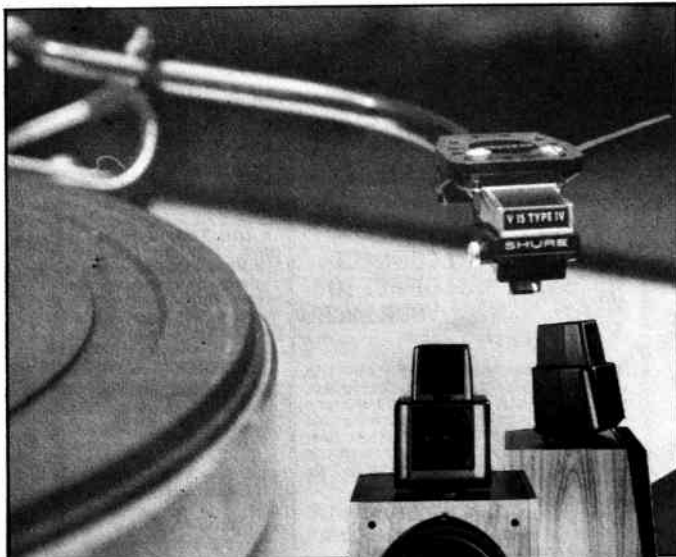


Fig. 3. The difference between the two plots in Fig. 2 drawn against frequency. The various troughs and peaks are introduced by ear lobes, the shape of the head etc.



These were the two hi-fi components which produced the most pronounced effect from the C-4000. The Shure V15 IV cartridge and the KEF 105 II loudspeakers. Good results were obtained with all the systems we placed the C-4000 into, but these transducers appeared to work better than others.



Overall the sound is warmer and more accessible and the image is no longer simply hung in between the speakers in a flat two-dimensional manner. Switching back to stereo from holographic reproduction is quite a disappointment in many ways as the depth appears to vanish and the image contracts so much.

## Adding Up

The time delay amps included in the preamp (of around 20 W RMS) are to drive additional speakers to the rear of the listener to enhance the effect. Frankly, I didn't feel this was needed at all. Putting in the extra units *did* change things, but two speakers were quite enough!

Experiments also showed that some ancillary equipment works better than others. KEF 105s gave the best results of the speakers tried and the Shure V15 IV cartridge gave consistently better results than any other pickup. It probably maintains better phase relationships between signal components than the rest.

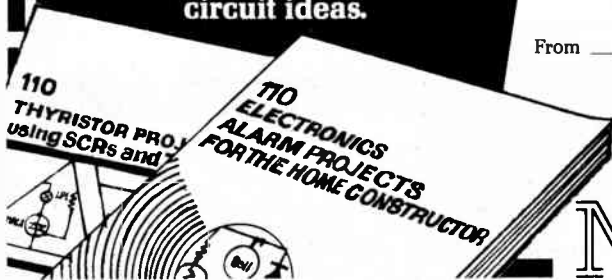
So there it is. A new approach to music reproduction in the home — and one that works. The C-4000 is not cheap at around £600 but in view of the fact that it offers greatly enhanced reproduction of most material it deserves very close consideration.

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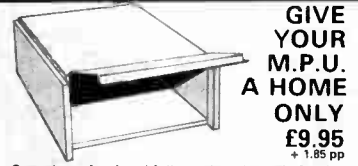
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AY-3-8500 + kit **£12.98**. AY-3-8550 + kit **£9.28**.

### PRINTED CIRCUIT MATERIALS ★

PC etching kit: economy **£2.42**, standard **£5.78**. 40 sq in pcb 50p. 1lb FeCl **£2.20**. Etch resist: economy 50p, dialo 90p. Drill bits 1/32" or 1/16" 36p. Etching dish 82p. Laminated cutter **£1.30**.

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### COMPONENTS ★

1N4148 1.5p. 1N4002 3.7p. NE555 8 dil 26p. 7416 6 dil 20p. BC182, BC184, BC214, BC214, BC547, BC549 8.1p. Resistors 5%, 1/4W E12 10R to 10M 1.5p, 0.5p for 50+ of one value. Polyester capacitors 160v .015, .088mf 2.9p, .047, .1mf 4.4p, .01mf 3.3p, .022, .033mf 3.7p, .15, .22, .33mf 5.4p, .47mf 8.9p. Polystyrene capacitors E12 63V to 10 1000pF 4p, 1n2 to 10n 5p. Ceramic capacitors 50v E6 22pF to 47n 2.5p. Electrolytic capacitors 50v 5, 1, 2mf 8p, 25v 5, 10mf 6p, 16v 22, 33mf 5p, 47mf 5p, 100mf 7p, 330, 470mf 9p, 1000mf 11p. Zeners 400mW E24 2v7 to 33v 7p. Preset pots subminiature 0.1W horiz or vert 100 to 2M2 5p. IC sockets 6 dil 0.7p, 14 dil 10.1p, 16 dil 12p.

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# INFRA RED REMOTE-CONTROL

Specifically designed to remote-control three mains switches and two lamp dimmers in a single room, this infra-red system can be used to activate virtually any electrical appliance from the comfort of the armchair or bed. Pure luxury at a modest price. Design by Ray Marston. Development by Plamen Pazov.

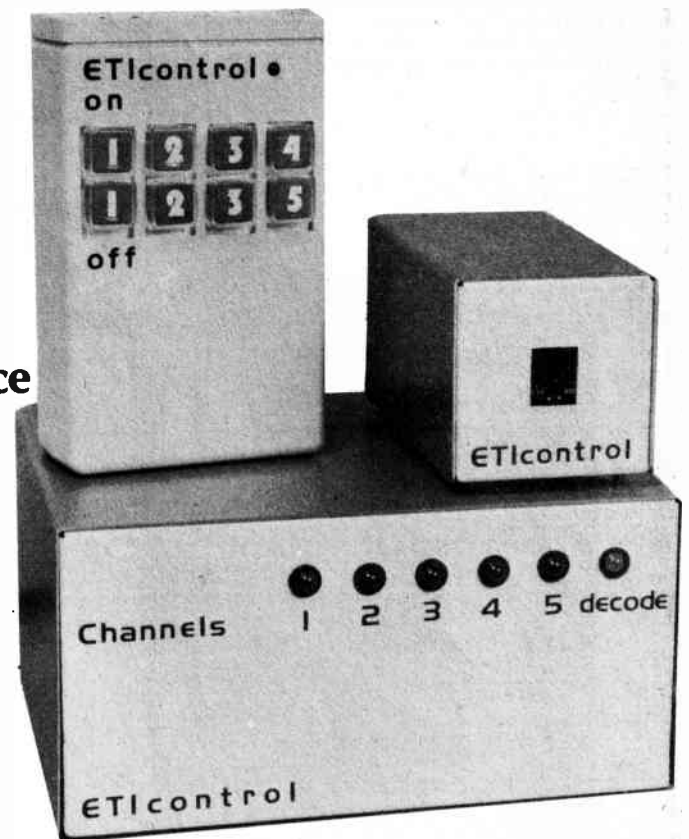
This sophisticated five-channel infra-red remote control system comprises a small hand-held transmitter and a combined receiver/decoder unit that provides five independent channels of decoded outputs (logic 0 or logic 1). Three of the control channels are of the latching type and are each controlled by a pair of push-buttons (one ON, one OFF) on the transmitter: an ON instruction produces a logic 1 output from the appropriate channel of the decoder, while an OFF instruction produces a logic 0 output.

The remaining two control channels are of the non-latching type and are each controlled by a single push-button in the transmitter: the decoder produces a logic 1 output when a non-latching transmitter button is pressed or a logic 0 output when the button is released. The transmitter thus uses a total of eight push-buttons to control the total of five remote-control channels. The system has a typical remote-control range (from transmitter to receiver) of about 10 m.

The system is specifically designed to control up to three mains power switches and two lamp dimmers in a single room. With this in mind, the remote-controlled power switch and the remote-controlled touch dimmer projects described elsewhere in this issue of ETI, and the noiseless power switch project of the March '81 issue, have been specifically designed to interface with the outputs of the decoder unit of this five-channel remote-control system. The power switches are designed to be controlled by the latching channels, and the dimmers by the non-latching channels.

Thus, you can use the system to turn on lamps, TVs, hi-fi systems, or any other appliances that draw mains currents below 5 A, by using it in conjunction with this month's remote-controlled power switch project; or to control electric heaters or other appliances that draw mains currents up to 15 A by using it in conjunction with the noiseless power switch from the March issue; plus two touch controlled lamp dimmers, all from the comfort of an armchair or bed.

In practice, of course, you can use the single hand-held transmitter to control up to five appliances in every room of the



house if you so wish. All you need to do is fit a duplicate receiver/decoder unit, etc., in all required rooms. Thus, you can use the transmitter to control dimmers, hi-fi and TV when you are in the lounge, and use the same transmitter to control a lamp, radio and electric heater when you are lying in bed. Nice.

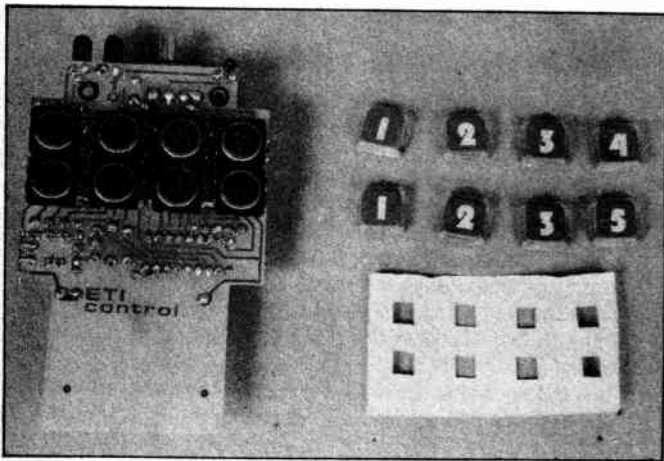
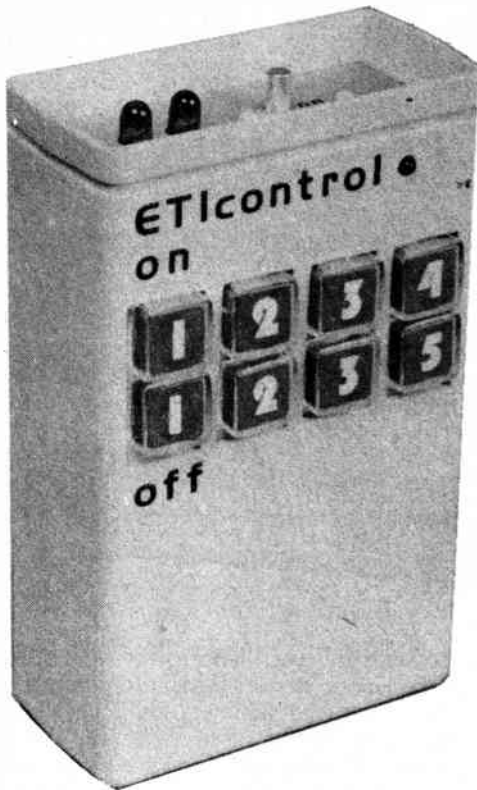
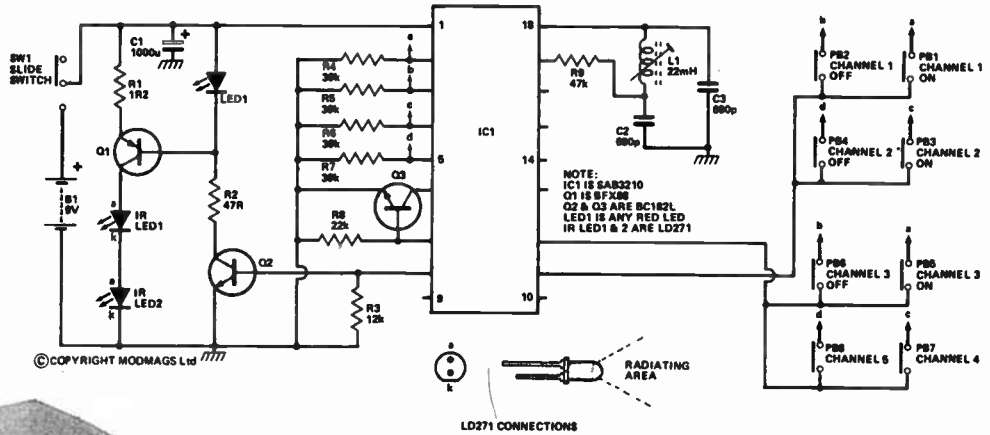
## Construction: The Transmitter

The transmitter unit is specifically designed to fit in a small Verobox (see Buylines). All components, including the eight push-button switches, are mounted on a single PCB, with the switches mounted directly on the copper side of the PCB and all other components mounted on the 'plain' side. A good deal of care is required in the construction.

Start the construction by etching the PCB and cutting it to size, noting its unusual shape. Now assemble all components other than the push-button switches, LED1 and IC1 on the plain side of the PCB and solder them in place, noting the following points;

(i) All but three of the resistors are mounted vertically on the PCB; (ii) An 18-pin DIL socket is soldered to the PCB to accommodate IC1; (iii) The two IR diodes are mounted vertically on the PCB but are then bent at right angles to pass through holes cut in the case front panel. Slide switch SW1 is soldered directly to Veropins on the PCB and is angled so that its control knob passes through a slot in the front panel. Capacitor C1 has a 10V rating and needs to be as small as possible. →

**Fig.1 (Right) Circuit diagram for the infra-red transmitter.**  
 Below: The completed transmitter. The two infra-red LEDs and the on/off switch are mounted through the front panel; the 'transmit' LED is positioned on the top of the case with the push-buttons so that it can be seen during operation. Note that channels 1 to 3 have two buttons each (on and off). Channels 4 and 5 are non-latching and only require one button.



This photograph shows the copper side of the assembled PCB, with the ingredients of the 'mylar sandwich'. The plastic fits over the switches and the caps hold it in place.

## HOW IT WORKS

### TRANSMITTER

The heart of the transmitter is IC1, an LSI PMOS chip. This chip receives instructions via an eight-row (pins 9-16) by four-column (pins 2-5) matrix that can be activated by up to 32 push-button switches. Only eight switches are used in our application. The circuit is clocked at about 60 kHz by the R9-L1-C2-C3 oscillator when the IC is active.

When the transmitter is in the quiescent state the IC is disconnected from the battery by turn-on transistor Q3 and the complete circuit (including the clock oscillator) is de-energised. Under this condition the entire circuit draws a total leakage current of only a few microamps from the supply battery. When any of the key switches are pressed, negative potential is applied to one of the 'row' pins via one of the resistors R4-7; pin 7 goes high and turns Q3 on, thus energising the IC and its clock oscillator.

Whenever the IC is energised by a press-button operation a keyboard scanner comes into operation, detects the code of the actuated switch and converts this information into a clock-related serial output code that appears on pin 8 and is unique to that particular switch. This serial code signal is fed to the infra-red transmitter LEDs via Q2 and Q1.

The transmitter serial code consists of a start bit, followed by six information bits, which are read out in biphasic code at half the clock frequency. This seven-bit serial code signal has a total frame time of about 11 mS and is repeated at a time-base rate of about 130 mS throughout the duration of a key press. When the press-button is released a seven-bit 'end of signal' code frame is transmitted and the transmitter then automatically deactivates again when Q3 turns off.

The serial output code from pin 8 is amplified by Q2 and is used to pulse constant-current generator Q1 on and off via R2 and LED1. Q1 feeds current pulses of several hundred milliamps to the two series-connected infra-red transmitter LEDs, this high current being supplied by storage capacitor C1. Although the peak IR LED currents are very high (thus ensuring a good operating range), the mean currents (averaged over one time-base period) amount to only 5 mA or so.

Thus, considering that the transmitter will typically only be required to operate for about half-a-second per instruction, it can be seen that roughly 100,000 instructions can be transmitted from a single PP3 battery during its life. Put another way, a single PP3 is capable of transmitting 250 instructions every day for about one year.

## BUYLINES

The SAB3210 and SAB3271 are available from Electrovalue and Watford Electronics — Watford can also supply the LD271 and SFH205. The push-button switches and switch caps are available from Ambit International, as is the variable inductor L1. The cases used for the preamp and decoder unit are obtainable from West Hyde Developments (order as Samos 006 and 001 respectively).

# PROJECT : IR Remote Control

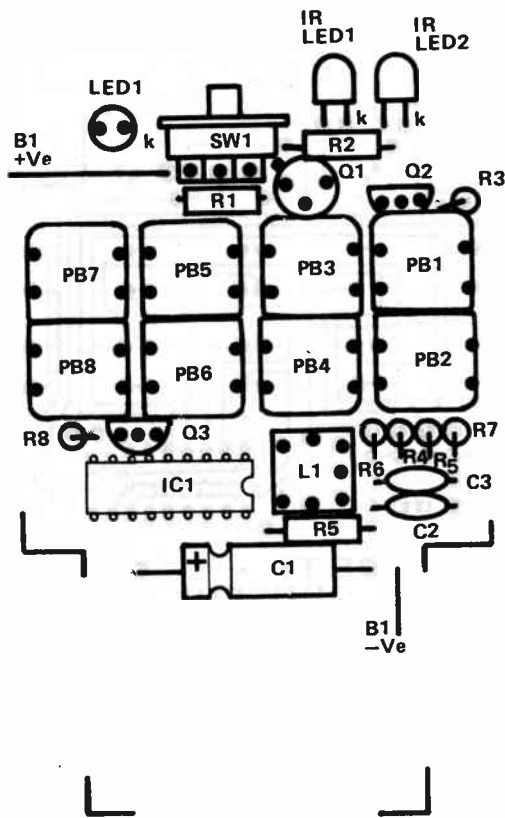


Fig.2 Component overlay for the infra-red transmitter; the board is a peculiar shape so that it will fit the case specified. Most of the resistors are mounted vertically to save space. The overlay is drawn with the component side uppermost — PCB1-8 and LED1 are actually soldered on the copper side, as shown in the photographs.

## PARTS LIST

### TRANSMITTER

#### Resistors (All 1/4 W, 5%)

R1	1R2
R2	47R
R3	12k
R4,5,6,7	39k
R8	22k
R9	47k

#### Capacitors

C1	1000u 10 V axial electrolytic
C2,3	680p polystyrene

#### Semiconductors

IC1	SAB3210
Q1	BFX88
Q2,3	BC182L
LED1	any red LED
IR LED1,2	LD271

#### Miscellaneous

SW1	miniature slide switch
PB1-8	KHC10901 (push-to-make non-locking)
L1	87BN132HM (22 mH variable inductor)
Verocase (code 202-21303J)	caps for switches (KT5 — 8 off)

Now turn the PCB over and solder the eight push-button switches (and LED1) to the copper side. A great deal of care is required here and a miniature soldering iron is needed. Proceed as follows. First, remove the snap-on caps of the switches and straighten the four switch mounting legs, using a pair of pliers. Note that small pips are moulded into the underside of the switches, to fix their height slightly above the surface of the PCB: do not remove these pips. Now press one switch into position from the PCB copper side and solder its four legs to the PCB. Repeat the process, soldering one switch at a time, until all eight switches are in place. You'll find this a distinctly fiddly process.

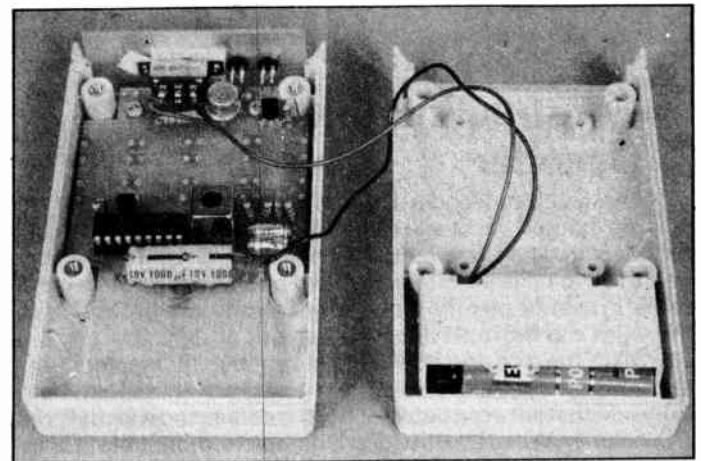
When all eight switches are in place, take a strip of white mylar film (available from your local art shop), place it over the bank of switches, cut holes in the strip so that the eight push-button operating shafts pass freely through the mylar, and then fit the switch caps back in place and check that the switches operate freely. The mylar film simply enhances the appearance of the finished transmitter unit.

This completes the construction of the electronics side of the transmitter and it can now be given a simple functional test. First, set the adjustable core of L1 to mid position, fit IC1 in place, connect a 9 V (PP3) battery, and turn SW1 on. Now press the push-button switches one at a time and check in each case that LED1 flashes intermittently for the press duration. If all is well, you can fit the unit into its case, as follows.

First, offer the PCB assembly up to the top half of the case (the battery holder is in the lower half), align it with the two small front mounting holes and carefully mark out the positions of the eight push-button switches on the case, so that four broad accommodating slots can be cut in the case to accept the switches as shown in the photographs. Cut the slots and re-check the fit.

Now similarly line up the PCB assembly so that holes/slots can be cut in the metal front panel to accept LED1, the two IR diodes, and the control knob of SW1. Once the holes are cut, complete the connections to the PP3 battery in the holder in the lower half of the case and screw the whole assembly together. The transmitter construction is then complete.

Note that the transmitter cannot be given a final test until the receiver/decoder construction is complete. When using the unit, however, note that the only function of SW1 is that of ensuring that the transmitter will not be activated accidentally when carried in the pocket, etc: in normal use SW1 can be left permanently on, since the unit consumes virtually zero quiescent current.



The transmitter PCB mounted in its case. You can see how the infra-red LEDs are bent at right-angles, and the slide switch soldered to Vero pins, so that they face forward through the front panel.

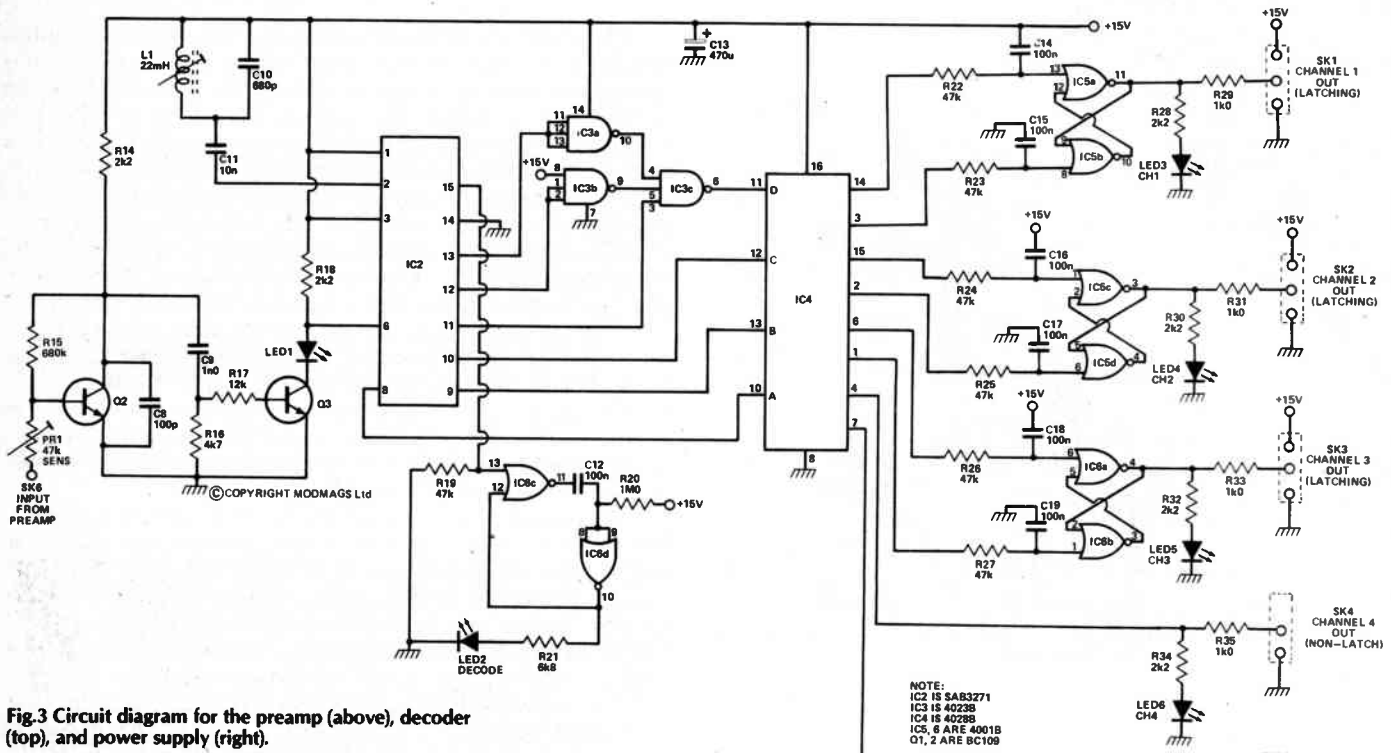
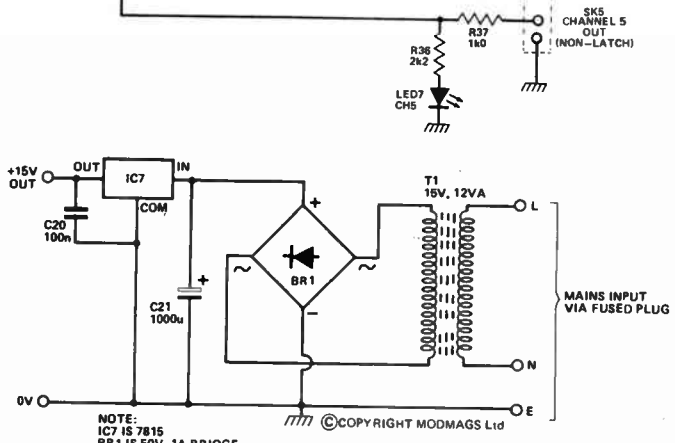
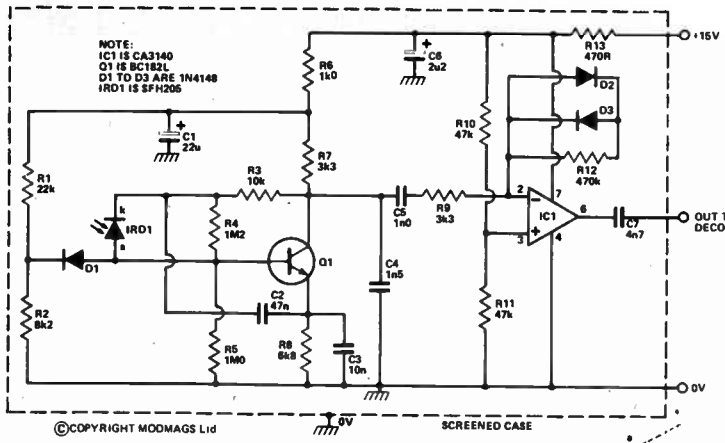


Fig.3 Circuit diagram for the preamp (above), decoder (top), and power supply (right).



## Construction: The Receiver/Decoder

The receiver/decoder is built as two units, with the IR preamp housed in one small screened case and the main decoder circuit and power supply housed in a separate, larger, box: the two units are interconnected by a length of three-core cable. In use, the preamp is placed in a clearly visible position in the room and the main unit is hidden out of sight.

Start the construction by building the IR preamplifier, assembling the components as shown by the overlay. Take care to ensure that infra-red detector IRD1 is connected with the correct polarity. When construction is complete, mount the PCB in a steel or tin case, after first cutting a hole in the case front for IRD1, and ground the case to the 0 V supply line. Finally, fit a DIN socket in the rear of the case, to facilitate connections to the main decoder/power supply unit, and complete the interwiring.

Rear view of the preamp and decoder units. In use the two are connected by three-core cable. There are five-pin DIN sockets on the decoder because we ran out of three-pin sockets!



## HOW IT WORKS

### THE RECEIVER/DECODER

The receiver/decoder unit detects the infra-red signals from the remote-control transmitter, amplifies them to a useful level, decodes the information that the signals carry, and then uses this information to implement a switching action on one or other of the latching or non-latching outputs of the decoder. These outputs can then be used to activate external power switches and lamp dimmers, etc. The receiver/decoder unit comprises three main sections, an infra-red receiver/preamplifier, the main receiver/decoder unit, and the power supply.

The transmitter IR signals have a basic frequency of about 30 kHz (half the transmitter clock frequency): they are detected by IRD1 in the receiver preamp and are amplified first by Q1 and then by IC1. A problem in designing IR preamplifiers is that the circuit not only has to provide high gain for long range operation but must also not saturate when the transmitter is placed only a few inches from the receiver.

With the latter point in mind, R1-R2-D1 and C2 are used to prevent the bias point of Q1 shifting under heavy drive conditions. D2 and D3 clip the level of the final IC1 output signal, to prevent overdriving of following stages. The values of C2-C3-C4-C5 and C7 are chosen to make the preamplifier reasonably frequency selective, thereby ensuring a good low-noise figure. The preamplifier unit must be mounted in an electrically screened case.

The output of the preamp is further amplified by the Q2-Q3 stages of the decoder circuit and are then passed on to pin 6 of IC2. Preset PR1 enables the effective sensitivity of the circuit to be varied over a wide range and LED1 is used as a sensitivity indicator when initially setting up the circuit.

IC2, which uses L1 and C10-C11 as clock elements, inspects the incoming pin 6 signal, checks it for compatibility with its own clock frequency and with certain logic parameters, and if all is well converts the seven-bit biphasic serial input signal into an equivalent six-bit parallel code, which appears on pins 8 to 13. Simultaneously, each time that a correct code conversion is made, a brief positive pulse appears on pin 15, and this pulse is used to trigger monostable IC6c-IC6d and thereby drive LED2 on to give a visual indication of the decoding action of the circuit; this LED indication is of value when initially adjusting L1 to set up the system.

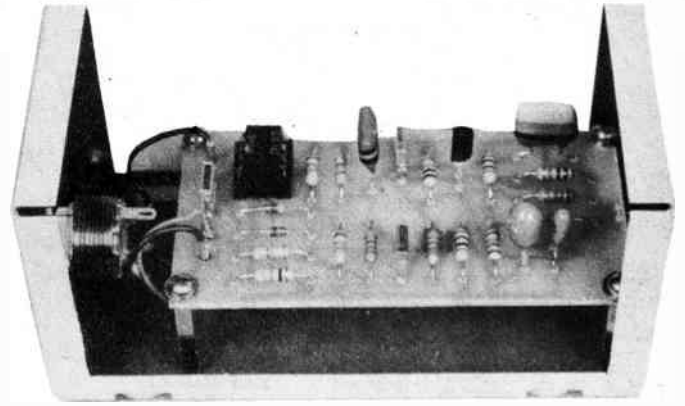
The six-bit parallel output code signals of IC2 are fed to IC3 and IC4, which decode eight of the possible six-bit combinations (corresponding to the eight possible codes generated by the eight push-buttons in the infra-red transmitter) and these decoded signals are made available on pins 14, 3, 15, 2, 6, 1, 4 and 7 of IC4. Each of these outputs is normally low, but can be driven high by closing the appropriate button on the IR transmitter.

The pin 4 and pin 7 outputs of IC4 are made available, via 1k $\Omega$  limiting resistors, at output sockets SK4 and SK5 respectively of the decoder unit, and act as non-latching remote control output channels. The 14/3, 15/2 and 6/1 outputs, on the other hand, are each used to control a simple set-reset bistable which has its output taken to one of the SK1-3 sockets, each of which acts as a latching remote control channel output. Note that the inputs to the bistables are damped by simple R-C networks, to eliminate transient activation. Also note that all output channels are provided with LED indicators, to give a visual indication of the channel state.

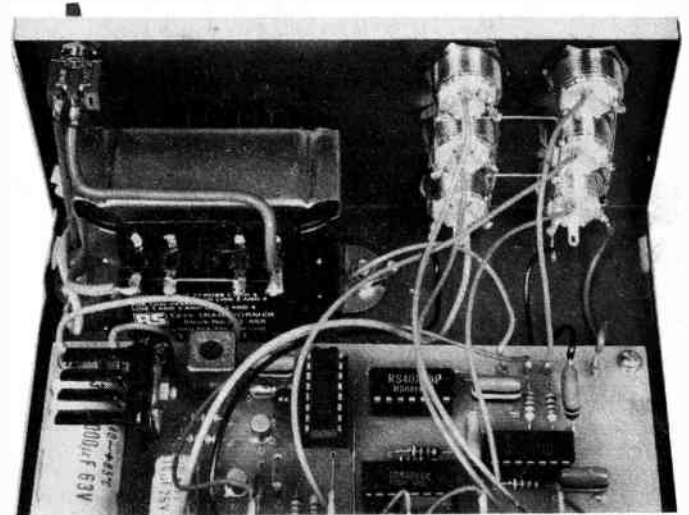
The complete receiver/decoder unit is powered from 15 V DC supply, derived from the mains via T1-BR1 and IC7. This supply is also made available at channel output sockets SK1 to SK3 and can be used to power auxiliary circuitry, such as the remote-controlled power switch described elsewhere in this issue of ETI.

Proceed now with the construction of the main decoder/power supply unit, noting that some care is needed in the construction of the PCB. Start the PCB assembly by fitting the four wire links and the Veropins and then systematically fit the remaining components in place, working through the assembly from the left (PSU components) to the right. Fit the regulator (IC7) with a small heatsink, sufficient to dissipate roughly 3 W.

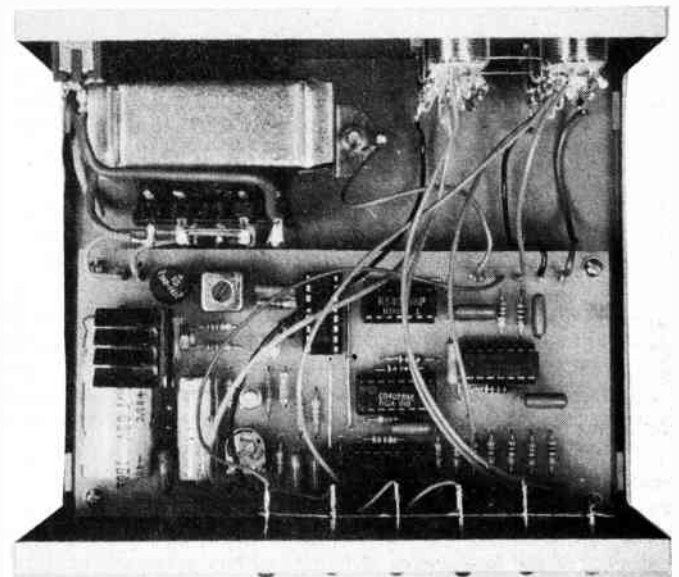
When the assembly is complete, fit the PCB assembly into a suitable case, together with mains transformer T1, six DIN sockets (one input, five output) and the six indicating LEDs, and complete the interwiring. Finally, complete the mains connections and check that the 15 V regulator circuit is working correctly, with outputs available at sockets SK1 to SK3. If all is well the system is ready for setting up.



Inside the preamplifier case; power and signals pass via the DIN socket on the left. The infra-red detector diode is fitted at the far right of the PCB and requires a cut-out in the side of the case.



Close-up of the wiring for the sockets on the decoder unit. One of these is for the input from the preamp — the other five distribute the decoded signals to the equipment under control.



General view of the decoder/power supply unit showing the internal layout. The common ground connection for the LEDs is made by soldering a length of tinned copper wire to the cathodes.

# PROJECT : IR Remote Control

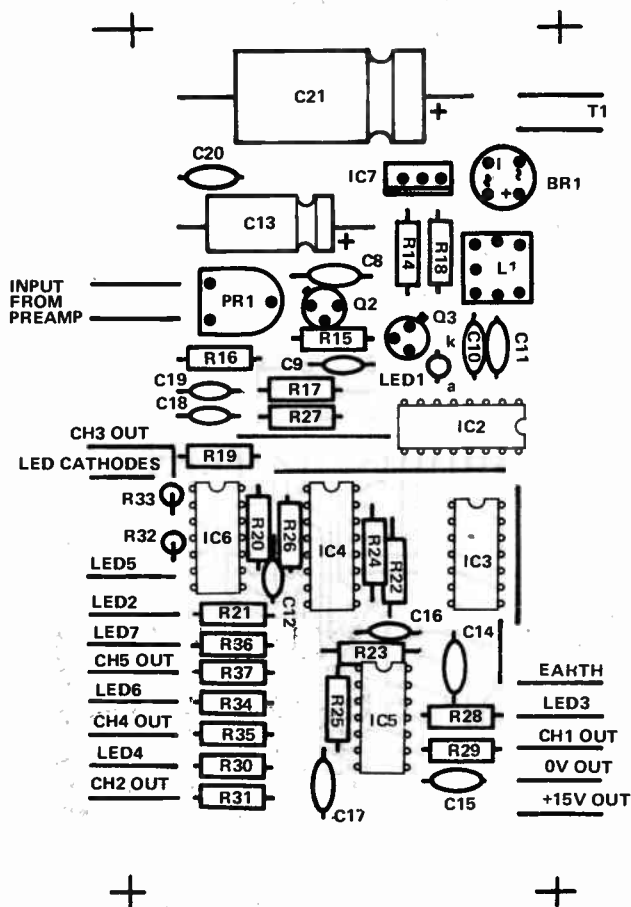


Fig.4 Component overlay for the decoder PCB. Note that LED1 is for setting up only and is soldered to the PCB.

## Setting Up The System

To initially set up the five-channel remote control system, proceed as follows. First, interconnect the preamp and the main decoder/power supply unit. Switch the units on and adjust preset PR1 so that LED1 (mounted on the PCB) just glows faintly and then turn PR1 back so that the LED just turns off. Now operate the transmitter by pressing one of its buttons and see if LED2 illuminates, indicating that a decoding action is taking place. Adjust the core of L1 (in the decoder) to find the extreme positions at which decoding ceases and then finally set the core halfway between these points. If you can't get the circuit to work, use a 'scope to check that a code signal is being received from the output of the preamp; if not, you've probably fitted the transmitter LEDs or the preamp detector diode the wrong way round.

When all is well, check (by means of the indicating LEDs) that you can turn all five control channels on and off by using the appropriate press buttons on the transmitter. Finally, check that the system has a control range up to about 10 m, slightly adjusting the PR1 setting if necessary. The setting up procedure is then complete and the system is ready for use.

## Using The System

To use the system with the touch dimmer, simply take the outputs of the SK4 and/or SK5 non-latching channels to the + and - inputs of the dimmer unit. To use the system with this month's power switch project, use the latching outputs of sockets SK1, SK2 or SK3 to feed instructions and power to the switch units.

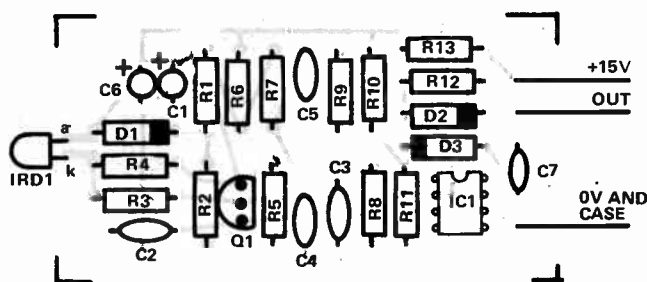


Fig.5 Overlay for the preamplifier. The leads of IRD1 have to be bent so that the sensitive face points forward.

## PARTS LIST

### IR PREAMP/DECODER/POWER SUPPLY

#### Resistors (All 1/4 W, 5%)

R1	22k
R2	8k2
R3	10k
R4	1M2
R5,20	1M0
R6,29,31,33,35,37	1k0
R7,9	3k3
R8,21	6k8
R10,11,19,22,23,24,25,26,27	47k
R12	470k
R13	470R
R14,18,28,30,32,34,36	2k2
R15	680k
R16	4k7
R17	12k

#### Potentiometers

PR1	47k miniature horizontal preset
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#### Capacitors

C1	22u 25 V tantalum
C2	47n polyester (C280)
C3,11	10n polyester (C280)
C4	1n5 polycarbonate
C5,9	1n0 polycarbonate
C6	2u2 35 V tantalum
C7	4n7 polycarbonate
C8	100p polystyrene
C10	680p polystyrene
C12,14,15,16,17,18,19,20	100n polyester (C280)
C13	470u 25 V axial electrolytic
C21	1000u 63 V axial electrolytic

#### Semiconductors

IC1	CA3140
IC2	5AB3271
IC3	4023B
IC4	4028B
IC5,6	4001B
IC7	7815
Q1	BC182L
Q2,3	BC109
BR1	50 V, 1 A bridge rectifier
D1-3	1N4148
IRD1	SFH205
LED1-7	0.2" red LED

#### Miscellaneous

L1	87BN132HM (22 mH variable inductor)
SK1-6	three-pin DIN sockets
Transformer (15 V, 12 VA), 3/8" grommet, cases (see Buylines).	

Finally, to use the system to control the noiseless power switch project of the March '81 issue, use one of the latching outputs of the decoder to feed control information only (NOT power) to the noiseless switch.

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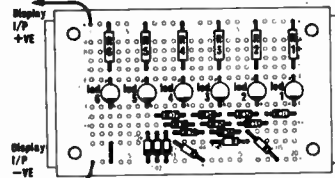
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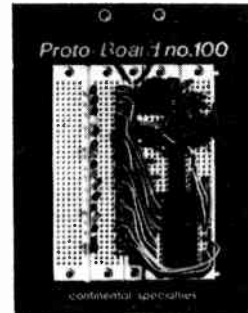
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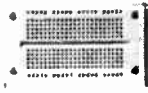
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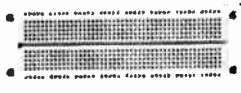
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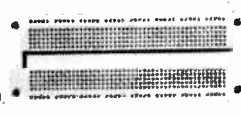
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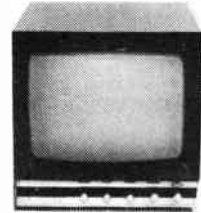
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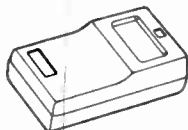
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PROJECT KIT 800104 £26.50

## MUSICAL BOX

This 'electronic musical box' can be used in a variety of applications. These include toys, video games and doorbells. It can be programmed to play no less than 27 tunes. The circuit is based on the AY-3-1350 which offers a considerable improvement over similar devices. The output can be switched from 'piano' to 'organ' like quality. The project includes all the components, case, loudspeaker and full instructions. An easy project for the beginner. An additional amplifier is available if required.

PROJECT KIT 80502K £25-95 (Musical Box)  
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Frequency Range 20-18Hz (+0, -3dB)  
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Output Sensitivity DIN 130mV/79k ohm

Distortion less than 0.2%  
Noise reduction at 100Hz : 15dB  
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The project packs include all the electronic components, self adhesive front panel, prebuilt and tested HIGH COM modules and PCBs. The meter circuit uses an LED bar display and is essential for the operation of the unit.

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## DISCO PROJECTS

### MINIMIXER

This mixer is easy to assemble, most parts are mounted on the single PCB. It incorporates two stereo disc inputs, two microphone inputs and a stereo tape input. Slider controls for level controls, rotary pots for tone controls. Distortion is approx 0.1%, frequency response 20Hz to 25kHz (3dB)

Project Pack 81068 £37-50 Case £7-50

### DISCO LIGHTS

This ceiling lights project controls a matrix of 25 x 100W lamps. A preprogrammed IC switches them in 22 different sequences of patterns. Patterns can be repeated if required. Triac controlled outputs. Lamps not supplied. Mains operation.

Project Pack 81012 £53-95

### SWINGING POSTER

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Project Pack £17-70

## HOW TO ORDER

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# ASTROLOGUE

When it finally gets off the ground, the Space Shuttle may have a solar power system. Ian Graham reports on the latest developments

Crossword  
Competition  
results

**D**espite last minute hitches in the Space Shuttle's first-flight preparations, plans for future flights are well advanced. To help provide power for Space Shuttle flights, Lockheed Missiles & Space Company is building a huge solar array wing for NASA. The wing, which folds up like an accordion, will be used on an early mission to prove that Solar Electric Propulsion (SEP) arrays can generate the enormous power required.

The amount of fuel that can be carried on-board the Shuttle

limits its time in orbit to seven days. The SEP array offers a means of extending the vehicle's orbital period.

The experimental wing is 105 ft long and 13½ ft wide. In space it is unfolded from the cargo bay, and on its first flight it will be unfolded and retracted several times to study its behaviour in space.

## Materially Speaking

The wing is not a rigid structure, but is made from a lightweight, flexible plastic (called kapton) and contains wrap-around-contact cells welded directly to the array blanket. This printed circuit approach has been adopted to eliminate heavy adhesives and allow greater flexibility during handling.

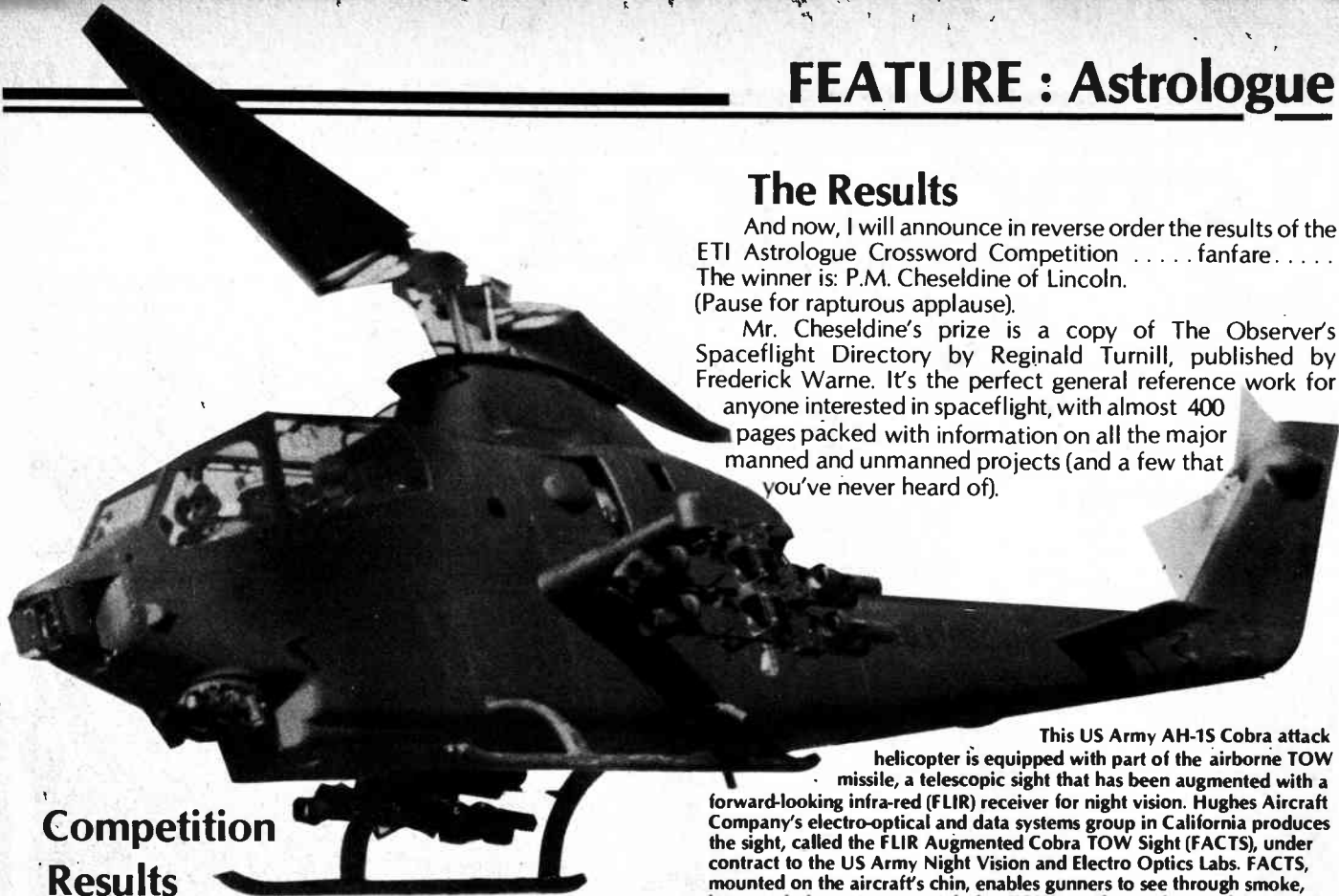
The structure represents an advance in solar power generation. It can produce 66 W per kilogram compared with 20 W per kilogram in present systems. Up to 75 W per kilogram is feasible using the same structural concepts.

Lockheed originally produced this design for use with a space propulsion system incorporating ion engines to power Earth-orbital and planetary missions. The potential fuel economy of ion propulsion is 10 times that of any conventional propulsion system.

## The Results

And now, I will announce in reverse order the results of the ETI Astrologue Crossword Competition . . . . . fanfare . . . . . The winner is: P.M. Cheseldine of Lincoln. (Pause for rapturous applause).

Mr. Cheseldine's prize is a copy of The Observer's Spaceflight Directory by Reginald Turnill, published by Frederick Warne. It's the perfect general reference work for anyone interested in spaceflight, with almost 400 pages packed with information on all the major manned and unmanned projects (and a few that you've never heard of).

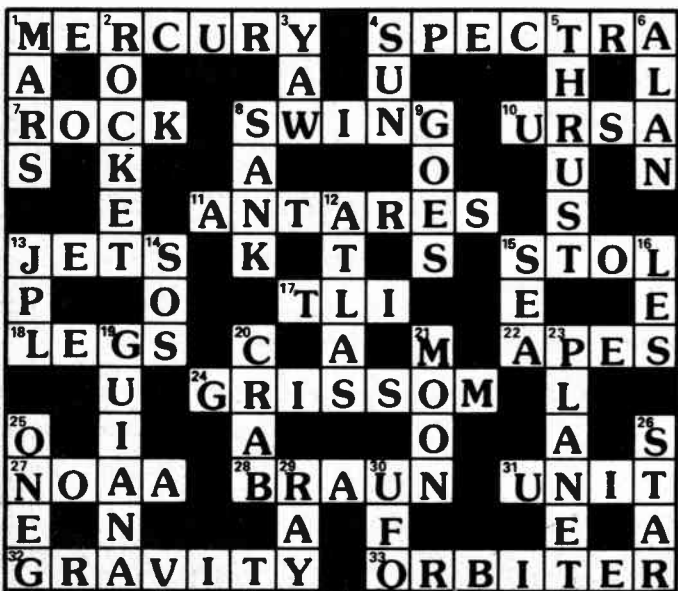


This US Army AH-1S Cobra attack helicopter is equipped with part of the airborne TOW missile, a telescopic sight that has been augmented with a forward-looking infra-red (FLIR) receiver for night vision. Hughes Aircraft Company's electro-optical and data systems group in California produces the sight, called the FLIR Augmented Cobra TOW Sight (FACTS), under contract to the US Army Night Vision and Electro Optics Labs. FACTS, mounted on the aircraft's chin, enables gunners to see through smoke, haze or darkness to accurately fire TOW missiles, rockets and cannon. It makes the helicopter gunship a round-the-clock combat machine.

## Competition Results

January 31st marked the end of the Astrologue Crossword Competition, set in the January issue. Check your answers against the correct solutions shown here. Most of the millions of entries received (a slight exaggeration) were correct. Some found their way to Astrologue from as far away as South Africa and India. However, the business of totting up the numerical value of the solutions sorted out the men from the boys.

If you gave each square of the grid a value and did the arithmetic, you should have arrived at 1522. If you wrote down all the solutions and added up the value of each, you should have had 2169 on the bottom line (as some letters appeared in both across and down positions and were counted twice). Some enterprising readers came up with their own computer programs to take the pain out of the arithmetic. My thanks to Henry Budgett of Computing Today for his assistance in bringing the magic of the silicon chip to bear on the Astrologue Crossword.



## SHORTS

**Representatives of 17 European governments met in Paris** in January to discuss plans for an Operational Meteosat System. It was felt that such a system would be of substantial benefit to Europe and would also be a valuable contribution to the global observation programme of the World Meteorological Organisation. Meteosat 1, launched in November 1977, still collects weather information from land, marine and airborne observation platforms.

**British Aerospace Dynamics Group's Bristol Division** has just taken delivery of a fourth Ferranti Argus 700 computer system, valued at £93,000. This latest addition to British Aerospace's 700 family will be used in the development of real-time software for military applications.

**Galileo, NASA's Jupiter probe** (featured in ETI March '81 Astrologue), will be fitted with a European engine. Messerschmitt-Bolkow-Blohn are to build the engine, which will consist of one main thrust chamber and 10 small attitude control thrusters.

**The Space Shuttle launch** has been put back to some time in April, because of a fault found in the thermal insulation of the External Tank. When the tank was fuelled, some of the insulation separated from the contracting tank. Martin-Marietta engineers will have to make repairs in situ.

**One of Jimmy Carter's last acts** before packing up his knick-knacks was to propose a 1982 NASA budget of \$6.72 billion, more than a 20% increase over this year's budget. The Space Shuttle gains by the increase — its funding goes up from £1.94 billion to £2.23 billion.

ETI



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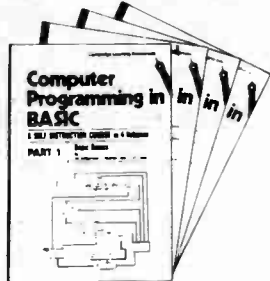
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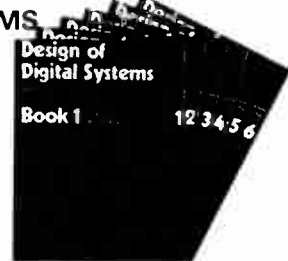
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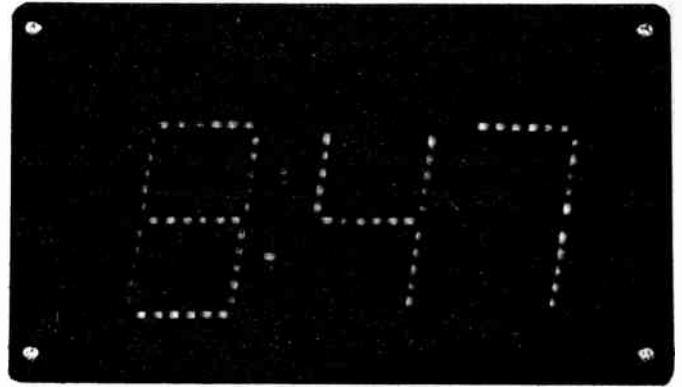
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# DIGITAL CLOCK

Here's the ideal thing for the kitchen, workshop, garage or shed — in fact, anywhere you need a digital clock that just can't be missed! Design by Barry Wilkinson.



Isn't it what you've always wanted — a digital clock with a decent sized display? Seeing the time at a glance is convenient in many situations and that's precisely what this clock has been designed for. The display features three seven-segment digits for the 'minutes units', 'minutes tens' and 'hours units' plus a single column '1' for the hours tens' displays. Each segment in the individual display is made up of a string of LEDs connected in series. Each vertical segment contains five individual LEDs, while each horizontal segment contains six. Overall height of the display is around 60 mm.

We used rectangular LEDs as they provided by far the best looking display compared to the more familiar round LEDs. A 'flashing colon' between the hours and minutes digits is provided to reassure you that the clock is going! However, as a binary divider clocking from the mains is used to drive the clock, a 1 S output is unfortunately not available and so the next best output was chosen. This proved to be a division of 32 and thus, from 50 Hz, a pulse is obtained every 1.56 S — this is used to flash the colon.

## Design

There are a number of interesting aspects to the design of this digital clock. For a start, conventional CMOS binary dividers have been used in preference to one of the special clock divider chips. The latter are very handy, no doubt about that, but they are incapable of driving a large sized display like the one used here. The voltage drop across each segment of the multi-LED display varies depending on the type and colour of LED used. Whilst we have used red LEDs, which have a voltage drop of around 1V6 each, green or yellow LEDs may be used and these have around a 2V1 drop each; some of the new 'high efficiency' LEDs also exhibit a 2V1 drop. This means that for a horizontal segment in our display, the maximum voltage drop may be as high as 12V6 (six LEDs times 2V1). The clock chips available cannot readily cope with this but CMOS decoders can be arranged to do what we want.

You will notice from the circuit that the LED segments are driven by 4511 CMOS decoders which provide up to 25 mA per segment, with the actual current being determined by current limiting resistors. The current per segment in our circuit is limited to around 20 mA. However, the maximum voltage across CMOS is limited to 15 V and a supply of around 18 V was necessary to allow for the drop across the display segment plus the drop across the limiting resistor and the 1V5 lost in the 4511 output circuit. To overcome this difficulty, we stabilised the negative supply rail for the CMOS to 12 V and the negative side of all the display segments is taken to the *unregulated* negative

supply. The zener action of the LEDs (ie, there is no current flow below about 1V4 per LED) ensures that the outputs of the 4511 are never 'pulled' below their negative supply rail.

## Construction

We found it necessary to use a double-sided printed circuit board for this project to avoid a large, cumbersome board which we feel sure you'd agree would be rather unattractive.

The board used in our prototype did not use plated-through holes as it is not really necessary. However, there are many fine tracks on the board and we recommend you use a soldering iron with a small tip. When soldering tracks on the top side of the board where a component lead connects to a corresponding track on the underside of the board, always ensure that you heat the joint sufficiently to get a good flow of solder and avoid a dry joint.

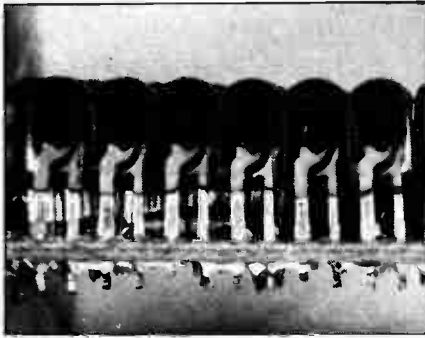
To commence assembly, first check that the three mounting holes around the board perimeter and the two holes for the time setting push button switches are the correct diameter. It's awfully hard to drill the board after the other components are mounted.

Commence assembly by soldering in all the resistors, capacitors and diodes and the two transistors. You could leave C1, which mounts on the rear side of the board, until all the other components are assembled if you wish. Take care with the orientation of the diodes, paying particular attention to the component overlay. Note that different value current-limiting resistors are required, according to the type (and thus the voltage drop) of LEDs chosen. Refer to Table 1 for the appropriate values.

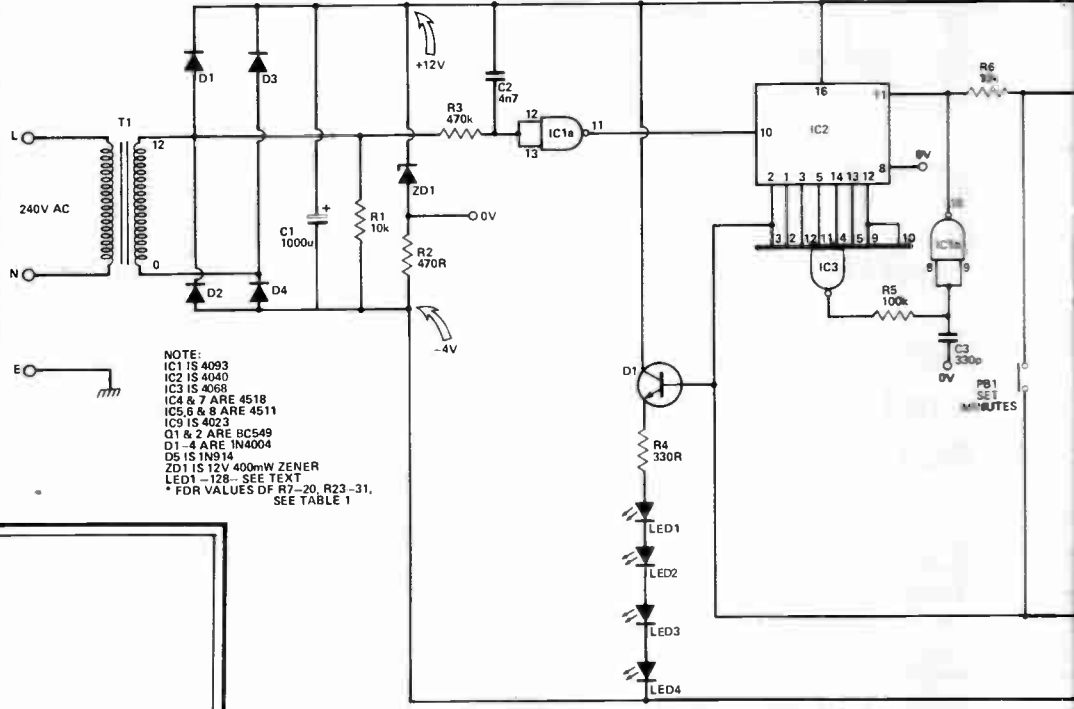
Resistor	1V6 LEDs	2V1 LEDs
R7, 10, 13, 14, 17	180R	150R
R20, 23, 26, 29	180R	150R
R8, 9, 11, 12, 15, 16	270R	180R
R18, 19, 24, 25, 27, 28	270R	180R
R30, 31	270R	180R

Table 1. Value of current limiting resistors for the LEDs.

As CMOS ICs are used, take care when inserting them that you handle the devices with due care. Carefully remove them from their packaging, taking care not to handle the pins — pick them up with your thumb and forefinger grasping the ends of the package, not the pins. Make sure you have them correctly.



Above: The LEDs are mounted by butting the 'shoulders' on the leads against the PCB.  
Fig.1 (Right) Circuit diagram of the Digital Clock.



NOTE:  
IC1 IS 4093  
IC2 IS 4040  
IC3 IS 4068  
IC4 & 7 ARE 4518  
IC5, 6 & 8 ARE 4511  
IC9 IS 4023  
Q1 & 2 ARE BC549  
D1-4 ARE 1N4004  
D5 IS 1N914  
ZD1 IS 12V 400mW ZENER  
LED1-128 - SEE TEXT  
\* PDR VALUES DF R7-20, R23-31,  
SEE TABLE 1

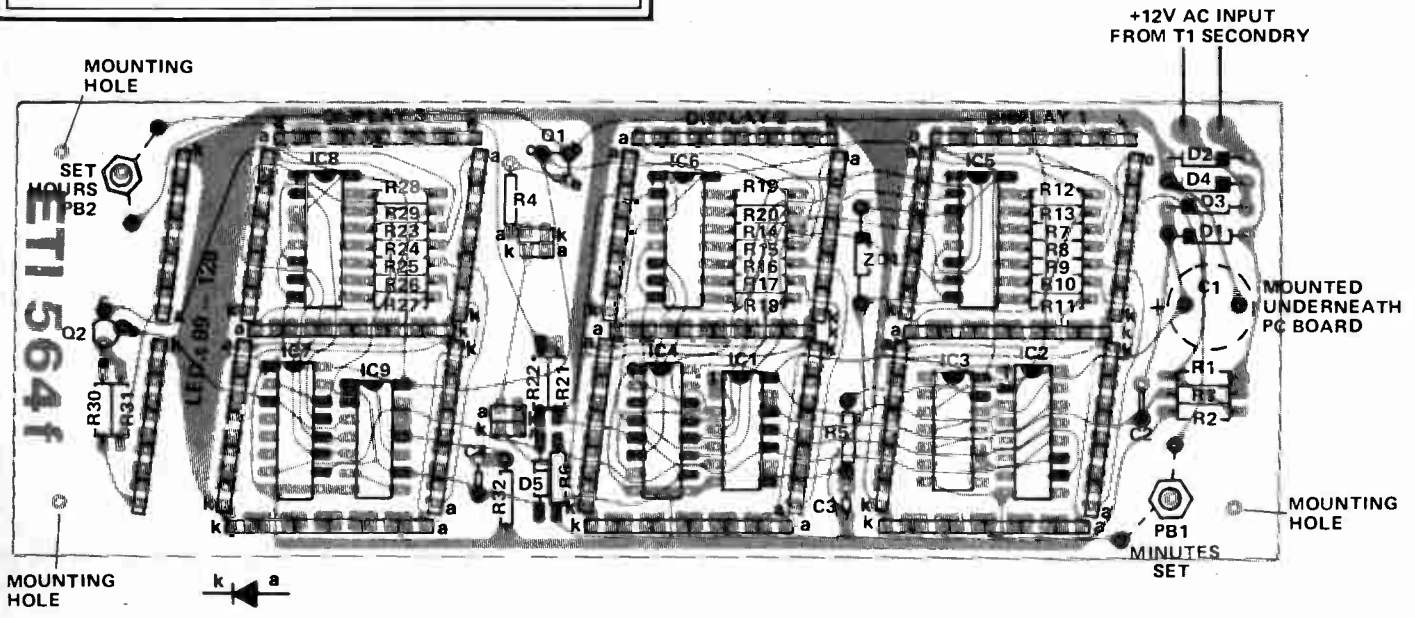
### PARTS LIST

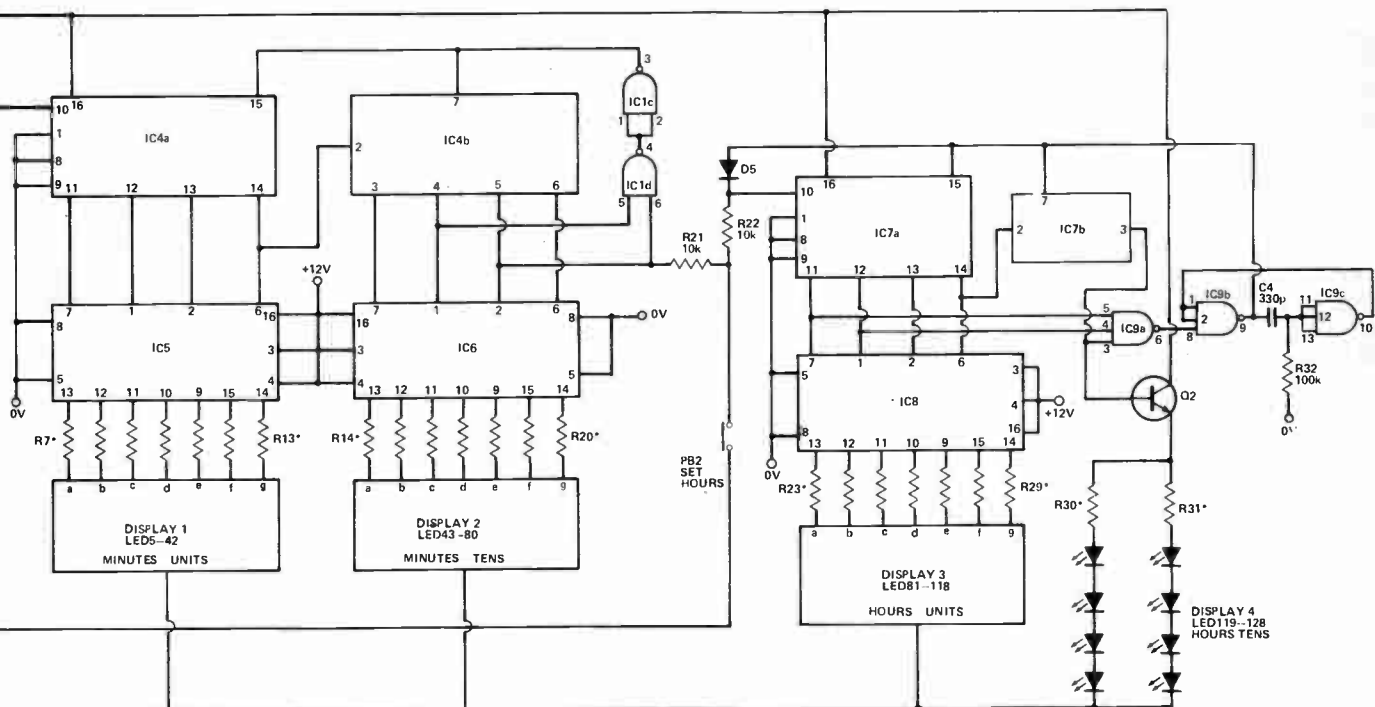
<b>Resistors (all 1/4 W, 5%)</b>	
R1,6,21,22	10k
R2	470R
R3	470k
R4	330R
R5,32	100k
R7-20	see Table 1
R23-31	see Table 1
<b>Capacitors</b>	
C1	1000u 25 V electrolytic, PCB-mounting
C2	4n7 polyester
C3,4	330p ceramic
<b>Semiconductors</b>	
IC1	4093B
IC2	4040B
IC3	4068B
IC4,7	4518B
IC5,6,8	4511B
IC9	4023B
Q1,2	BC549
D1-4	1N4004
D5	1N914
ZD1	12 V, 400 mW
LED1-128	rectangular LEDs (see text)
<b>Miscellaneous</b>	
PB1,2	push-button switches, non-latching
Transformer (12 V @ 1 A), sheet of plastic, case etc.	

The power supply is simply a transformer with a 12 V secondary, whose output is full wave rectified by D1-4 and filtered by C1. The IC supply is stabilised by ZD1 to 12 V DC. The AC voltage is also coupled to the input of IC1a by R3 to provide a 50 Hz clock frequency. R3 protects IC1a against input damage as the AC voltage exceeds the supply rail of the ICs. C2 acts as a filter to prevent false counting, and IC1 has Schmitt trigger inputs which also help to prevent false triggering. The output of IC1a is a clean 50 Hz square wave.

To derive the 'minutes' output the mains frequency must be divided by 3000: this is done by IC2, a 12-stage binary counter. The total division ratio of this IC is 1:4096, so the outputs of the 4th, 5th, 6th, 8th, 9th, 10th and 12th stages are decoded (when all are high), taking the output of IC3 low on the count of 3000 (binary 101110111000). After a short delay (about 30 uS) due to R5/C3, the output of IC1b goes high, resetting IC2. This immediately causes the output of IC3 to return high

Fig.2 The overlay as seen from the component side. Note that this is a double-sided board.





## HOW IT WORKS

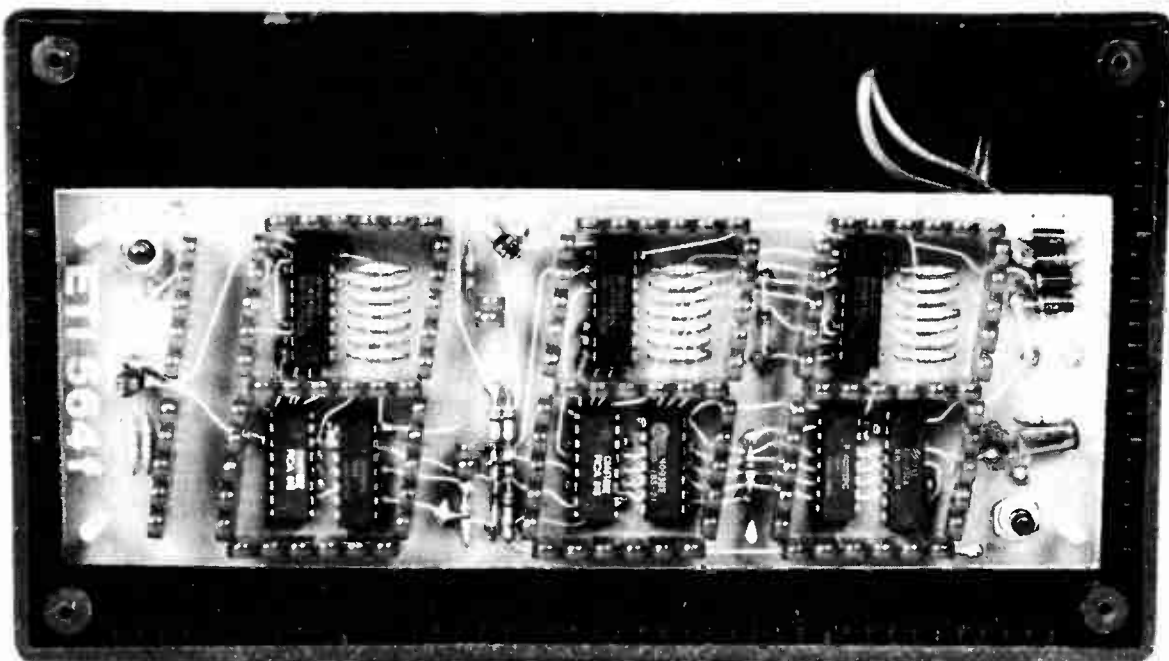
but, again due to R5/C3, the output of IC1b will remain high for about 20  $\mu$ s, ensuring correct resetting and the clocking of the minutes counter.

One of the outputs of IC2 (pin 2) is used to drive the colon and to provide the clock pulses for the 'fast set' modes. Using a binary divider means that a 1 Hz pulse is not available, so we chose the 1.56 S output (50/32).

The output of IC1b (a 20  $\mu$ s pulse once per minute) is used to clock IC4a, one half of a dual decade counter. The outputs of IC4a are decoded by IC5, which drives the 'minutes units' display. The 'divided-by-10' output of IC4a clocks IC4b, whose outputs are decoded by IC6 to display the 'tens of minutes'. As time has yet to be decimalised (!), IC4b is set to divide by six. This is done by IC1d which detects when the 2nd and 3rd outputs are high (binary 0110) and provides the reset pulse via IC1c.

The third output of IC4 is used to clock the hours counter, IC7. This, like IC4, is a dual decade counter with the first half being decoded by IC8 and the second being clocked by the output of the first. As only a simple '1' is needed for the tens of hours (12 hour clock) no decoder is necessary, only a buffering transistor. IC9a detects when IC7 reaches decimal 13 (0001 0011 binary) and triggers a monostable formed by IC9b and IC9c. This is used to reset IC7 to zero hours but as there is no zero hour in the 12 hour system we need to reset to a '1'. This is done by D5, which pulls pin 10 of IC7 high for the duration of the reset pulse and allows it to fall back again a few microseconds after the end of reset pulse, (the delay being due to stray capacitance). This causes IC7 to clock on to '1'.

Fast setting is done simply by injecting the 1.5 S pulse directly into the minutes or hours counters, using the push buttons.



oriented before inserting them in the board. Also ensure that you put each IC in its correct place and on the correct side of the board too! Sockets cannot be used for the ICs as many of the pins are soldered on both sides of the board.

## LED Astray

The rectangular LEDs specified measure 2.5 mm wide by 5 mm long. If you elect to use conventional round LEDs, the miniature 3-4 mm diameter types should be used. Many of the larger sized round LEDs will not fit this PCB as they have a shoulder around the base of the unit that measures 6 mm in diameter, preventing the close packing possible with the other types.

The LEDs we used have a shoulder or 'step' in their leads a few millimetres from the base. We pushed the LEDs down onto the PCB until this shoulder stopped them going any further. The outside lead of each segment array was soldered and then each group checked for alignment before soldering the other leads. Once you have the LEDs mounted and soldered in place, the two push button switches may be mounted.

At this stage, if you are satisfied everything has been mounted correctly, the board may be tested — *but give it another thorough check first!* In particular, look for solder 'bridges' between IC pins or across closely-spaced tracks as well as possible dry joints.

Simply apply 12 V AC to the two pins marked on the board overlay and see that the clock operates as it should. Try the 'hours set' and 'minutes set' buttons to see that they have the required effect. If all is not well, switch off and re-check the component placement and orientation, check for dry joints, etc.

Now the clock may be finally assembled. An earth lug should be mounted under one of the transformer mounting bolts and the mains cable earth soldered to it. The PCB should be mounted behind a sheet of red plastic (if you're using red LEDs) to improve the contrast of the display and hide the other components. It will be necessary to drill two small holes in the plastic opposite the time-set buttons — a match can then be inserted to depress the buttons. If you prefer, you can mount the switches off-board and fit them in a convenient position on the case. Make sure the case has adequate ventilation, as the clock dissipates some 10 W. Once the clock is complete, all that remains is to plug in and set the time.

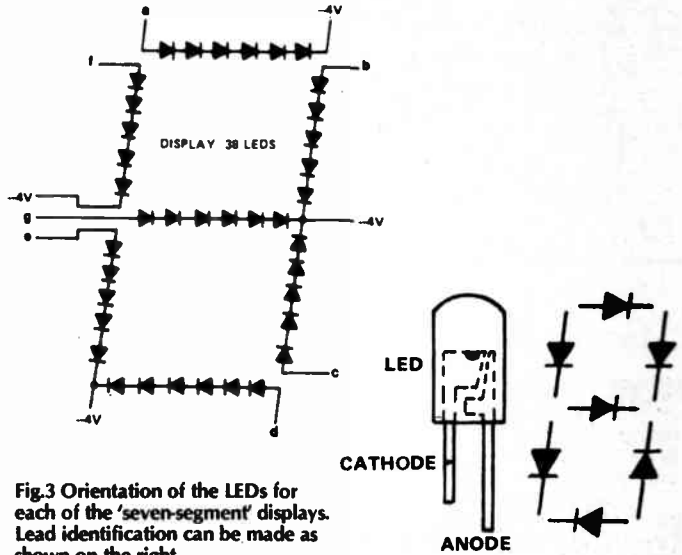


Fig.3 Orientation of the LEDs for each of the 'seven-segment' displays. Lead identification can be made as shown on the right.

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## Setting the time

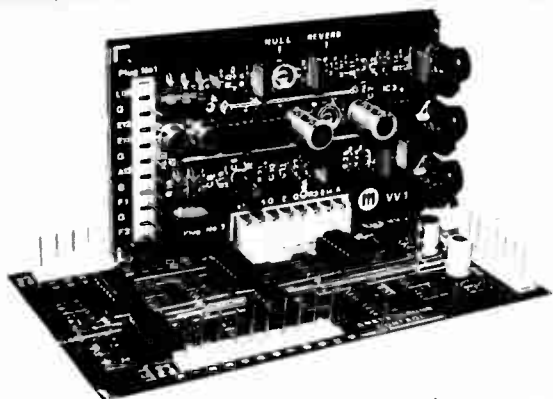
1. Switch on.
2. Press the minutes button until the minutes display is correct. To prevent multiple pulsing due to contact bounce, the button should be pressed and released when the colon is off.
3. Set the hours in a similar manner to the minutes. If the minutes display is less than 40, again operate the button when the colon is off. If the minutes display is 40 or more, operate the button when the colon is on.
4. An easy way to set the clock to the exact time is to first set it some 20 - 30 S fast by the push buttons, then compare it to a known time standard (you might use a radio time signal for this). Turn off the power for the exact time difference and the clock will cease counting. The large filter capacitor will hold its charge long enough to store the last time, for up to a few minutes, until power is returned. When the time signal equals the clock display, turn the power back on.

## BUYLINES

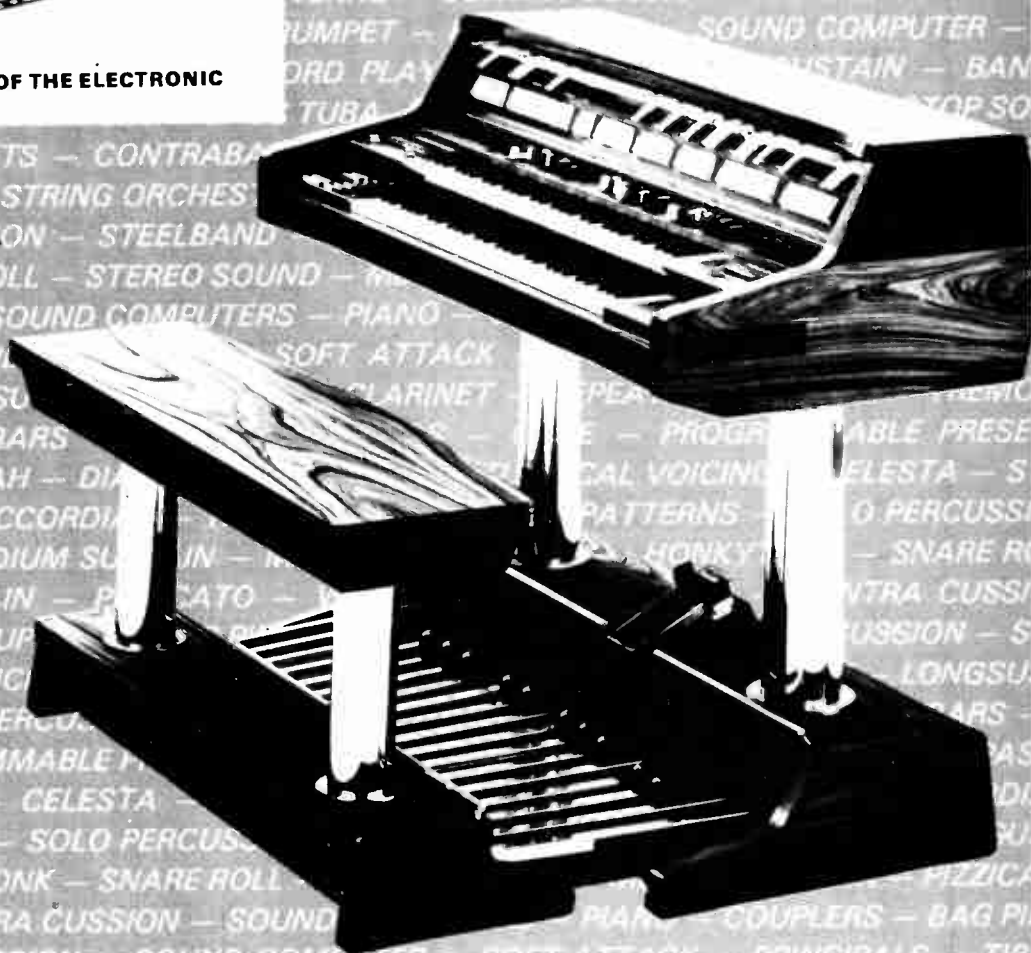
There should be no problem obtaining any of the components for this project as nothing is out of the ordinary. Although you can expect to pay nearly £30 for the LEDs alone, it should be borne in mind that the nearest commercial equivalent to this clock costs over £100.

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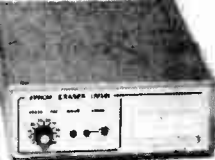
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## 74C

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## 74LS

74LS00 14p	74LS08 14p	74LS13 14p	74LS16 14p	74LS20 14p	74LS22 14p	74LS24 14p	74LS25 14p	74LS27 14p	74LS28 14p	74LS29 14p	74LS30 14p	74LS32 14p	74LS34 14p	74LS35 14p	74LS36 14p	74LS37 14p	74LS38 14p	74LS39 14p	74LS40 14p	74LS41 14p	74LS42 14p	74LS43 14p	74LS44 14p	74LS45 14p	74LS46 14p	74LS47 14p	74LS48 14p	74LS49 14p	74LS50 14p	74LS51 14p	74LS52 14p	74LS53 14p	74LS54 14p	74LS55 14p	74LS56 14p	74LS57 14p	74LS58 14p	74LS59 14p	74LS60 14p	74LS61 14p	74LS62 14p	74LS63 14p	74LS64 14p	74LS65 14p	74LS66 14p	74LS67 14p	74LS68 14p	74LS69 14p	74LS70 14p	74LS71 14p	74LS72 14p	74LS73 14p	74LS74 14p	74LS75 14p	74LS76 14p	74LS77 14p	74LS78 14p	74LS79 14p	74LS80 14p	74LS81 14p	74LS82 14p	74LS83 14p	74LS84 14p	74LS85 14p	74LS86 14p	74LS87 14p	74LS88 14p	74LS89 14p	74LS90 14p	74LS91 14p	74LS92 14p	74LS93 14p	74LS94 14p	74LS95 14p	74LS96 14p	74LS97 14p	74LS98 14p	74LS99 14p	74LS100 14p
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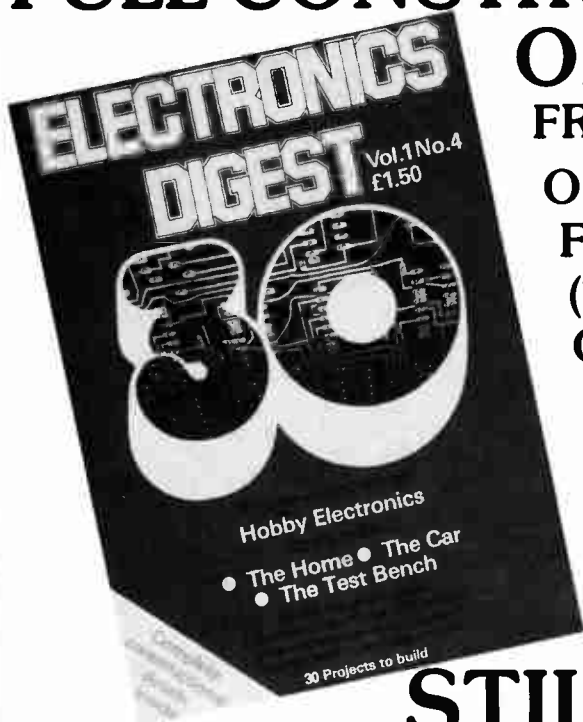
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# MICROBASICS

This month Microbasics returns to the hardware. Henry Budgett takes a look at the 6500 family in general, and the 6502 in particular.

The hardware side of Microbasics is returning briefly this month for a close look at just one chip, the 6502 CPU. Although this device has hogged the limelight owing to its starring roles in such machines as the PET, Apple, Microtan and ATOM it is far more than just a one-off. Part of a complete family of devices, the 6500 series, it represents the public face of the design architecture. Why look at it in detail? Well, in the near future you are going to see one of its brethren in a major new role, but more of that in a month or two.

## Family Characteristics

Figure 1 and Table 1 give the details of the whole range; there is a new device promised but I don't have details yet. Although I'm going to concentrate on the 6502, most of the information is directly relevant to the others in the family.

Physically it is supplied as a standard 40 pin DIP which needs a single 5 V supply and a clock generator. Internally the device operates on a two phase clock but this is generated from

Features	R6503, R6513	R6504, R6514	R6505, R6515	R6506	R6507
Addressing Capability	4096 Bytes (AB00-AB11)	8192 Bytes (AB00-AB12)	4096 Bytes (AB00-AB11)	8192 Bytes (AB00-AB11)	8192 Bytes (AB00-AB12)
Interrupt Request Capability	IRQ, NMI	IRQ	IRQ	IRQ	—
"Ready" Signal	—	—	RDY	—	RDY
*Timing Signals Required	Single Phase TTL Level $\phi 0$ (IN) or Crystal or RC	Single Phase TTL Level $\phi 0$ (IN) or Crystal or RC	Single Phase TTL Level $\phi 0$ (IN) or Crystal or RC	Single Phase TTL Level $\phi 0$ (IN) or Crystal or RC	Single Phase TTL Level $\phi 0$ (IN) or Crystal or RC
Other Control Signals	RES, R/W	RES, R/W	RES, R/W	$\phi 1$ (OUT), RES, R/W	RES, R/W

\*6513, 6514 and 6515 are slave microprocessors requiring external  $\phi 1$  and  $\phi 2$  clock inputs

Table 1. Details of each of the CPUs.

a single input which should be crystal controlled. The CPU actually sends the second clock phase back out again for synchronisation purposes and this appears on pin 39.

The size of the internal data bus and its associated registers is eight bits — hence the term 'eight bit micro'. These registers and the rest of the internal workings are shown in Fig. 2. It should

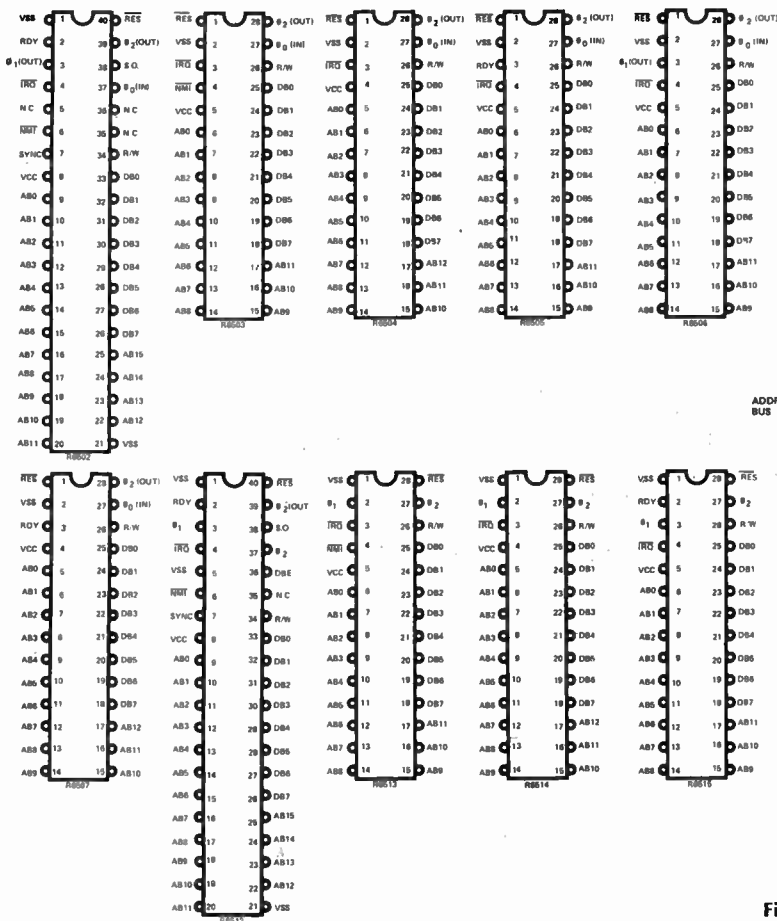
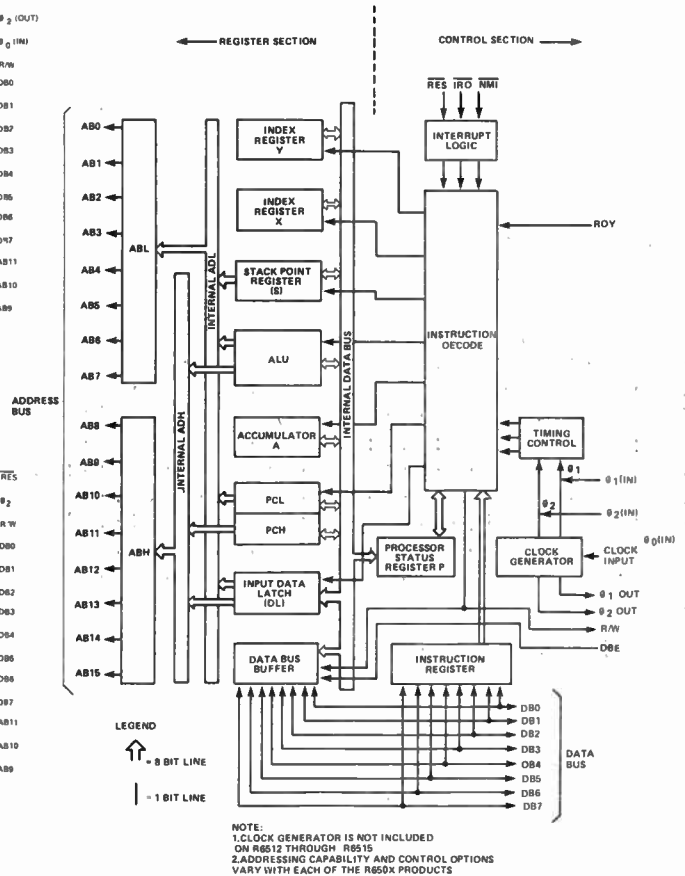


Fig.1 Pin designations for all the CPUs in the 6500 family.



NOTE:  
1. CLOCK GENERATOR IS NOT INCLUDED ON R6512 THROUGH R6515  
2. ADDRESSING CAPABILITY AND CONTROL OPTIONS VARY WITH EACH OF THE R650X PRODUCTS

Fig.2 Block diagram of a 6500-series CPU. The registers are all eight bits wide except the program counter; this consists of a high and low byte (PCH and PCL).



be noted that this block diagram is for the generalised 6500 device and not the 6502 specifically but the differences are slight. Although the data bus is only eight bits wide the address bus is a full 16 bits across which gives access to 65,536 possible memory locations. Some of the other members of the family, notably those with only 28 pins, have a more limited addressing capability. Table 1 has the details.

## Pin By Pin

In order to take a close look at the functioning of the device I'll go through it pin by pin. Where to start? Being logical (?) let's begin with the data bus. This occupies eight pins, 26 to 33 (DB7 to DB0) and is a true tri-state, bi-directional highway. What's actually on it at any given instant is controlled by the pins R/W (34) and RDY (2). The functions of these will be explained later.

The address bus is found on pins 9 to 25 (AB0 to AB15). This is a unidirectional bus, you can't 'read' an address. The addressing capabilities of these 16 lines are shown in Fig. 3, obviously those 6500 series devices with fewer address lines can only access a part of this range. An address is set onto the lines during the  $\emptyset 1$  clock pulse and is stated as being 'valid', jargon for being stable and OK, some 300 nS after  $\emptyset 1$  goes high (given a 1 MHz clock). The address remains stable on the bus until the next  $\emptyset 1$  clock pulse.

BINARY ADDRESS		DECIMAL NUMBER	HEXADECEMAL Address Code	ADDRESSABLE MEMORY FIELD
High-Order	Low-Order			
15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0	
0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	
0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 1	
0 0 0 0	0 0 0 0	1 1 1 1	1 1 1 1	
0 0 0 0	0 0 0 1	0 0 0 0	0 0 0 0	
1 1 1 1	1 1 1 0	1 1 1 1	1 1 1 1	
1 1 1 1	1 1 1 1	0 0 0 0	0 0 0 0	
1 1 1 1	1 1 1 1	0 0 0 0	0 0 0 1	
1 1 1 1	1 1 1 1	1 1 1 1	1 1 1 1	
				Page Number    Byte Number 0                00 — 00 1                00 — 01 255              00 — FF 256              01 — 00 65279            FE — FF 65280            FF — 00 65281            FF — 01 65535            FF — FF

Fig.3 The addressing range of the 6500-series. Only part of this range can be covered by some of the CPUs.

## Of Reading And Writing

The R/W pin (34) controls the direction in which information travels on the data bus. The line is normally high (READ mode), unless the processor wishes to send something to memory or the outside world (WRITE mode) in which case it is forced low. All transitions (changes of state) occur during the  $\emptyset 1$  period which allows data to be transferred during the  $\emptyset 2$  clock period. The second major control line for the buses is the Ready (RDY) line found on pin 2. This is normally high but when pulled low, during  $\emptyset 1$ , it effectively shuts the CPU down — provided the current operation is not a WRITE. This allows slow memory devices such as EPROMs to be catered for and, more importantly, operations such as DMA, Direct Memory Access, to occur.

## Interruptions

The 6502 supports two types of interrupt, Non Maskable and 'normal'. The Non Maskable Interrupt (NMI) is a control input found on pin 6 and this should normally be held high. The processor must break off from whatever process it is currently performing (it performs essential 'housekeeping' first) when this line goes low. Being an edge triggered control the line can stay low indefinitely without causing further interrupts, to issue another it must first be taken high and then low again. When an NMI occurs the current status of the program counter and the status word are saved on the stack and the program counter is then loaded with the interrupt vector, in the case of the 6502 this

is FFFA and FFFB. The contents of this memory pair contain a further address which is the start of the interrupt service routine.

The case of the other interrupt is rather more complicated in that it can be turned off if you want by manipulating a bit in the status register. The physical manifestation (classy eh?) of this control is a pin labelled IRQ (4) which is normally held high. When pulled low by a peripheral device it signals an interrupt to the processor. If the interrupts are enabled then a similar action to that of the NMI is performed. It should be noted that the IRQ line is not edge triggered so as long as the line is low the CPU will try to service interrupts.

The ultimate interrupt to any CPU is the RESET ( $\overline{RES}$ ) signal which is found on pin 40. During power-up this line should be held low until conditions have stabilised and then taken high. In practice a simple RC combination will suffice. When the line goes high it causes the processor to fetch a new 'vector' from a specific address, this loads the program counter to a known starting point in the user program. In this way the machine powers up with all the functions set correctly; the line should also be fed out to all the support chips to ensure that they too turn on correctly.

Alone in the 6500 series the 6502 possesses a control line called SYNC which is found on pin 7. This is used to identify the specific cycle taking place within the CPU, (it approximates to the M1 signal in the 8080). The line goes high during  $\emptyset 1$  of an OP-CODE FETCH and is used to tell the outside world to mind its own business for a while. If the RDY control is taken low during the same  $\emptyset 1$  cycle as the SYNC goes high it stops the processor in its current state. This allows single instructions to be executed if handled correctly.

There is one further control line called SO which appears on pin 38. It is not used — except with a specialised I/O port — so you can ignore it.

## Registered Design

So much for the outside, what goes on inside that hunk of black plastic? The block diagram of Fig. 2 shows the registers; the only ones of interest from our point of view are the stack pointer, the program counter and the status word. Although the address range of the 6502 requires a full 16 bit bus the stack pointer only contains eight bits. These eight bits act as the lower half of an address, the top half being set at 01 Hex. The 6502 stack is an area of memory that resides in Page 1 (hence the 01 Hex top half), which is used by the CPU and the user programs as a temporary storage area.

A Program Counter consists of a 16 bit register which contains the address of the next instruction to be executed, or rather it contains the address of the next memory location which will be accessed.

The status word is important to both the hardware and software engineer. Eight bits wide, it contains seven flags which indicate the current status of sections of the hardware within the CPU. Bit 0 indicates the carry status; it gets set if the result of a calculation in the Accumulator exceeds 255, and is effectively a ninth bit in the Accumulator. Bits 1,3,6 and 7 are concerned with the programming aspects of the device and Bit 5 is not used. This leaves Bit 2 which is the Interrupt Disable flag that I mentioned earlier, and Bit 4 which indicates that a BREAK instruction has been found.

## Programming The Beast

As this is mainly a hardware orientated article I'm not going to say anything about the actual programming of the 6502; only that ETI has a major new project planned which involves the 6500 series and will answer all your questions. I can't go into any greater detail at present, but in a month or two all will be revealed.

ETI

# computing today

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## LIVING IN BABEL?

With the ever increasing family of computer languages to contend with we decided to start taking a look at some of the most important ones for the micro user. Just what they do and why one does it better than another are the sort of questions we'll be trying to answer over the next few issues. We start with COMAL, the newest recruit onto the micro scene.

## BINDING IT TOGETHER

Many computers seem to lack sufficient documentation and, unfortunately, the ZX80 is no exception. A veritable library seems to have sprung up around it and we take a look at some of the best, and worst, on offer.

## CONQUERING EVEREST FOR FUN

Computer games often take real-life events and mimic them in miniature. This example is more than just a game, it's a complete simulation of an attempt to climb Everest, down to the last oxygen cylinder and footsore Sherpa. Can you plan far enough ahead to cope with sudden changes in the weather or will you risk all in a quick dash for the summit? It calls for strong nerves and a clear mind but will fit into just 8K of RAM, how's that for good planning?



## GETTING OUT AND ABOUT

So you want more I/O than your computer is provided with? Well, you might actually have more than you thought in the first place. We show you how to increase the power of your PIO in easy practical steps. Any computer with a parallel port qualifies for this improvement.

## A LITTLE BIT OF MAGIC

Following in the footsteps of the successful TRS-80 came the Video Genie system. Now, however, it may well have taken a step or two ahead of its American cousin by going all multicoloured. We sent in our expert to have a look and his report on this low-cost colour graphics machine makes very interesting reading for anyone thinking of taking the Eastern path to computerisation.

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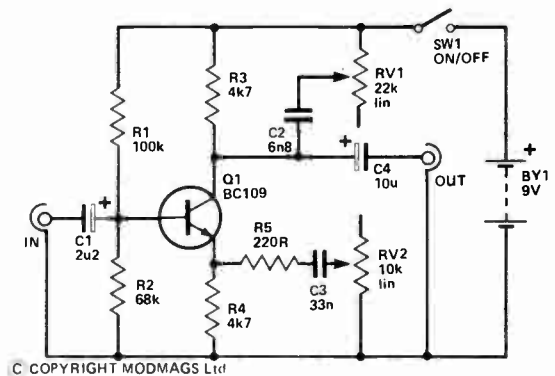
# SPOT DESIGNS

## Guitar Treble Booster

This simple treble booster circuit can be used to give a more brilliant sound to an electric guitar and could possibly be of use with other instruments. Q1 is connected as a straightforward common emitter amplifier with R3 as the collector load, R4 as the emitter bias resistor and R1 plus R2 to provide base biasing. Although the voltage gain provided by a common emitter stage is normally quite high, this is not the case here, since the emitter bias resistor is not bypassed by a capacitor. As R3 and R4 have the same value, the voltage gain of the circuit is approximately unity.

In fact there is an emitter bypass capacitor (C3), but this has a low value and is in series with R5 and RV2. With RV2 at maximum resistance the effect of C3 on the response of the unit is minimal and for practical purposes the degree of treble boost applied is of no significance. If RV2 is adjusted for lower resistance, C3 has more effect and begins to produce a significant amount of treble boost. The boost is only produced at higher frequencies incidentally, due to the low value of C3 and its consequent high impedance ineffectiveness at low frequencies. With RV2 at minimum resistance the response starts to rise at about 800 Hz and reaches a maximum degree of boost of about 26 dB at frequencies of around 10 kHz or more. R5 limits the degree of high frequency boost and this is necessary in the interest of low noise and good stability.

The full degree of boost at the highest audio frequencies may give a sound that is too harsh for some tastes and so RV1 and C2 have



been included in the circuit. With RV1 at maximum resistance these do not have any significant effect on the unit, but at lower resistance settings the high frequency response becomes flattened off and towards minimum resistance the response turns over at frequencies above about 8 kHz. RV1 and RV2, therefore, give considerable control over the treble boost and enable the response to be tailored to suit individual tastes.

## Simple MW Radio

This simple medium wave broadcast receiver has an output power of up to about 150 mW RMS for an internal high impedance loudspeaker and is based on two ICs. The familiar ZN414 is used to provide the RF amplifier, detector and AGC functions, while a ULN2283B device is used as the audio power amplifier.

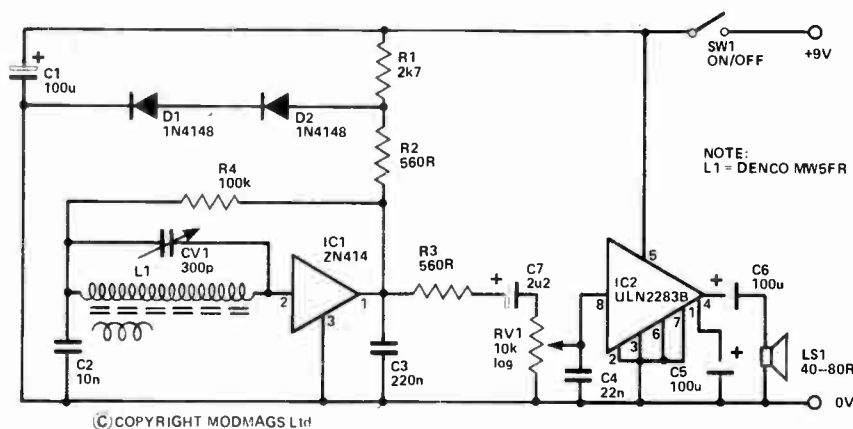
The circuitry around IC1 is quite straightforward with D1, D2 and R1 being used as a shunt stabiliser, which gives the required operating voltage of 1V2 to 1V3 for IC1. CV1 is the tuning control and L1 is the tuned winding of the ferrite aerial. The ZN414 has a high input impedance which renders the low impedance coupling winding on the ferrite aerial unnecessary. This can either be ignored or it can be carefully removed from the aerial, if preferred.

RF filtering at the output of IC1 is provided by C3, R3 and C4. Effective RF filtering is essential as a small amount of RF leakage into the

input of audio amplifier IC2 would almost certainly be sufficient to cause severe instability in the circuit as a whole. RV1 is the volume control and is also used to bias the input of IC2. C5 decouples the supply to the input stages of IC2 and helps to prevent low frequency instability due to feedback through the supply lines. C6 couples the output of IC2 to the loudspeaker.

IC1 receives an audio output signal of 25-30 mV RMS on reasonably strong signals. The voltage gain of IC2 is set at a nominal figure of 43 dB (about 140 times) by an internal negative feedback circuit and this is, therefore, well matched to the signal level provided by IC1.

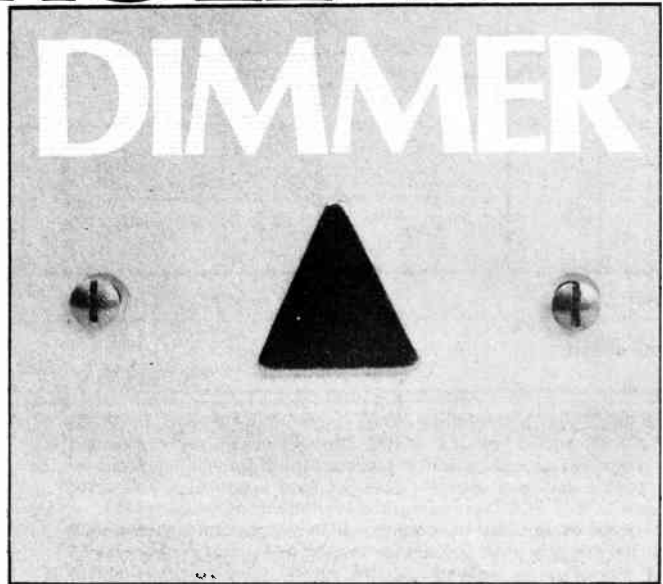
The quiescent current consumption of the circuit is typically about 15 mA, but as IC2 has a class AB output stage, the current consumption rises somewhat (to a maximum average level of about 25 mA) at higher volume settings. The ULN2283B device used in the IC2 position is available from Ambit International.





# REMOTE- CONTROLLED TOUCH DIMMER

**This smart lamp dimmer can be controlled directly by the built-in touch pad or remotely with the five-channel transmitter unit described elsewhere in this issue. Design by Ray Marston. Development by Plamen Pazov.**



**T**his sophisticated little touch dimmer is an updated version of the programmable touch dimmer described in the April '80 issue of ETI, in that this new unit can be controlled either directly by a touch pad fitted to the unit or remotely with a press button on the transmitter of the five channel remote control system described elsewhere in this issue; the new dimmer can thus be remote-controlled from the comfort of an armchair, etc. The 'five channel' system can, in fact, independently control two of these dimmer units. Each dimmer can power any lamp load up to 300 W.

The dimmer is 'smart' in that it has built-in logic and sensing networks that enable the unit to be turned on or off or dimmed up or down by using a single touch pad or remote-control button. If the pad (or switch) is simply touched for a brief period (60 to 400 mS) the lamp merely changes state, ie, from off to on, or vice versa, depending on the previous state.

A longer touch (greater than 400 mS) causes the lamp brilliance to cycle slowly from dim to bright or vice versa for the duration of the touch, taking about 7 S to span the full brilliance range: when the touch is removed the prevailing brilliance level is latched into memory and maintained indefinitely. At switch-off (a brief touch) the prevailing brightness level remains in store and is automatically resumed again at switch-on (another brief touch). In the case of dimming, control starts from the stored value.

## Remote Control

The dimmer can be controlled locally by the touch pad or remotely using the infra-red remote controller. In either case, the dimmer works in the OR mode, so that alternate operation is directly available. The remote control system has a maximum range (from transmitter to receiver) of about 10 m; the remote control facility can be implemented by a pair of wires taken to the dimmer from one of the decoder outputs of the remote control system. These wires pass only a few milliamps from a 12 V

source and can easily be concealed in a slot made in the wall plaster. The wires connect to an opto-isolator built into the dimmer unit and this isolator ensure that the wires have several kilovolts of mains isolation, thereby ensuring a very high safety factor.

## Construction

Our prototype is designed to fit into a standard plaster-depth lighting switch box. Before starting construction, check the project's suitability to your existing wiring by making an accurate cardboard cut-out of the PCB and checking that it will fit comfortably into your existing lighting switch box. If not, you'll need to fit a new (modern) box. If all is well you can proceed with the construction.

Construction calls for a certain amount of care. Note that the S556B IC is a special-purpose touch dimmer device manufactured by Siemens and must not be confused with the similarly numbered NE566N VCO IC. On our prototype we've mounted the S566B and the 6 pin opto-isolator IC in a single 16 pin DIL socket. Triac SCR1 is fitted with a small heatsink, made from a piece of scrap aluminium; ensure that this heatsink will not foul the lighting switch box when the dimmer unit is fitted in to place. Note that two Veropins are fitted to the PCB to provide the remote-control connections. Connections to the mains live terminal and the lamp load are made via a two-way screw terminal strip mounted on the PCB.

## Blank Checks

When construction is complete, connect the unit to the mains via a lamp load in accordance with the circuit diagram and the overlay and give the unit a functional check, using the touch pad point at the centre of the PCB. Check that the unit dims and turns on and off as already described. Also check that it does not cause excessive interference on your radio set; if ex-

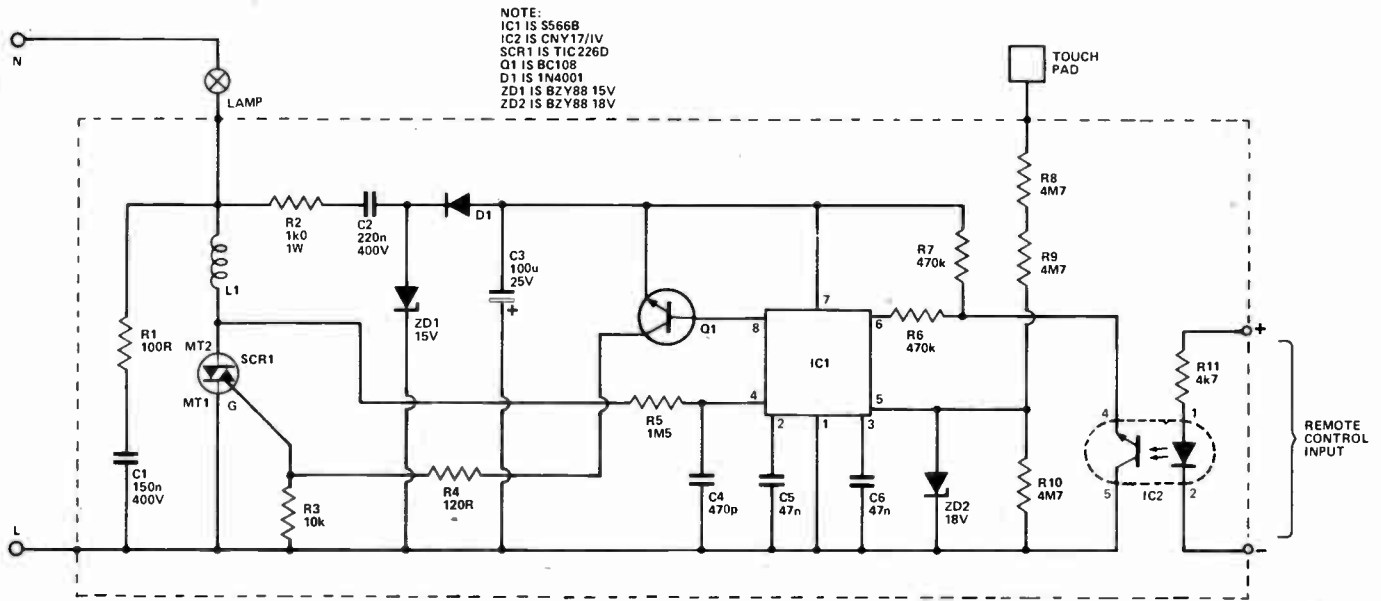


Fig.1 Circuit diagram.

## HOW IT WORKS

The 'intelligent' action of the circuit is carried out in special-purpose PMOS integrated circuit IC1. This chip receives instructions from a touch-pad or a touch 'switch'. It processes the input touch-duration information and then sends (or does not send) appropriate gate drive pulses to triac SCR1 via pin 8 and current-boasting transistor Q1.

If IC1 decides that the lamp should be switched on it sends one 30  $\mu$ s, 100 mA gate pulse to the triac in each mains half cycle (every 10 mS), at some phase-delayed time after the start (zero-crossing point) of each half cycle. The magnitude of the phase delay determines the brilliance of the lamp. If the triac is triggered shortly after the start of each half cycle (short delay) the lamp burns brightly: if it is triggered near the end of each half cycle (long delay) the lamp burns dimly. The maximum and minimum phase delays are limited to 150° and 30° respectively, enabling the lamp power to be varied from roughly 3% to 97% of maximum by the triac.

Although IC1 and Q1 generate relatively high peak drive power (1 W2), their mean power dissipation is very low (about 12 mW). This power is derived from the mains via R2-C2-ZD1-D1 and C3 and is delivered to IC1 and Q1 as a smooth 14 V DC from reservoir capacitor

C3. This method of operation is only made possible by the fact that the triac is not gated on until at least 30° after the start of each half cycle, thereby enabling C3 to attain and maintain a virtually full 14 V charge throughout each half cycle. The IC logic operation is synchronised to the zero-crossing points of the mains signal by the R5-C4 network.

Touch information can be fed to either pin 5 or pin 6 of IC1. The pin 5 input is intended for genuine touch contact use and works on the high-impedance hum-pickup principle. The touch pad is effectively connected to the mains live terminal via high-value resistors R8-R9-R10, which limit the touch pad current to safe and minimal levels. ZD2 limits the pin 5 hum signal amplitudes to safe values.

The pin 6 input is intended for use with push-button switches connected between the mains live terminal and the junction of R6-R7. In our circuit the built-in transistor of opto-isolator IC2 is used in place of a conventional push-button and can be activated by one of the non-latching decoder outputs of our five-channel remote control-system.

The dimmer can be used with lamp loads up to 300 W, this limitation being imposed by the heat dissipation of triac SCR1. L1, R1 and C1 are RFI-suppression components.

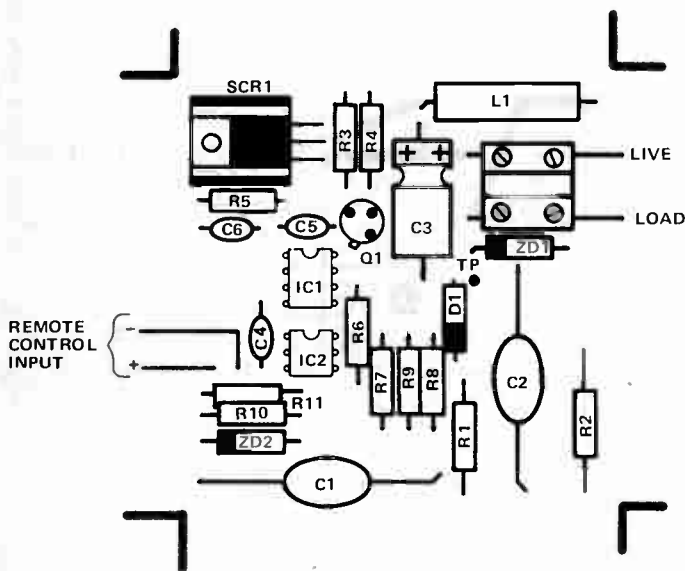


Fig.2 Component overlay for the touch dimmer.

## PARTS LIST

Resistors (all 1/4 W 5% unless otherwise stated)

R1	100R
R2	1k0 1 W
R3	10k
R4	120R
R5	1M5
R6,7	470k
R8,9,10	4M7

Capacitors

C1	150n 400 V polyester
C2	220n 400 V polyester
C3	100u 25 V axial electrolytic
C4	470p ceramic
C5,6	470n polyester

Semiconductors

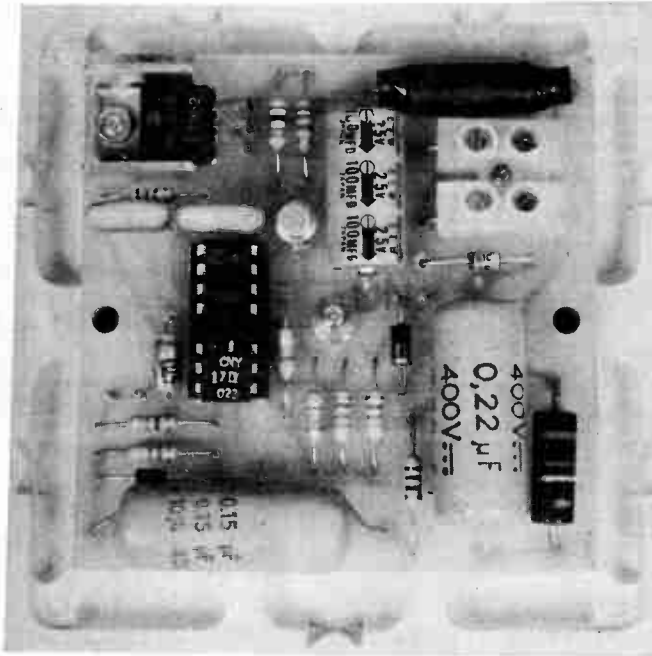
IC1	S566B
IC2	CNY17/IV
SCR1	TIC226D
Q1	BC108
D1	1N4001
ZD1	BZY88 15V zener
ZD2	BZY88 18 V zener

Miscellaneous

L1	3 A suppressor choke (ref. TV3C)
MK	blanking plate, touch plate, 2-way terminal block.



# PROJECT : Touch Dimmer



Component-side view of the PCB. Note the small heatsink on the triac and the small size of the high-voltage capacitors. The PCB is secured by the central fixing bolt.

cessive interference is experienced, try reducing the value of R1 to 47R. To check the remote control facility, use a push button switch to connect a 9-12 V DC supply to the terminals, observing the polarity shown.

When you are satisfied that the unit is operating correctly you can fit the PCB and the touch pad (see Buylines) to a standard blanking plate (available from your local electrical shop) as shown in the photos. The plate is provided with a central 'knock-out' hole. Open the hole, push the touch pad through the plate hole and the central hole in the PCB and bolt the two units firmly together, using a pair of nuts and washers (one on either side of the PCB) fitted to the screwed thread of the touch pad; a certain amount of fiddling may be necessary to ensure a firm fitting. Check that the holes on either side of the PCB line up with the securing holes in the blanking plate.

When you finally fit the completed unit into its switch box take care to ensure that no shorts occur. To play really safe, you can cover the inside of the box and the SCR1 heatsink with insulation tape at vulnerable points. You can bury the remote-control wires in a groove made in the plaster, taking the connections to the dimmer through one of several knock-out holes provided in the switch box. The other end of the wires goes to one of the non-latching outputs of the remote-control decoder.

## BUYLINES

This project uses a few hard-to-get parts. Electrovalue can supply IC1, IC2 and the choke. Wafford can supply IC1, SCR1 and the anodised touch plate. All other components should be readily available, but ensure that the capacitors are reasonably small types.

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## SPECIFICATIONS

Type	O/P/ohms	I/P/ohms	PSU	H/Heatsink	Slew	S/N	Sensitivity	T.M.O (typ)	F.R.	Size
CE 608	6		CP51	50mm	30V/μs	110dB	775mV	0.0035%	1.5kHz 50kHz (3dB)	80 - 120 - 25
CE1004	44		CP53	100mm	30V/μs	110dB	775mV	0.0035%	1.5kHz 50kHz (3dB)	80 - 120 - 25
CE1008			CP53	100mm	30V/μs	110dB	775mV	0.0035%	1.5kHz 50kHz (3dB)	80 - 120 - 25
CE1704	85	121	CP56	150mm FM1	30V/μs	110dB	775mV	0.0035%	1.5kHz 50kHz (3dB)	80 - 120 - 25
CE1708	125		CP56	150mm FM1	30V/μs	110dB	775mV	0.0035%	1.5kHz 50kHz (3dB)	80 - 120 - 25
CP3000		250	CP56	FM2	30V/μs	110dB	775mV	0.0035%	1.5kHz 50kHz (3dB)	161 - 102 - 35
CPR1(S)	Output	775mV	REG1		3V/μs	70dB	2.8mV RMS	0.008%	20Hz 20kHz	138 - 80 - 35
MC1(S)	Output	2mV	REG1			65dB	30V/150	0.008%	20Hz 20kHz	80 - 120 - 35
XO2, XO3	Output	775 2500mV	REG1		9V/μs	80dB	1775mV	0.01%	X over points	150 - 40 - 70

\*Power output is quoted WRMS and is given for two modules run off the same power supply. Higher powers are obtainable if using one module per P.S.U. or if using a stabilised P.S.U.

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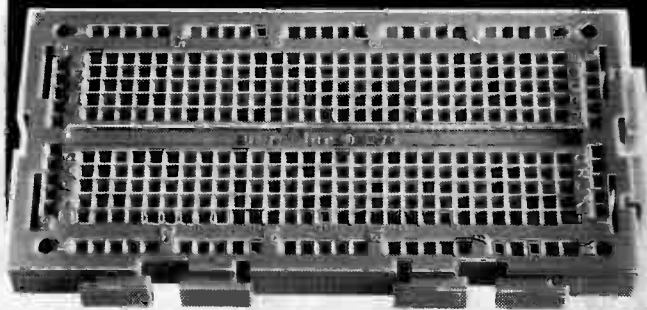
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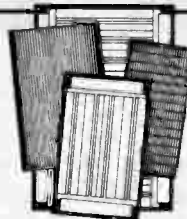


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# AUDIOPHILE

This month Ron Harris reviews a new eastern loudspeaker design and a pair of pickups whose coils are mobile, whose price is low and whose output is high!



**W**e begin this month with a review of the Mitsubishi DS-32B, a £250 speaker from the land of the rising yen. Loudspeakers remain the one significant area of hi-fi which the Oriental production machine has — so far — failed to dominate.

Only the Yamaha NS1000 and the Sony G1 have achieved any sort of acclaim in England's green and pleasant land, despite recent spending to engineer a "European Sound". The DS-32B is the Mitsubishi attempt to redress that balance.

It is a three-unit bass reflex design, claimed to handle 120 W of amplifier power and constructed to a very high standard indeed. The enclosures are supplied in stereo pairs (offset drive unit) with level controls fitted to the cone mid-range unit and the titanium tweeters.

## Magnetic Personality

Mitsubishi make great play of the magnets used on their units, claiming to have developed a new ferro-nickel alloy for the woofer. Basically, what it actually comes down to is that strong magnets with high field strength and a 'long' gap have been employed to ensure linearity on high cone excursions.

The level controls are positioned on the front panel behind the grille and offer three positions of adjustment to the user. First reactions of the suspicious British will undoubtedly be to turn down the treble control.

The second will be to put it back again.

These units show none of their earlier Eastern brethren's tendency to cut through anything in their path with a sword-edged treble. If anything, Mitsubishi have over-compensated a little.

At approx 24 x 12 x 13 inches these speakers are not going to dominate the average living room, but they should be used on stands for best results — about 10-12 inches clear of the carpet will put the tweeter nicely at ear level and free the bass response remarkably. Connection is simple, as the speaker uses those 'push-clamp' terminals, which bite into the lead once released. Not as useful as screw terminals, but a universe ahead of the dreaded DIN.

## Tested Responses

The DS-32B should not prove a difficult load to drive, as the impedance did not fall below 4R at any point in the frequency spectrum. Second order filters are used in the crossover networks, giving a 12 dB/oct roll-off, centred on frequencies of 800 Hz and 5 kHz. The unit changover was smooth, with no attendant irregularities in the frequency response of the speaker as a whole.

The titanium tweeter gave a particularly fine account of itself, exhibiting a smooth and extended performance with excellent dispersion — the offset arrangement means that 'lobes' are created in the dispersion pattern of a stereo pair, thus creating a better field around a central listening position.

For listening tests the DS-32Bs were set up — on stands — next to my reference speakers, the KEF 105 II. Obviously no attempt at direct comparison can be made, but it is important when auditioning, loudspeakers in particular, to have a standard available for comparison.

## Ear Lies The Rub

Overall the DS-32B gave a very creditable performance. The balance tends to be a little 'warm' and the mid-range is slightly recessed in the 1 kHz-3 kHz region. Whilst this does take any hint of an 'edge' off the sound it lends a slightly unreal smoothness to the sound. I found I was turning up the mid-range unit to restore the balance. For the size of cabinet the bass response is very good, with nice definition of the instruments. The cut-off is sharp at the bottom end and this would tend to enhance the clarity of an enclosure of this size, so this is no bad thing overall.

At the top of the spectrum, that metal tweeter is well integrated into the system and has a generally good performance. It can sometimes add a little uncertainty to high energy, high frequency material, but only sometimes and only to a degree which is very acceptable at its price.

## Concluding Tones

Judged against the asking price, I feel the DS-32B is an excellent speaker. Its value for money rating *has* to be high, when you consider the quality of the finish and high degree of engineering present in the units.

The sound quality is competitive indeed and deserves a chance to compare itself against better known enclosures from this side of the channel. I can recommend the DS-32B and would suggest that anyone in the £200-£300 speaker market makes the effort to hear them before committing his money.

## Moving Onto Coils

Moving coil cartridges have only recently descended into the mainstream of hi-fi. With that emergence has come an increase in the number of units which do not require a step-up device, thus reducing the cost.

The best known of these was probably the Ultimo 10X — 'was' because the model has now been replaced (by Dynavector) by the Mark 2. And this, by the sheerest of contrived coincidences is one of two high-output cartridges under test this month. The other is the Mayware MC3L, a fine-line stylus design from the 'Formula 4' people.

The output of these units is similar at around 2-3 mV, sufficient to drive most preamps and higher than many moving magnet designs. You can pick up the rest of the technical details from Table One. As the two cartridges are priced at approximately £65 and £55 respectively they are well within the financial reaches of 'mid-fi' buyers and offer an interesting alternative to other moving magnet cartridges in this price range.

## The Ultimo End?

The 10X2 is an increased output version of its predecessor, but unusually in these days and ways, no price increase accompanies the model change. Indeed under the Dynavector exchange system, if you trade in your old unit it will generate a hefty discount on the price of a new 10X2. Therefore you could say the price has actually *fallen* for a change.

The cartridge is a low compliance design, at around 15 cu, and will this transmit more energy back into the arm than units such as the 900IGC and 600LAC which are possessed of more units in their compliances.

This means that the arm used will have to have a fairly high mass, to bring the combined resonant frequency to an acceptable frequency — above warps but below audibility — say between 10Hz and 15 Hz. To test the 10X2 I used an AT1010 and an integrated turntable with mid-mass arm. In addition an SME Series III was used with its mass suitably raised to match the Dynavector.

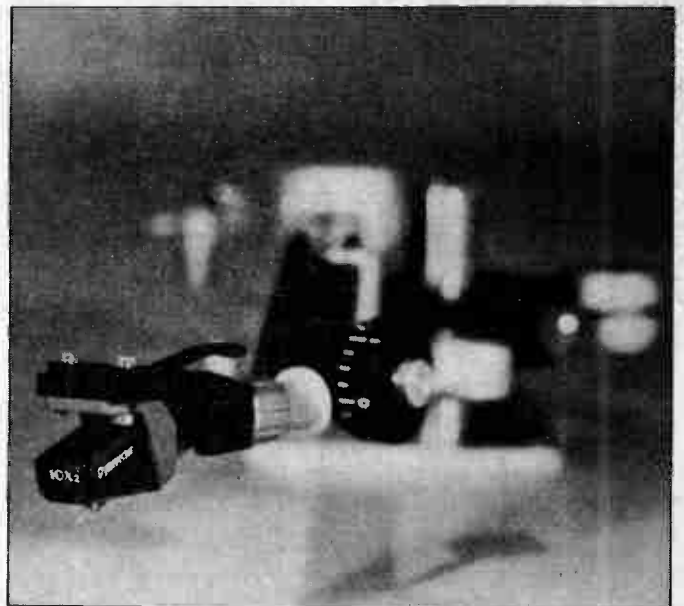
Because the SME is such a low mass design, it is possible to *add* mass to its effective value, in order to use low compliance pick-ups. Any readers out there who wish to know more details of this can write to SME for information sheet No. 24. Tell them ETI sent you!

## Good Public Image

The 10X2 is startling to see in the end of *any* arm, having retained that transparent red plastic case, with a long cantilever and rigid mounting bracket. The disc clearance is substantial to say the least, and arm height should be carefully adjusted.



The 10X2 in close up. Note the massive fixing bracket and the "see-through" casing. Bright red too.



Fitted to an arm, on this the Dynavector, the 10X2 looks a little less imposing. It never looks anything less than striking, though!

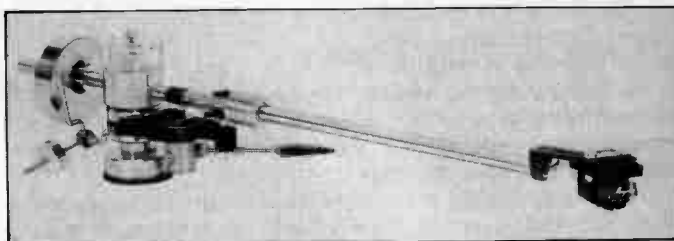
The sound is a distinct improvement on the already high standard of its earlier version. The balance is well struck between bass extension and detail in the low registers, and the imaging is nothing short of excellent. Treble quality is sweet and extended with very good detail rendition.

At the price the Dynavector offers very good value for money indeed, having most of the virtues of the more expensive moving coils and lacking their vice of price (!?) If I have any criticism at all of the 10X2 it is in that the low mid-range can sound a little constricted with some material, such as massed voices. It is a minor aberration.

A sound design then, well recommended, and with the advantages of (i) not needing a step-up device and (ii) a good trade-in deal on your old Ultimo if you're upgrading.

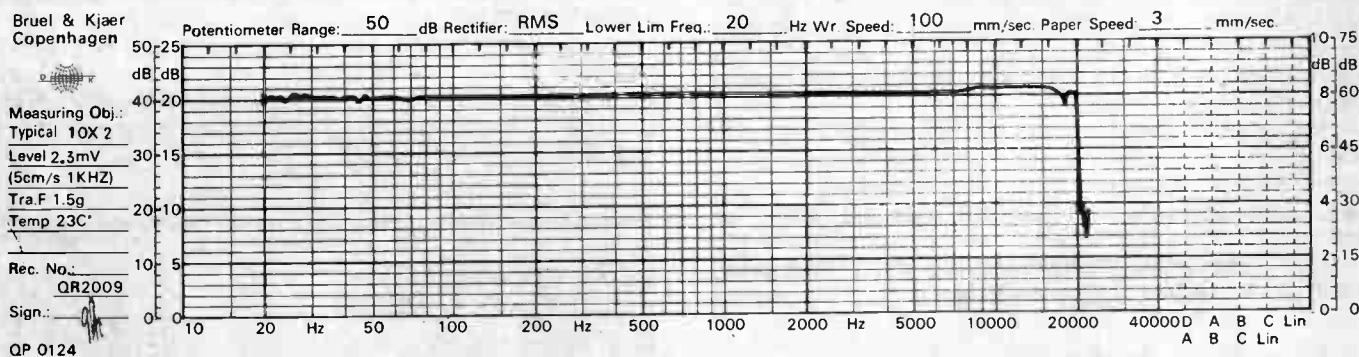
# TABLE ONE

	MAYWARE MC3L	DYNAVECTOR DV10X2
Compliance (vertical-horizontal) (cm/dyne)	8 x 10 <sup>-6</sup>	15 x 10 <sup>-6</sup>
Output level (1 kHz/5 cm sec)	2.6 mV	2.4 mV
Stylus type	line contact	elliptical
Separation (5 kHz)	22 dB	24 dB
Freq response (20 Hz-20 kHz)	± 2 dB (see graph)	± 2 dB (see graph)
Optimum tracking weight	2 g	1.6 g
Weight	7 g	9.6 g
Typical price	£53	£68 (less with exchange)

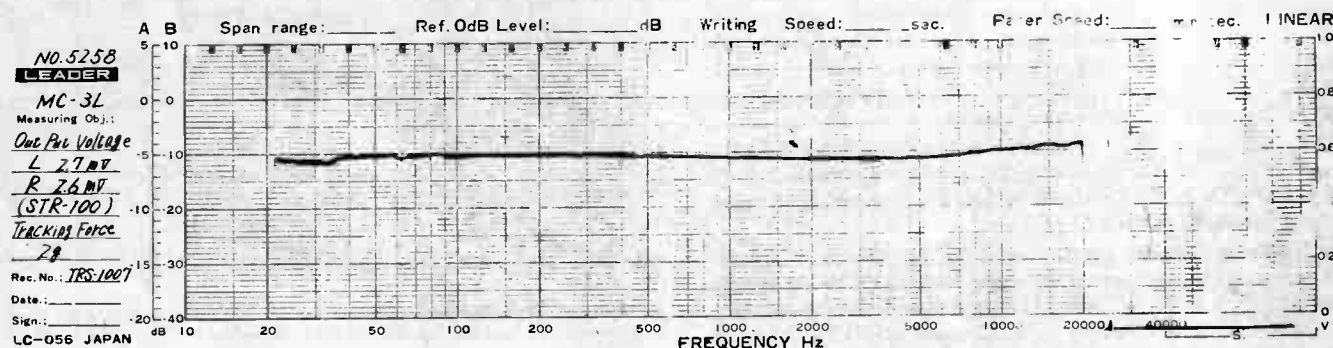


Above: the faithful Formula 4 pickup arm in which the cartridges were tried during listening tests. It is well suited to low compliance designs such as these, and gave good results.

Left: the lab test results for the MC3L and the 10X2 set out for comparison.



Above: the frequency response of the new Dynavec 10X2 pickup. Not a lot to comment on is there?



Above: measured frequency response of the Mayware MC3L moving coil cartridge.

## Mayware Mayhap

The MC3L is the latest from Mayware, best known for their excellent Formula 4 pickup arm — now in its Mark 3 incarnation. Their previous pickup, the MC-2C, is a low device of high quality and so the DC3L is their next step in cartridge design.

Visually it is the opposite of the flamboyant Dynavec, being simple and black in appearance. The cartridge body is very sensibly shaped with a good large surface area to the top, which aids fixing to the arm. This means that the pickup as a whole will be better integrated, as it will inevitably be more rigid than it would with a smaller contact area between headshell and cartridge.

Mayware's new high-output moving coil cartridge. The body is designed to absorb reflected energy from the cantilever.



The compliance of this unit is very low indeed at 8 cu, a figure which I feel will limit the arm it can be employed with. For the purposes of review I managed to beg, steal and borrow a Formula 4 (an earlier model) and fitted the unit into it. Listening tests were mainly conducted with this assembly, although for interest and devilment I did fit the MC3L into my SME III, with maximum damping and highly modified effective mass to tune the resonance.

## Testing Benches

On test the MC3L acquitted itself well, the frequency response in particular impressing with its high linearity and well maintained separation. Output measured at 2.6 mV per channel.

There was nothing at all to cause the slightest worry here, so I was able to move on happily to playing some music, expecting something pleasant in the light of the test results.

## ... And Ears

I was not disappointed. Initial impressions, later reinforced by continued use, were of a wealth of detail with fair bass extension and 'smooth-as-silk' treble. Mid-range is firm and weighty with good control of vocals — not always a strength of moving coil units. Overall the balance is full and rich with good imaging and better than average tracking ability. My only real quibble is with that lower-than-low compliance. It does limit the versatility of the MC3L considerably, which is a shame as it has the virtue to delight a wide audience.

## Common Ground

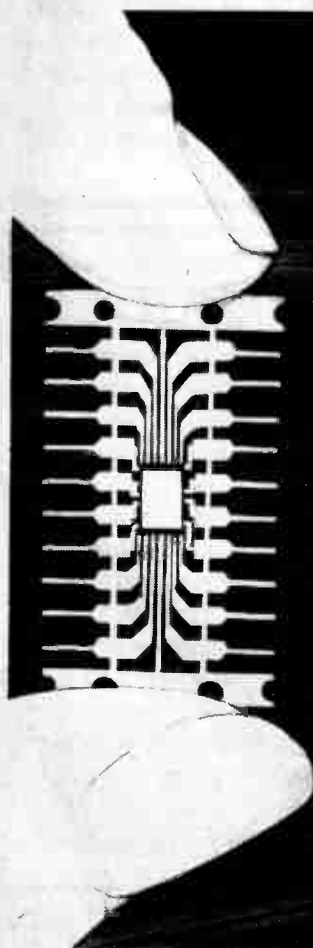
These two cartridges have a lot in common, in that neither requires a step-up device, both are low compliance, both are sensibly priced and have that rendition of detail which makes moving coils such an attractive proposition. Few moving magnets (C900 IGC?) can equal them in this respect.

Each has its good and not-so-good points. The 10X2 handled bass energy a little better than the MC3L, but the Mayware leaves it for dead on vocal material where there is a deal of energy in the mid-range; opera in particular. Both sound very good indeed on most rock music and which is 'best' is really up to the purchaser. I shall refrain from choosing between the two — I liked them both!

## Reference Point

The cartridge I used as a reference in the comparison was the Ortofon MC30 with the T30 transformer. It is priced right at the top-end of the market and makes an interesting counterpoint to this month's models. I was intending to run the review in this month's Audiophile, but I just haven't the space to do it justice — so I'm holding onto the verbiage until next month. With all the tales of wonders unveiled by such exotic groove followers as the Linn Asak and the Koetsu filling the printed page these days, the Ortofon appears to have been overlooked. This is unjust indeed.

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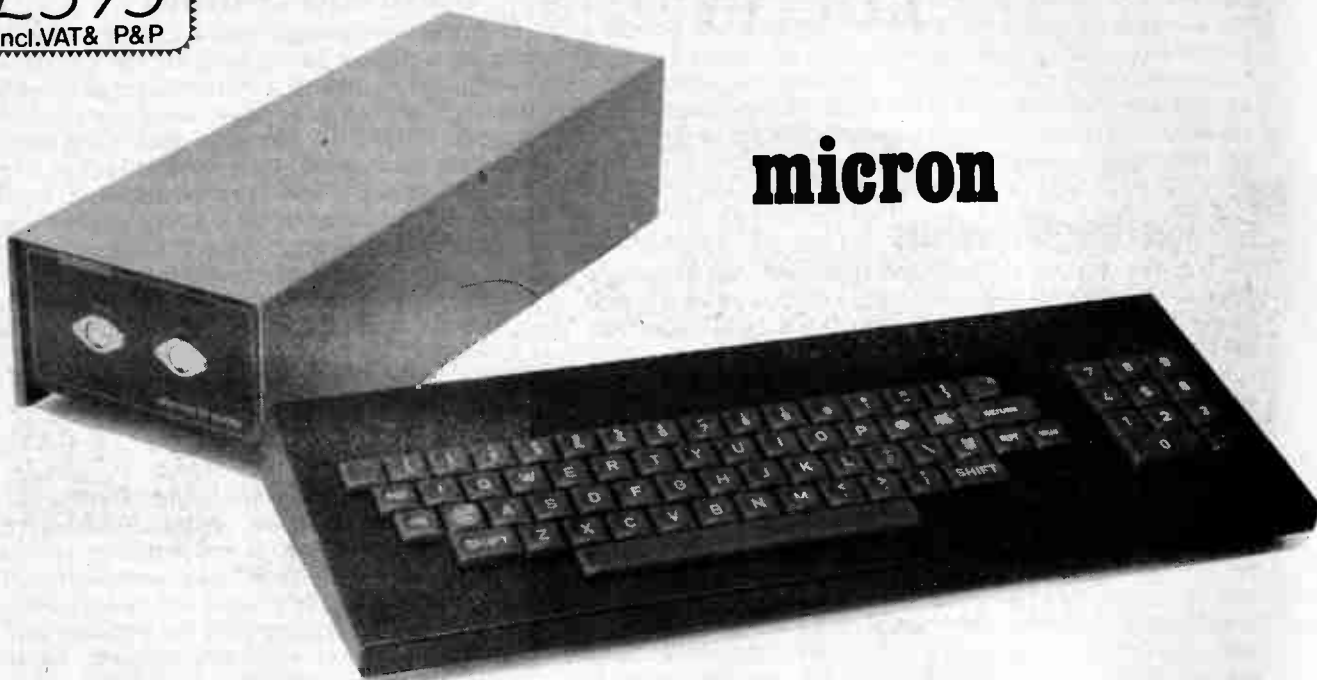
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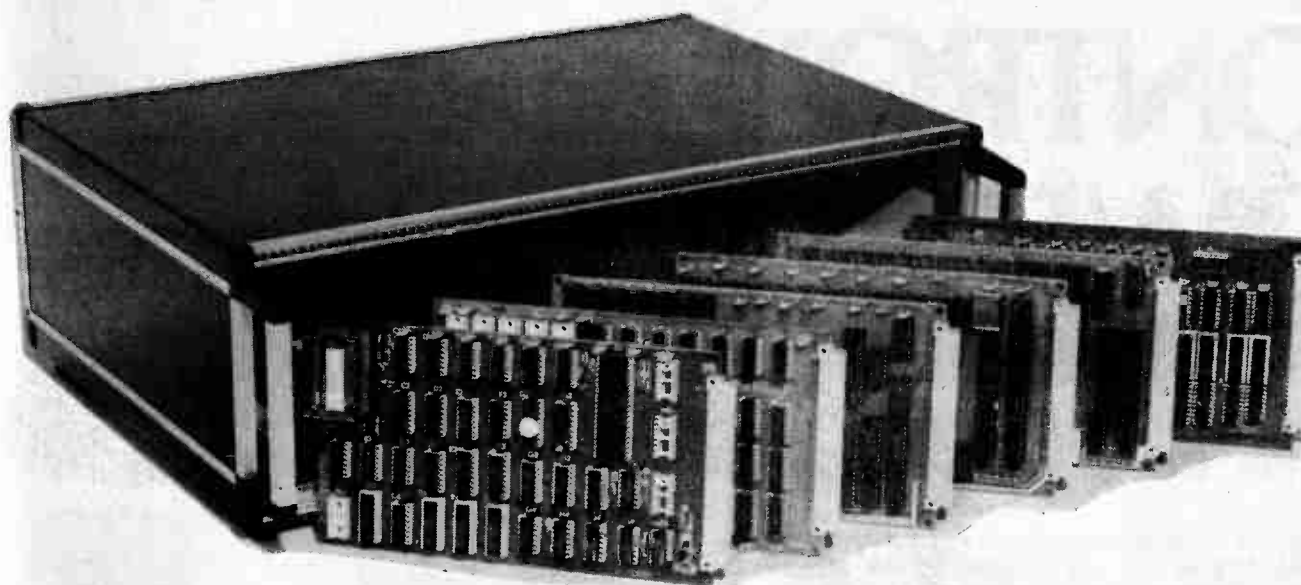
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# REMOTE-CONTROLLED POWER SWITCH

Designed to interface with the five-channel remote control system, this 5 A mains switch can be activated directly or with the remote control transmitter. Design by Ray Marston. Development by Plamen Pazov.

This project is a 5 A mains switch that is specifically designed to interface with the five-channel remote control system described elsewhere in this issue of ETI. When the interface is complete, the switch can be activated either directly by a built-in toggle switch or with a pair of control buttons on the infra-red transmitter. The switch can be remote-controlled at ranges up to 10 m and can be used to activate lamps, TVs and hi-fi systems, etc, from the comfort of an armchair. Three such switches can be controlled by the remote control system.

The power switch is designed to fit into standard surface mounting mains sockets: a single switch can be fitted in a standard socket or two switches can be fitted in a double socket. A feature of the design is that the actual control input to the switch is made via an opto-coupler, which provides several kilovolts of mains isolation; an input current of only a few milliamps from a 9 V or greater supply is required to activate the switch in the remote mode. The switch is thus quite versatile and can, with a little ingenuity, be activated automatically by suitable sensor networks, such as those published in last month's ETI.

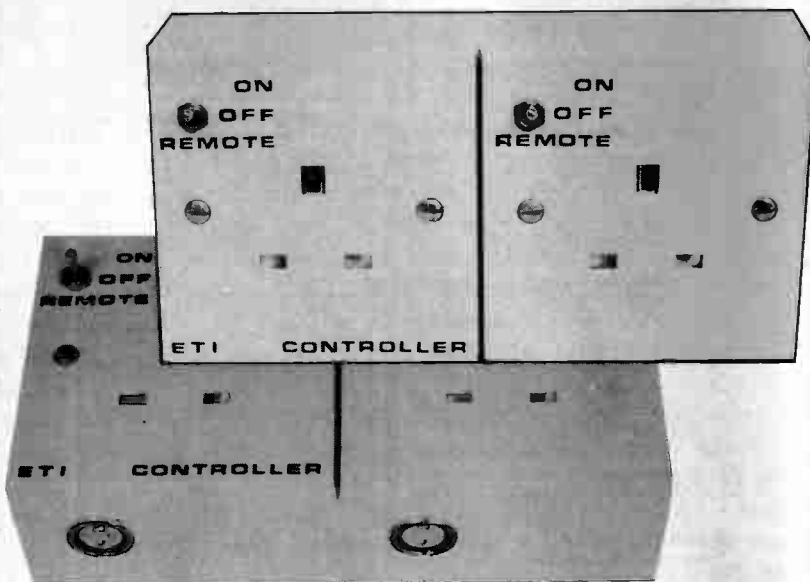
## Construction

When building this project it must be noted that the PCB is designed to be used with a specific miniature type of relay (see Buylines) and that the board is fairly cramped, with all resistors and diodes mounted vertically on the PCB. The relay has two sets of contacts, which are wired in parallel; external connections to the relay are made using a vertically-mounted two-way terminal strip. All other connections are made using Veropins.

When constructing the unit, build up the PCB as shown, fitting the relay last of all, and fit the unit in one corner of the surface mounting box after first completing the interwiring to SW1, SK1 and SK2 (the mains output socket) in accordance with the circuit diagram.

Now fit the top plate/socket into place, complete the mains connections, connect SK1 to one of the latching outputs of the five-channel decoder and give the unit a functional test. Check that the switch can be turned on and off directly with SW1, and that it can be controlled remotely (using the five-channel transmitter) when SW1 is set to the remote position.

Note that SW1 should be fitted to the actual socket plate of the power switch and that socket SK1 (a DIN socket) should be fitted to the lower face of the surface mounting box.



To make a dual power switch unit, simply fit two identical units into a double surface mounting box, but use two single sockets.

## HOW IT WORKS

Circuit operation is so simple that it is virtually self-evident. Q1 is used as a relay driver and the relay contacts are used to make or break the live mains connections to output socket SK2. Q1 can be activated either directly by SW1 or remotely via opto-coupler IC1 and one of the latching outputs of the decoder of the five-channel remote control system. The decoder also provides the relay-driving circuit with a 15 V DC supply.

When SW1 is set to the on position, Q1 and the relay are driven on via R2, and parallel-connected contacts RLA/1 and RLA/2 feed mains power to the load through SK2. When SW1 is set to the off position, no drive is fed to Q1 base, so Q1 and the relay are off and no power is fed to the load.

When SW1 is set to the remote position, opto-coupler IC1 is used to control the base drive to Q1. Q1 and the relay turn on when the control input (B) is fed with a logic 1 or high signal, or off when fed with a logic 0 or low signal: these signals are available from the output of the five-channel decoder and can be set with the remote control transmitter.

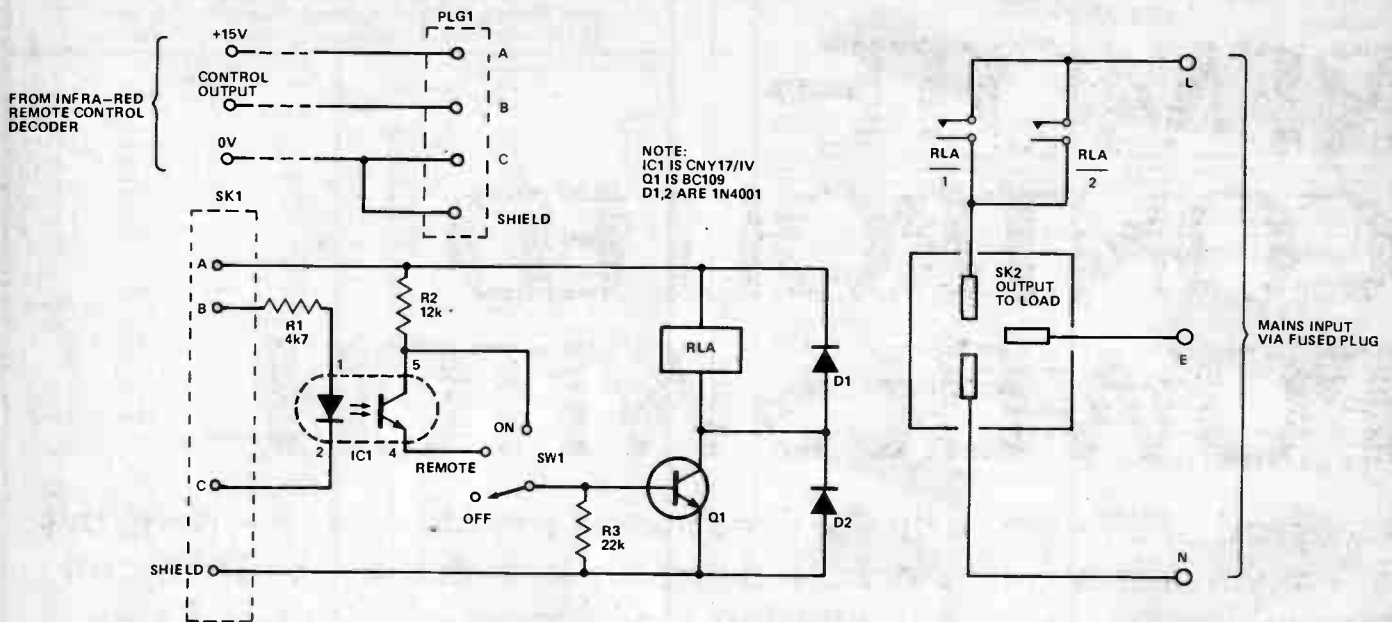


Fig.1 Circuit diagram.

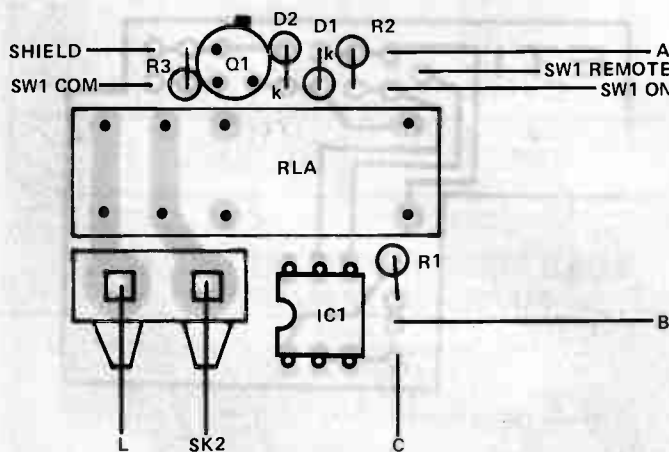


Fig.2 Component overlay. The terminal block is secured by tightening the lower pair of screws onto wires soldered to the PCB.

## PARTS LIST

### Resistors (all 1/4 W, 5%)

R1	4k7
R2	12k
R3	22k

### Semiconductors

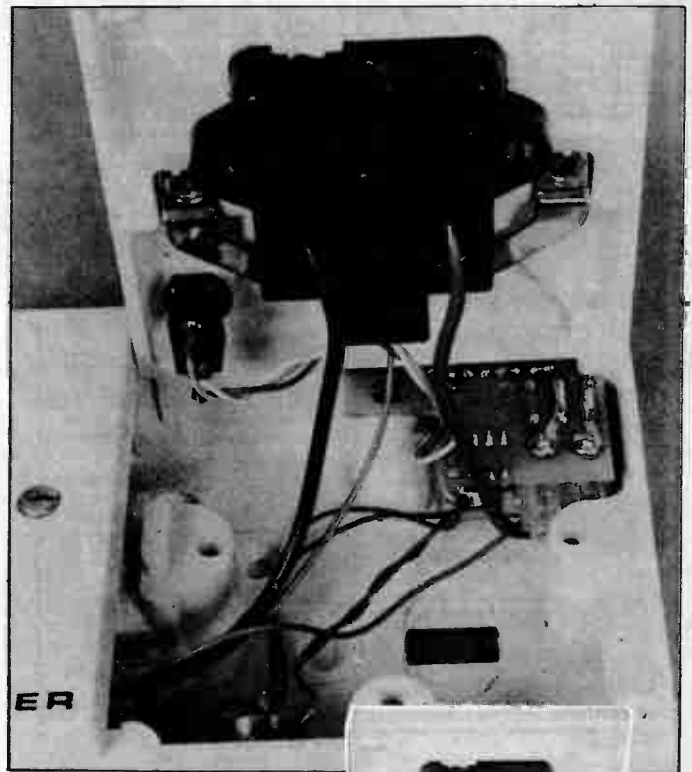
IC1	CNY17/IV
Q1	BC109
D1,2	1N4001

### Miscellaneous

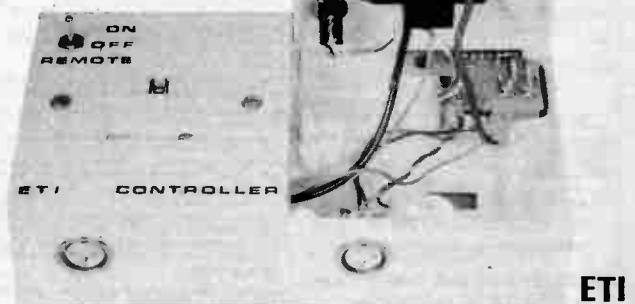
SW1	three-way toggle switch
SK1	three-pin DIN socket
SK2	surface-mounting mains socket
PLG1	three-pin DIN plug
RLA	12 V, coil > 120R, PCB-mounting, 5 A mains-rated contacts

## BUYLINES

The relay is a miniature type for PCB-mounting and is available from Watford Electronics, ref. RL6. The CNY17/IV opto-coupler is available from Electrovalue.



Two internal views of the power switch, showing the interwiring. The mounting box is MK reference number 2025.



ETI

### 3 CHANNEL SOUND/LIGHT CHASER

LB31000SLC **£32.70**



A high performance sound to light system which automatically switches to a chase when the music ceases. Super sensitive with an anti-interference circuit, the unit will operate from practically any amp and control up to 1,000W/channel, 5Hz to 70K. Controls: bass/mid/treble/master sensitivity/chase speed.

### STEREO DISCO MIXER/PREAMP

LBPA3  
M - Magnetic  
C - Ceramic



**£33.70**  
Magnetic or ceramic deck versions - please state

All the requirements of a stereo disco preamp on one board: left and right deck mixers/tone controls/mic mixer/tones/mic, auto fade over decks/and P.F.L. The unit can be used with either LB100/150/250

Full set of pots - **£8.63**

### 3 CHANNEL SOUND/LIGHT

LB31000SL



**£22.70**  
All the advantages of the SLC without chase. Controls: bass/mid/treble/master sensitivity.

### LBPA2 **£17.20** LBPA1 **£19.50**

A four channel mixer and tone stage for mics, guitars, etc. Can be used with any LB amps. Set of pots **£2.74**.

A stereo hi-fi preamp and tone stage for mag. p.u./tape/tuner, etc. Set of pots **£3.27**.

### 2/4/8 CHANNEL CHASER

LB81000LC



**£28.00**  
An all logic chaser system for use with up to 8 channels at 1,000 watts each. Facilities include footswitch trigger and mode cascading (16, 24, 32 channel, etc.), chase speed and re-cycle delay.

### 3-WAY ACTIVE CROSSOVER

LBACO1 **£17.90**



Bass/mid/treble active crossover with stage booster! Available with crossover points of 200 or 300Hz, and 2K or 3KHz (please specify) LBPSU1 supply for LBACO1 (1 or 2).

### 4 CHANNEL SEQUENCER

LB41000LS



**£19.20**  
A 4 channel sequence generator for banks of lamps up to 1,000W per channel. Two speed controls, cross effect to provide settings between seconds and rapid burst.

### POWER AMPLIFIERS

Tough dealing power amps for use in sound systems. Open/short circuit protection and fused. Heavy gauge heatinks and rugged o/p devices (all operate down to 4 ohms).

25W R.M.S.	110W R.M.S.	160W R.M.S.	270W R.M.S.
20Hz to 60K	5Hz to 25K	5Hz to 25K	5Hz to 25K
0.07% THD	0.1% THD	0.1% THD	0.1% THD
90dB S/N	110dB S/N	110dB S/N	110dB S/N
LB25	LB100	LB150	LB250

**£11.20 £19.70 £29.20 £43.50**

Note all models are available with either 500mV or 775mV sensitivity. Please state when ordering.

### 1 AND 3 CHANNEL DIMMERS

LB31000LD



**£16.20**  
Single channel version LB11000LD **£7.20**

Power dimmer units for theatre/stage applications up to 1,000W per channel, with on board suppressing. The unit is also available without rotary pots for use with sliders - LB31000LD (no pots) **£15.00** Sliders **75p** each.

### LBRLD1 **£6.20**

A de-thump unit for use with any LB power amps.

### ROPE LIGHTS/DRIVER

LB41000LC-S **£24.20**



4 COLOUR ROPES (6 metre) **£36.50**  
(8 metre) **£45.40**

ROPE LIGHTS **£45.40**

A four channel chaser up to 1,000W per channel, with a sound trigger facility. The music input signal modulates the speed of the chase giving an excellent sound/light effect. The unit will control up to 10 ropes with chase speed and trigger level control.

### POWER AMP POWER SUPPLIES

LB25PS	LB100PS	LB150PS	LB250PS
<b>£11.20</b>	<b>£16.20</b>	<b>£19.00</b>	<b>£26.50</b>
P/P £1.20	P/P £1.40	P/P £1.40	P/P £1.70

### FOR GUITAR, P.A. AND DISCO



**PJEZO HORNS £5.75**  
P/P 50p

### CELESTION LOUSPEAKERS

(All standard cone 8 ohms)

G10-50	G12-65	G10-100	G15-100
(10 inch 50W)	(12 inch 65W)	(12 inch 100W)	(15 inch 100W)
<b>£14.70</b>	<b>£20.70</b>	<b>£26.45</b>	<b>£36.45</b>
P/P £1.70	P/P £1.70	P/P £1.70	P/P £2

### NEW - MINI MODULES - NEW

Ingeniously designed mini pre-amplifier 'building blocks' for use in music and P.A. applications. You choose the type and number of units you require for your particular system and mount each module via its control direct onto your panel.

LBMM1 Pre-amp for mics, guitars etc.  
LBMM2 Mixer for up to 6 LBMM1/2/3/4/5  
LBMM3 Bass/boost/cut for either LBMM1/2/3/4/5  
LBMM4 Treble/boost/cut for either LBMM1/2/3/4/5  
LBPSU1 ± 15V supply for up to 12 modules  
LBPSU2 ± 15V regulated for up to 50 modules

MM1 **£4.50**; MM2 **£5.20**; MM3 **£5.70**; MM4 **£5.70**; MM5 **£5.70**; PSU1 **£7.20**; PSU2 **£14.50**.

Mini Module Discount. Any types between 10 and 24 (quantity) - 20% - 25+ - 30%.

### L & B ELECTRONIC MODULES

PROFESSIONAL ENGINEERING BY PROFESSIONALS

45 Wortley Road, West Croydon, Surrey  
CR0 3EB. Tel. 01-689 4138

Each module is manufactured from the highest quality components, fully tested, supplied with a connection and circuit diagram and guaranteed for twelve months.

All prices shown are V.A.T. inclusive. Please include 50p post/packing except where individually stated. To mail order, send cheque/P.O./registered cash or Access number, C.O.D. service £1 extra. For our catalogue/specifications send 50p.

Please note: This company has no connection with LB Electronics of Hillingdon.

# TRANSFORMERS

Panel Meters, Bridge Rectifiers, Power Supply Units  
Multimeters - Semi Conductors - Timers - Safebloc

Minimum & Sub Miniature			
Volts	Milli-amps	Ref. Price No. £	P&P
3-0.3	200	238 <b>2.60</b>	70
0.6 0.6	1A 1A	212 <b>3.00</b>	75
9-0.9	100	13 <b>2.30</b>	70
0.9 0.9	330 330	235 <b>2.15</b>	70
0-8.9 0-8.9	500 500	207 <b>2.75</b>	75
0-8.9 0-8.9	1A 1A	208 <b>3.85</b>	75
0-15 0-15	200 200	236 <b>2.15</b>	70
0-20 0-20	300 300	214 <b>2.75</b>	90
20-12-0 12-20	700(DC)	221 <b>3.50</b>	90
0-15-20 0-15-20	1A 1A	206 <b>4.60</b>	105
0-15-27 0-15-27	500 500	203 <b>4.05</b>	85
0-15-27 0-15-27	1A 1A	204 <b>6.10</b>	105

50 VOLT (Pri: 220-240V) Sec: 0-19.25-33.40-50V			
Amps	Ref. No.	Price £	P&P
0.5	102	<b>3.60</b>	90
1.0	103	<b>4.60</b>	1.05
2.0	104	<b>7.30</b>	1.20
3.0	105	<b>8.60</b>	1.20
4.0	106	<b>10.85</b>	1.30
6.0	107	<b>15.10</b>	1.50
8.0	118	<b>20.20</b>	1.70
10.0	119	<b>24.10</b>	2.20

60 VOLT (Pri: 220-240V) Sec: 0-24.30-40-48-60			
Amps	Ref. No.	Price £	P&P
0.5	124	<b>3.85</b>	90
1.0	126	<b>5.60</b>	1.05
2.0	127	<b>7.55</b>	1.20
3.0	125	<b>11.10</b>	1.30
4.0	123	<b>12.35</b>	1.50
5.0	40	<b>14.15</b>	1.60
6.0	120	<b>17.60</b>	1.60

12 AND/OR 24 VOLT Pri: 220-240 Volts			
Amps	Ref. No.	Price £	P&P
12v 0.5	245	11	<b>2.30</b> 75
1.0	05	213	<b>2.75</b> 90
2	1	71	<b>3.25</b> 90
4	2	18	<b>4.05</b> 85
6	3	70	<b>5.60</b> 95
8	4	108	<b>7.40</b> 1.20
10	5	72	<b>8.25</b> 1.20
12	6	116	<b>8.85</b> 1.20
16	8	17	<b>10.85</b> 1.30
20	10	115	<b>13.85</b> 1.50
30	15	187	<b>16.85</b> 1.50
60	30	226	<b>33.35</b> 1.80

30 VOLT (Pri: 220-240V) Sec: 0-12-15-20 24-30V			
Amps	Ref. No.	Price £	P&P
0.5	112	<b>2.85</b>	90
1.0	79	<b>3.60</b>	90
2.0	3	<b>5.60</b>	1.05
3.0	20	<b>6.30</b>	1.20
4.0	21	<b>6.60</b>	1.20
5.0	51	<b>9.60</b>	1.20
6.0	117	<b>11.10</b>	1.20
8.0	88	<b>14.35</b>	1.50
10.0	89	<b>16.60</b>	1.50

AUTO TRANSFORMERS Input/Output Tapped 0-115-210-240V			
VA (Watts)	Ref. No.	Price £	P&P
20	113	<b>2.65</b>	90
75	64	<b>4.10</b>	90
150	4	<b>5.60</b>	1.05

Input/Output Tapped 0-115-210-220-240V			
VA (Watts)	Ref. No.	Price £	P&P
300	53	<b>10.10</b>	1.20
500	67	<b>10.85</b>	1.50
1000	84	<b>18.60</b>	1.60

Also 1500/2000/3000VA

MAINS ISOLATING (Centre Tapped & Screened) Pri: 120/240V Sec: 120/240V			
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60	149	<b>6.60</b>	1.05
100	150	<b>7.60</b>	1.30
200	151	<b>11.10</b>	1.30
250	152	<b>13.30</b>	1.50
350	153	<b>16.30</b>	1.60
1000	156	<b>37.10</b>	3.20

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VLF/TR VCO/TR IB/TR BFO...

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**Shadow VLF/TR**. Full specification discriminator, not just ferrous/nonferrous indication. It works by measuring the conductivity of the target, now you can reject nail bottle caps even aluminium foil and ring pull tabs! Full ground effect exclusion over normal or high permeability soils. The head is thermally and capacitively shielded. 4 modes, deepseeking VLF plus 3 TR discriminating ranges. Push button 'memory' tuning. Performance equals commercial detectors costing £200! As described in ETI. **Complete kit now only £87.87 inc. VAT & post!**

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**Shadow TR/VCO**. An advanced version of the TR/IB. Use as a sensitive IB machine or switch to VCO mode when the sound changes to a varying pitch, allowing easier use over mineralised ground and enabling detection of negative, high permeability anomalies. **Kit price £38.67 inc VAT and Post.**

**Matching stereo headphones for all Shadow models £5.85 inc. VAT and Post.**

**Shell Kit**. Consists of the (hard to find) hardware items, for detectors of your own design. Fully adjustable shaft with handle, search head mouldings (int. diam. 185mm) with hinge assembly, special clips to mount your own control housing (any box is suitable). Completely non-metallic and undrilled. With assembly instructions **£14.45 inc. VAT and Post.**

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# 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 (OC) 50-80 Max.  
 Loads 4-16 ohms  
 Frequency response measured at 100 watts 25Hz-20KHz  
 Sensitivity for 100 watts 400mV @ 47K  
 Typical T.H.O. @ 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 chassis 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 socket

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**

CONSTRUCTORS PACK 7A plus £2.00 p&p  
 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

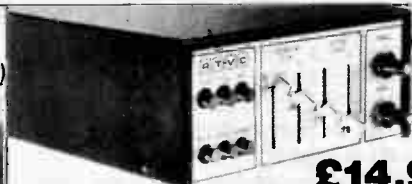
Viscount IV unit in teak simulate cabinet silver finished rotary controls and pushbuttons with matching fascia, red mains indicator and stereo jack socket. Functions switch for mic magnetic and crystal pickups, tape and auxiliary. Rear panel features fuse holder, DIN speaker and input socket 30 + 30 watts. RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers. Size 14 1/2" 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.



## 10+10 WATT STEREO AMPLIFIER KIT

**£14.95** plus £2.90 p&p

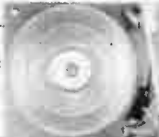
- Featuring latest SGS/ATES TOA 2006 10 watt output I.C.'s with in-built thermal and short circuit protection.
- Mullard Stereo Preamplifier module
- Attractive black vinyl finish cabinet. Size 9" x 8 1/2" x 3 1/2" approx.
- Converts to a 20 watt Disco amplifier.

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 ohm speakers  
 Frequency response 40Hz — 20KHz  
 P.U. 150mV Aux. 200mV Mic. 1.5mV  
 Input Sensitivity 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.

**RTVC**  
 323 EGGWARE ROAD, LONDON W2  
 21E HIGH STREET, ACTON W3 6NG

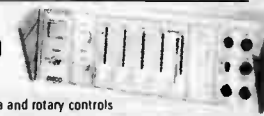
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## STEREO DISCO PREAMPLIFIER

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 **£21.95** plus £1.72 p&p our power module kits.

## 100 WATT MONO DISCO AMPLIFIER

Brushed aluminium fascia and rotary controls. Size approx 14" x 4" x 10 1/2". Five vertical slide controls, master volume, tape level, mic level, deck level. PLUS INTER DECK FADE for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre-fade level controls (PRU) 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 13 1/2" x 5 1/4" x 6 3/4". 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 15 1/2" x 12 1/4"  
 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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# TECH TIPS

## 555 VCO

J. Harrold, Bristol.

This circuit uses the 555 timer and a few external components to produce a simple low cost VCO, (not just pulse position modulation), and unlike other "cheap" VCOs does not require a MOSFET op-amp costing £1 or more to buffer the output up to a useful level.

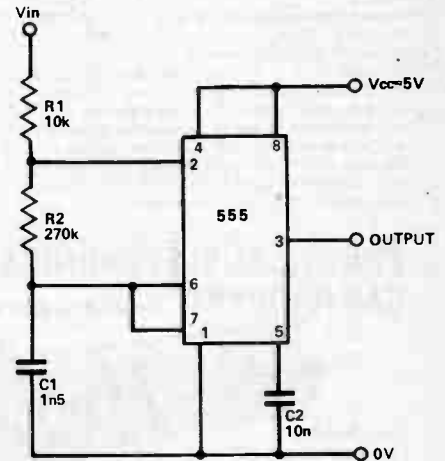
The 555 is basically connected in its astable mode, but instead of wiring the top of the timing chain R1, R2, C1 to V<sub>CC</sub> it is connected to the input voltage V<sub>IN</sub>. The mark/space ratio is set by R1, R2 in the usual way for the 555 and if R2 ≫ R1, it is unity. It should be remembered that pin 7 is grounded during part of the oscillation so R1 affects the current drawn from the input. The output (pin 3) of 555 can source or sink currents of up to 200 mA and so can drive TTL, CMOS or a high impedance loudspeaker directly. The frequency of oscillation f, in Hertz, is

$$f \sim \frac{1}{C1(R1 + 2R2) \ln \left[ \frac{V_{IN} - V_{CC}/3}{V_{IN} - 2V_{CC}/3} \right]}$$

From this it can be seen that oscillation begins as V<sub>IN</sub> rises above two-thirds V<sub>CC</sub>, so for maximum frequency sweep V<sub>CC</sub> should be as low as possible, ie 5 V. If R2 ≫ R1 so that R1 + 2.R2 ~ 2.R2 then the frequency range depends on the time constant C1.R2 and with the component values shown the output varies fairly linearly from 2 kHz to 15 kHz as V<sub>IN</sub> varies from 4 V to 12 V.

If the conditions R2 ≫ R1, V<sub>CC</sub> = 5 V and V<sub>IN</sub> > 4 V are satisfied, then

$$f \sim \frac{1}{C1R2} (V_{IN} \times 0.6 - 1.6)$$



If linearity is unimportant, the lower frequency limit can be substantially reduced (f = 0 when V<sub>IN</sub> < 2/3 V<sub>CC</sub>).

Capacitor C1 must be a low leakage type. The VCO output can also be modulated by applying a suitable signal to the control voltage (pin 5) of the 55.

## Computer-controlled Synthesizer Keyboard

P. McChesney, Wirral.

The technique described here produces an accurate analogue voltage from a synthesizer keyboard by processing digital data and converting it to an analogue voltage, replacing the well-known method that uses resistor ladders. It is primarily aimed at people who already possess a microcomputer and who are building a synthesizer, either of their own design, or using published circuits such as those which have appeared in ETI. Although the technique described might at first sight appear both more elaborate and expensive than the resistor ladder method, it possesses three major advantages — firstly, the number of discrete components is small and although they need not be of high precision, only minimal setting-up is required

to give high stability performance: secondly, software can be written to obtain a sequencer and also to produce special effects: thirdly, no substantial changes are required to make it polyphonic.

Figure 1 shows a diagram of the monophonic design. The keyboard uses a diode matrix such that when one key is pressed, a binary code is produced on the six-bit data bus. This code is linear (for example, if the fourteenth key is pressed, then binary 14 is produced) and of negative logic. It is therefore inverted either by using inverters as shown, or by writing software to perform the same task. The code then goes to the microcomputer (which, in the case of the author, is 6800-based but could have been any microcomputer) which continually checks the data received. If the code is zero, then the computer goes back and checks the code again and continues to do this until a code other than zero is received. Once this happens, the

computer searches a look-up table and outputs a corresponding eight-bit code which is passed to a D-to-A converter. The data in the look-up table follows a log-law and so the analogue output of the DAC likewise follows the log-law. This means that the VCO is linear, thereby making it both simpler and more accurate.

The strobe is optional and serves to prevent stray codes being generated if two keys are pressed simultaneously. Figure 2 shows the arrangement of resistors (tolerance not important) in the strobe. Each switch shown is the spare pole on the keyboard contact. Point X is at V<sub>CC</sub> when no key is pressed, at 0.5 V<sub>CC</sub> when one key is pressed and at 0.33 V<sub>CC</sub> when two keys are pressed, etc. A window discriminator is used to distinguish the case when only one key is pressed (monophonic operation). The output of the discriminator is adjusted to match the TTL levels required by the microcomputer input and the program is

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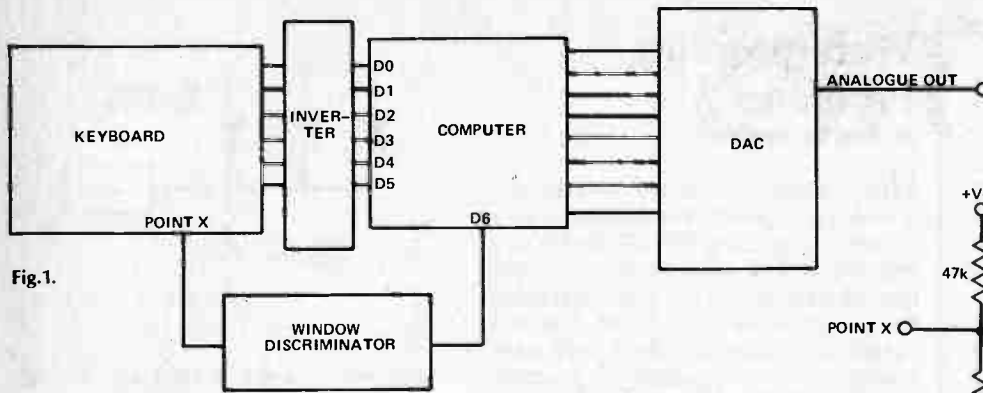


Fig. 1.

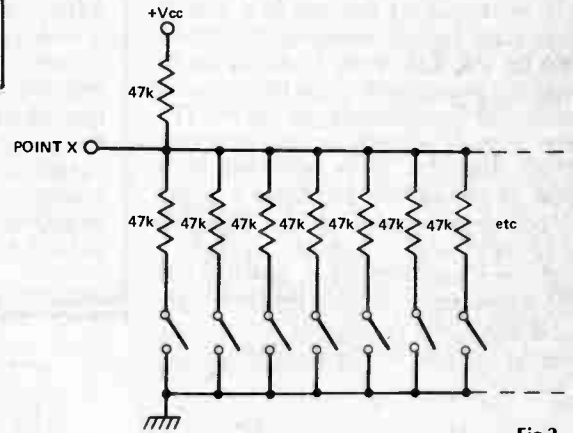


Fig. 2.

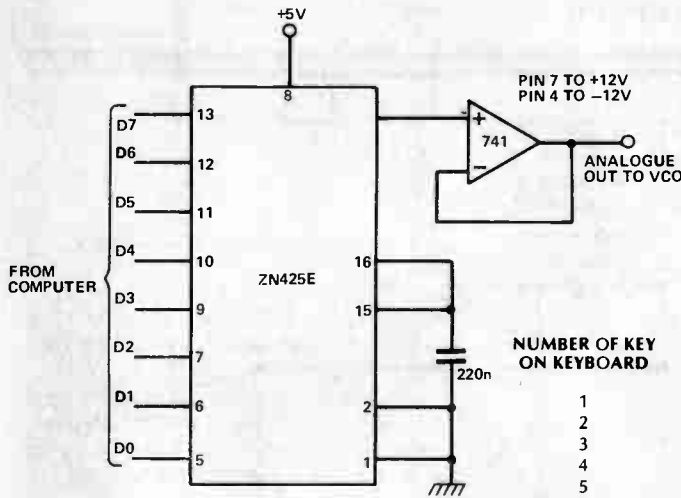


TABLE 1

NUMBER OF KEY ON KEYBOARD	SIX-BIT KEY CODE	EIGHT-BIT OUTPUT CODE
1	000001	00010001
2	000010	00010010
3	000011	00010011
4	000100	00010100
5	000101	00010101
6	000110	00010110
7	000111	00010111
8	001000	00011001
9	001001	00011011
10	001010	00011101
11	001011	00011110
12	001100	00100000
13	001101	00100010
14	001110	00100100
15	001111	00100110
16	010000	00101000
17	010001	00101011
18	010010	00101101
19	010011	00110000
20	010100	00110011
21	010101	00110110
22	010110	00111001
23	010111	00111100
24	011000	01000000
25	011001	01000100
26	011010	01001000
27	011011	01001100
28	011100	01010001
29	011101	01010101
30	011110	01011011
31	011111	01100000
32	100000	01100110
33	100001	01101100
34	100010	01110010
35	100011	01111001
36	100100	10000000
37	100101	10001000
38	100110	10010000
39	100111	10011000
40	101000	10100001
41	101001	10101011
42	101010	10110101
43	101011	11000000
44	101100	11001011
45	101101	11010111
46	101110	11100100
47	101111	11110010

TABLE 2

NUMBER OF KEY ON KEYBOARD	SIX-BIT KEY CODE	12-BIT OUTPUT CODE
1	000001	000100001111
2	000010	000100011111
3	000011	000100110000
4	000100	000101000011
5	000101	000101010110
6	000110	000101101010
7	000111	000110000000
8	001000	000110010110
9	001001	000110101111
10	001010	000111001000
11	001011	000111100011
12	001100	001000000000
13	001101	001000011110
14	001110	001000111111
15	001111	001001100001
16	010000	001010000101
17	010001	001010101011
18	010010	001011010100
19	010011	001011111111
20	010100	001100101101
21	010101	001101011101
22	010110	001110010000
23	010111	001111000111
24	011000	010000000000
25	011001	010000111101
26	011010	010001111101
27	011011	010011000010
28	011100	010100001010
29	011101	010101010111
30	011110	010110101000
31	011111	010111111110
32	100000	011001011001
33	100001	011010111010
34	100010	011100100001
35	100011	011110001101
36	100100	100000000000
37	100101	100001111010
38	100110	100011111011
39	100111	100110000011
40	101000	101000010100
41	101001	101010101110
42	101010	101101010000
43	101011	101111111101
44	101100	110010110011
45	101101	110101101000
46	101110	111001000001
47	101111	111100011010

written such that the code from the keyboard is ignored when the discriminator shows that more than one key has been pressed.

The look-up table of the micro-computer already referred to is given in Table 1. The first column gives the number of the key on the four-octave keyboard, the second column shows the binary number (positive logic) produced by the keys, whilst the third column shows the corresponding output number. Depending on the aural sensitivity of the listener, it is possible that at the bottom of the scale, one or two notes might sound slightly off-key due to inaccuracies of about 1.7%. To be undetectable, the note error should ideally be  $\pm 0.5\%$  but this is only obtainable using the 12-bit code given in Table 2. Unfortunately, outputting a 12-bit code would require the use of latches on the micro-computer output (which is normally eight bits wide), and also a 12-bit D-to-A converter which could be obtained by using two eight-bit DACs, scaling the output of one by 256 to give the correct weighting and then adding the two outputs together. However, for most applications the eight-bit code given in Table 1 is quite sufficient and has the advantage of requiring only one DAC.

## Active Audio Filter

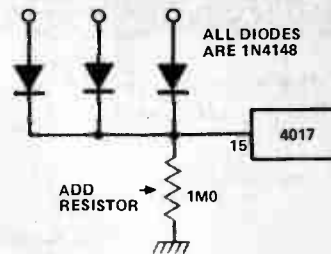
E. Vaughan, High Wycombe

The main drawback of passive IF filters is their insertion loss when using inductors, necessitating the use of a two or three stage high-gain preamp to compensate for this loss. With an active audio filter the insertion loss can be low, non-existent or even provide gain. In this FET filter there is virtually no insertion loss. When this filter is incorporated in a receiver and switched in, there is an apparent improvement in the signal-to-noise ratio and readability of signals. High and low frequency heterodynes and audio chatter outside the filter pass-band are quite noticeably attenuated, making listening much more pleasant.

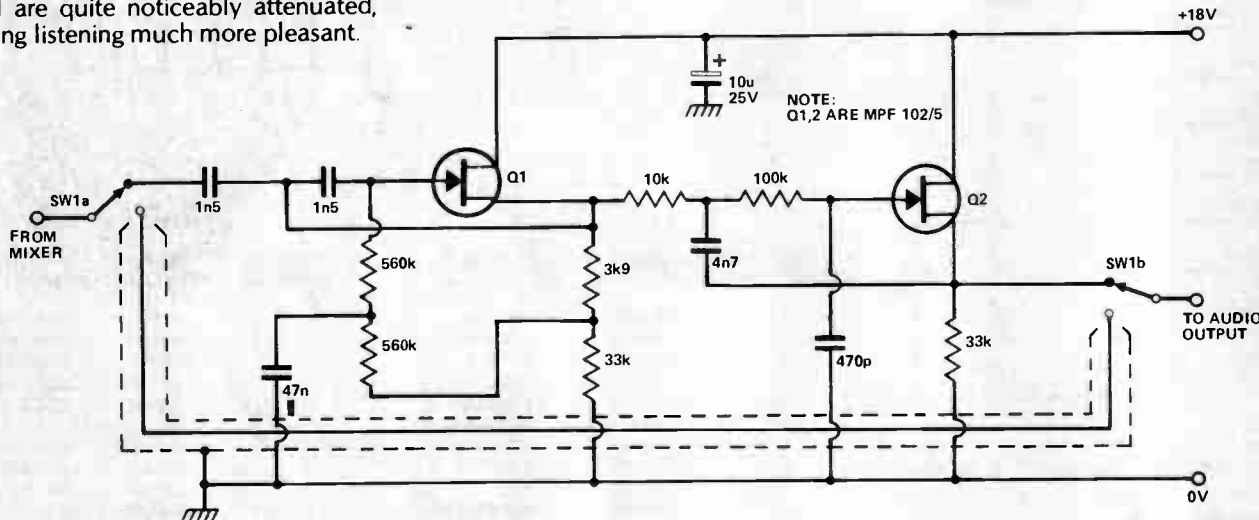
## Waterproofing Problems

J.E. Fox, Birmingham.

Here is a problem I encountered recently which may be of some interest to your readers. I was using 1N4148 diodes as a three-input OR gate to reset a 4017 decade counter. On trying to waterproof the circuit, it failed to count. This was eventually tracked down to a build-up of charge on the reset pin (pin 15). Insertion of a 1MΩ resistor to ground completely solved the problem. Obviously the



waterproofing eliminated any leakage from the reset pin which would occur on a normal PCB.



## Power Supply Metering

R.A. Fairs, Twickenham.

When constructing power supplies it is often desirable to include a voltmeter and ammeter in the actual unit. For cost purposes one meter may be made to read the two functions independently using a suitable switch. The first circuit depicts a simple way of achieving this using a single pole switch.

The paralleling resistor ( $R_p$ ) (which gives the original meter a greater current capability) is left in the circuit unswitched; since it has a very low value, there will be very little voltage dropped across it. For example, a 6 R meter having 10 mA FSD will have  $R_p = 0.06 R$  when converted to read 1 A.

$$R_p = R_m / I'$$

where  $I'$  = original current reading of meter for FSD

$I'$  = required current reading of meter for FSD

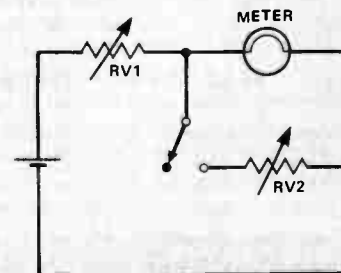
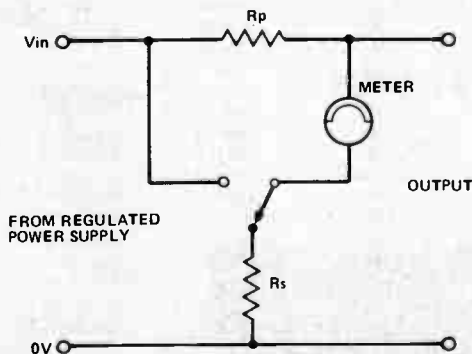
$R_m$  = Resistance of meter

The series resistor to convert the meter to a voltmeter is switched, its value is given by:

$$R_s = \frac{V_{IN} - I R_m}{I}$$

To find the resistance of the meter ( $R_m$ ) set up the second circuit, and proceed as follows:

- 1) Adjust RV1 for meter FSD.
- 2) Parallel RV2 with the meter via a switch, adjust RV2 so that the meter now reads 1/2 FSD.
- 3) Measure RV2: this is the resistance of the meter.



NOTE: RV1 IS HIGH VALUE RHEOSTAT  
RV2 IS LOW VALUE RHEOSTAT



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There are 2 stages, each stage having 9 encounters. In stage 1 the game speeds up with each encounter and in stage 2 the invaders attack from a closer position. After stage 2 the game reverts back to the beginning of stage 1, but the score, which is added and displayed after each encounter, is carried forward.

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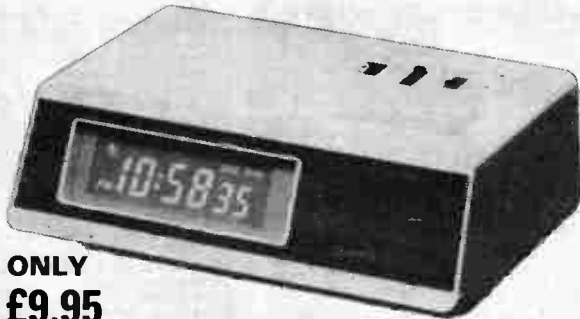


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SL490 32 Command Encoder/transmitter	2.40	Clip-on Plastic Reflector for IR LEDs, increases range	.20
ML922 10-channel receiver + 3 analogue outputs	4.20		

**NEW** ML925. A decoder designed for model/toy control, providing a 2-speed drive motor and three position latched steering system or a vehicle with momentary action steering and a third motor, eg. gun turret, winch, etc. Outputs also available for other facilities such as horn, turn indicators, headlights, etc. **2.10**

To make things EVEN EASIER, we have designed several new kits: —  
**MK6** — Simple Infra Red TRANSMITTER. A Pulsed infra red source which comes complete with a hand held plastic box. Requires a 9V battery. **4.20**  
**MK7** — Infra Red RECEIVER. Single channel, range approximately 20 ft. Mains powered with a triac output to switch loads up to 500W at 240V ac, but can be modified for use with 5 to 15V dc supplies and transistor or relay outputs. **9.00**  
 \*Special Price \*MK6 and MK7 together, Order as RC500K. **12.50**  
**MK8** — Coded Infra Red TRANSMITTER. Based on the SL490, the kit includes 2 IR LEDs, measures only 82x1.3 cms, and requires a 9V (PP3) battery. **5.90**  
**MK9** — 4 Way KEYBOARD. For use with the MK8 kit, to make a 4-channel remote control transmitter. **1.90**

**NEW** MK10 — 16 Way KEYBOARD. For use with the MK8 kit, to generate 16 different codes for decoding by the ML926 or ML926 receiver (MK12) Kit. **5.40**  
**MK11** — 10 On-Off Channel IR RECEIVER with 3 analogue outputs (0-10V) for controlling such functions as lamp brightness, volume, tone, etc. Other functions include an on/standby output and a toggle output, which may be used for sound muting. Based on ML922 decoder IC. Includes its own mains supply. **12.00**  
**MK12** — 16 Channel IR RECEIVER. For use with the MK8 kit with 16 on/off outputs which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Outputs may be latched or momentary, depending on whether the ML926 or ML928 is specified. Includes its own mains supply. **11.95**

**NEW** MK13 — 11-Way KEYBOARD. For use with MK8 and MK11 kits. Transmits programme step + and — analogue + and — (3), mute, normalise analogue outputs, and on/standby. **4.35**

## INTEGRATED CIRCUITS

555 Timer	21p
741 Op Amp	19p
AY-5-1230/2 Clock Timer	£2.80
AY-3-1270 Thermometer	£4.50
CA3080 Transconductance Op Amp	£8.20
CA3130 CMOS Op Amp	72p
ICL7106 DVM (LCD drive)	75p
LM377 Dual 2 W Amp	£1.45
LM379S Dual 6W Amp	£3.50
LM380 2W Audio Amp	80p
LM382 Dual /low noise Preamp	£1.00
LM386 250mW low voltage Amp	75p
LM1830 Fluid Level Detector	£1.50
LM2917 V-converter (14 pin)	£1.80
LM3909 LED Flasher / Oscillator	60p
LM3911 Thermometer	£1.20
LM3914 Dot/Bar Driver (linear)	£2.10
LM3915 Dot/Bar Driver (log)	£2.20
MM74C911 4 digit display controller	£6.50
MM74C926 4 digit counter with 7 seg o/p	£6.50
S5668 Touchdimmer	£2.50
SL440 AC power control	£1.75
SN76477 Complex Sound Generator	£2.52
TB800 5W Audio Amp.	88p
TB810AS 7W Audio Amp	£1.00
ICM7555 CMOS 555 Timer	78p
TOA1024 Zero Voltage Switch	£1.20
TDA2020 20W Audio Amp	£2.85
TL081 J-FET Op Amp	37p
TL082 Dual J-FET Op Amp	60p
ZN1034E Timer	£1.80
TMS 1121 Clock/7 day timer	£8.50

All ICs supplied with Data Sheets  
Data Sheets only — per device **10p**

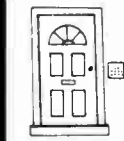
## CMOS

4000	17p	4019	42p	4069	19p
4001	18p	4023	22p	4070	19p
4002	18p	4025	21p	4071	18p
4007	17p	4026	£1.30	4077	26p
4011	19p	4027	40p	4081	20p
4012	17p	4028	50p	4093	54p
4013	38p	4040	80p	4501	24p
4015	75p	4049	38p	4511	90p
4016	35p	4050	40p	4514	£1.80
4017	70p	4060	£1.08	4516	£1.80

## CAPACITORS

<b>Polyester 250V</b>					
0.01	6p	0.22	12p		
0.002	6p	0.33	12p		
0.033	7p	0.47	15p		
0.047	7p	0.68	18p		
0.068	7p	1.0	24p		
0.1	7p	1.5	27p		
0.15	12p	2.2	31p		
<b>Electrolytics A Axial R Radial</b>					
63V	1.0 R	5p	16V	10 R	5p
	2.2 R	5p		22 R	5p
	4.7 R	6p		33 R	5p
	10 R	7p		47 R	6p
	47 R	12p		100 R	8p
	22 A	8p		220 R	11p
	47 A	10p		470 R	14p
	100 A	14p		1000 R	20p
	110 A	15p	10V	47 A	8p
	470 A	24p		100 A	8p
	1000 A	34p		220 A	12p
<b>Tantalum (bead)</b>					
35V	0.1	9p	10V	22	20p
	0.22	9p	6.3V	33	20p
	0.47	9p		47	27p
	1.0	9p	3V	100	27p
25V	2.2	10p			
	4.7	14p			
	10	20p			
<b>Ceramic 50V</b>					
100pF	4p	1,000pF	4p		
220pF	4p	2,200pF	4p		
470pF	4p	4,700pF	6p		
		10,000pF	6p		

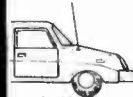
## EVERY DOOR SHOULD HAVE ONE



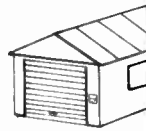
Whatever kind of door you have, our New Electronic Combination Lock will enable you to open it easily but make things very difficult for unwelcome visitors. The unit, which comes complete with a 10-way keypad, requires an easily remembered four digit code to be entered before the door can be opened, while the intruder has over 5,000 combinations to choose from. The code can be easily changed by means of a pre-wired plug and a momentary or latched output version can be made. The kit has even more uses in a car where it may be used to disable the ignition. Another useful feature is the Save Button. This stores the combination number, enabling the car to be used by authorised persons such as garage personnel without disclosing the code.

The complete kit measures 7 x 6 x 3 cms. deep and consumes a mere 40uA when not in use, and will drive a 5V to 15V (750mA) solenoid or relay coil (not supplied) directly. So why not treat your door to a new lock for

**ONLY £10.50**



and think about all the keys you can lose or forget without ever locking yourself out. As featured in PE, May '81.



## TRIACS

400V Plastic Case (Texas)		
3A TIC2060		46p
8A TIC226D		58p
12A TIC236D		85p
16A TIC246D		95p
25A TIC263D		190p
6A with trigger 04006LT		80p
8A isolated tab TXAL2268		65p
Diac		5p

## VOLTAGE REGULATORS

Available in 5V 12V & 15V versions.		
78L series 100mA pos.		26p
79L series 100mA neg.		60p
78 series 1A pos.		52p
LM317T adjustable 1.2V-37V 1.5A		£1.80
79 Series 1A neg-5vnl		75p

## RECTIFIERS

1N4001 1A/50V	4p
1N4004 1A/400V	6p
1N5401 3A/50V	8p
1N5404 3A/400V	10p
1A 50V Bridge	19p
1A 400V Bridge	22p
3A 50V Bridge	48p
3A 400V Bridge	58p

(Bridge rectifiers are miniature PCB mounting types)

## VAMOS POWER FETS

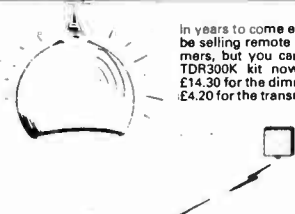
VN10KM 0.5A/60V (TO92)	52p
VN66AF 2A/60V (TO220)	88p

## TRANSISTORS

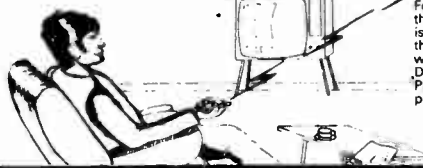
BC108	8p	BF50	20p
BC182	8p	TIP31A	20p
BC182L	8p	TIP32A	40p
BC212	8p	2N3055	48p
BC212L	8p	2N3442	90p
BC337	18p	2N3819	20p

## ARE YOU SITTING COMFORTABLY?

Our new TDR300K Touch Dimmer Kit will ensure that you are. Based on our highly successful TD300K touch controlled dimmer kit, the TDR300K incorporates an infra red receiver, enabling the lamp brightness to be varied and switched on or off by touch or remotely by means of a small hand held transmitter. The complete kit, which includes easy to follow instructions, will fit into a plaster depth box and the plastic front plate has no metal pads to touch, ensuring complete safety. Even a neon is included to help you locate the switch in the dark.



In years to come everyone will be using remote control dimmers, but you can have your TDR300K kit now for ONLY £14.30 for the dimmer unit and £4.20 for the transmitter.



For the more athletic of you, the TD300K Touchdimmer kit is still available at £6.50 and the TDE/K Extension kit, for 2-way switching etc., is £2. DON'T FORGET to add 50p P&P and 15% VAT to your total purchase.

## 24HR. CLOCK/APP. TIMER KIT

Switches any appliance up to 1KW on and off at preset times once per day Kit contains AY 5 1230 IC, 0.5" LED display mains supply, display drivers switches, LEDs triac PCBs & full instructions	
CT1000K Basic Kit	£14.90
CT1000KB with white box (56/131 x 71mm)	£17.40
Ready Built	£22.50

## DIGITAL VOLTMETER/THERMOMETER KIT

Based on the CL 7106. This kit contains a PCB, resistors, pre-set, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer using a single diode as the sensor. Requires a 3Ma 9V supply (PP3 battery).	
	£19.50

## DISCO LIGHTING KITS

Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto isolated audio input.

**OL1000K**  
This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimming control. **£14.80**

**DL21000K**  
A lower cost version of the above, featuring unidirectional channel switching with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum. **£8.00**

Optional Opto Input OLA1 **80p**

## MINI KITS

These kits form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB, short instructions and all components.

**MK1 TEMPERATURE CONTROLLER/THERMOSTAT**  
Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater. **1KW £4.**

**MK2 SOLID STATE RELAY**  
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. **£2.60**

**MK3 BAR/DOT DISPLAY**  
Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. **£4.75**

**MK4 PROPORTIONAL TEMPERATURE CONTROLLER**  
Based on the TOA1024 Zero voltage switch, this kit may be wired to form a "burst fire" power controller or a proportional temperature controller enabling the temperature of an enclosure to be maintained to within 0.5°C. **3KW £5.55**

**MK5 MAINS TIMER**  
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component changes. Maximum load 1KW. **£4.50**

## LEDS

0.1" Red	9p
0.1" Green	12p
0.1" Yellow	12p
0.2" Red	9p
0.2" Green	12p
0.2" Yellow	12p
0.2" clips	3p
Rectangular Red 18p	
Rectangular Green 17p	
Rectangular Yellow 17p	
Flat Face Rectangular, Triangular, Arrowhead Square	3p
Red	17p
Green	20p
Rec. Yellow	20p

## MINI TRANSFORMERS

Standard mains primaries 240V a.c.	
100mA secondaries	
6-0-6V	80p
9-0-9V	85p
12-0-12V	90p
Opto isolated TRIAC	
M D C 3 0 2 0	
0.6A/400V	£1.10

## DISPLAYS

DL504 Red 0.5" c.c. pin compatible with FND 504	75p
DL307 Red 0.3" c.c. pin compatible with DL707	75p
DL727 Dual 0.5" c.c. Red	£1.50
MP463 0.5" c.c. Red, four digit multi-plexed clock display	£2.20

## O.I.L. I.C. SOCKETS

8 pin	8p	18 pin	17p
14 pin	12p	28 pin	24p
16 pin	14p	40 pin	36p

Soldercon Pins **50p/100**

## ZENER DIODES

400mW 3V 30V	15p
3W 7.5 27V	

## RESISTORS

1/4W 10 ohm-10M	
E12 series	
Pack of 10 (one value)	10p
10 Packs (10 values)	80p

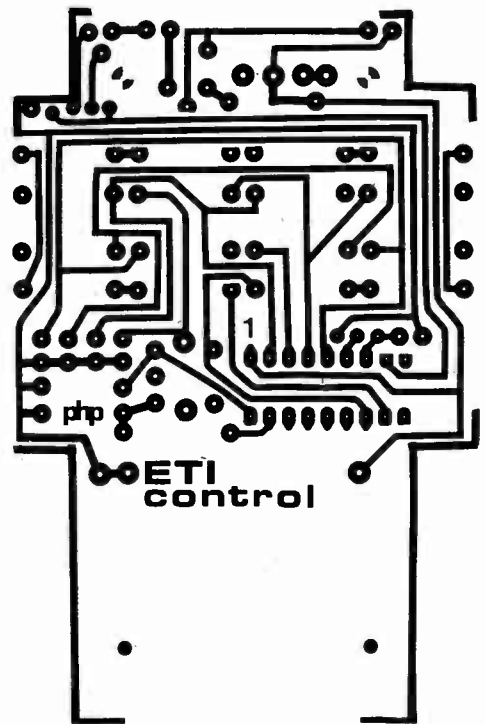
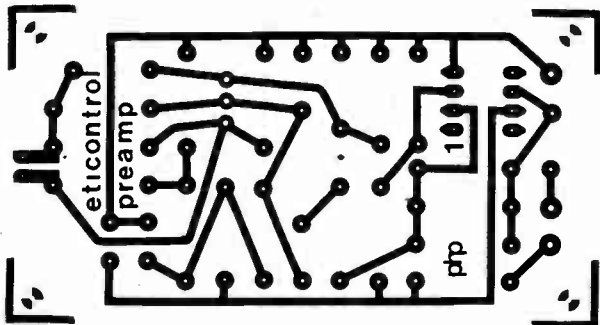
ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION. ADD 50p P&P and 15% VAT TO TOTAL. OVERSEAS CUSTOMERS ADD £1.50 (Europe), £4 (elsewhere) for P&P. Send us for price list and with all enquiries. Callers welcome 9.30-5.00 (Mon-Fri) 10.00-4.00 (Sat).



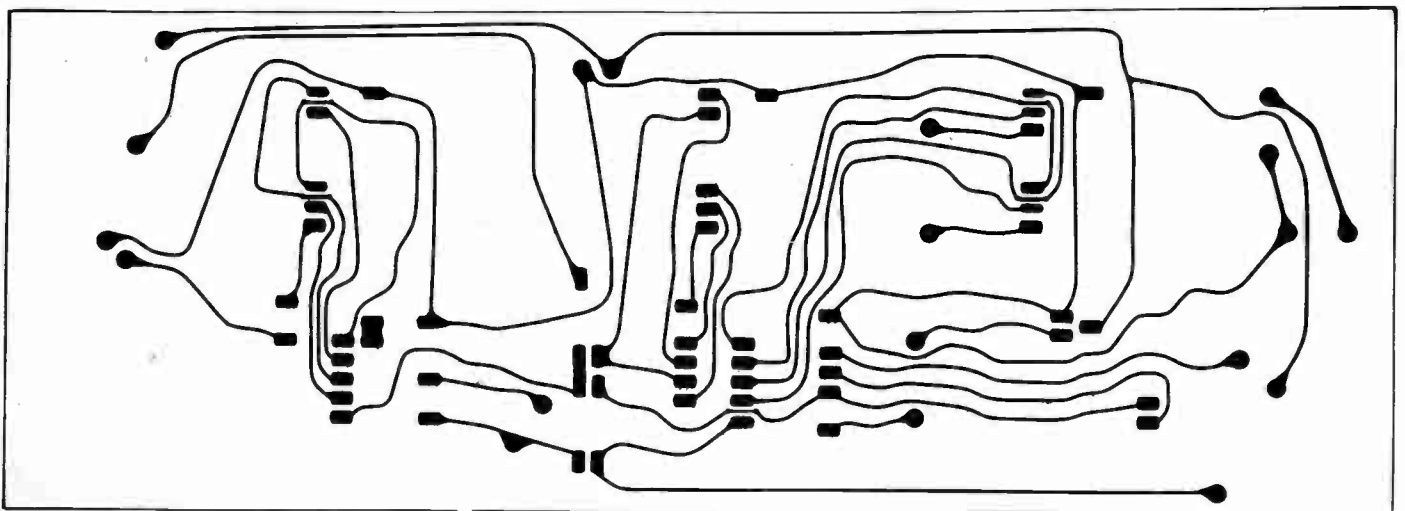
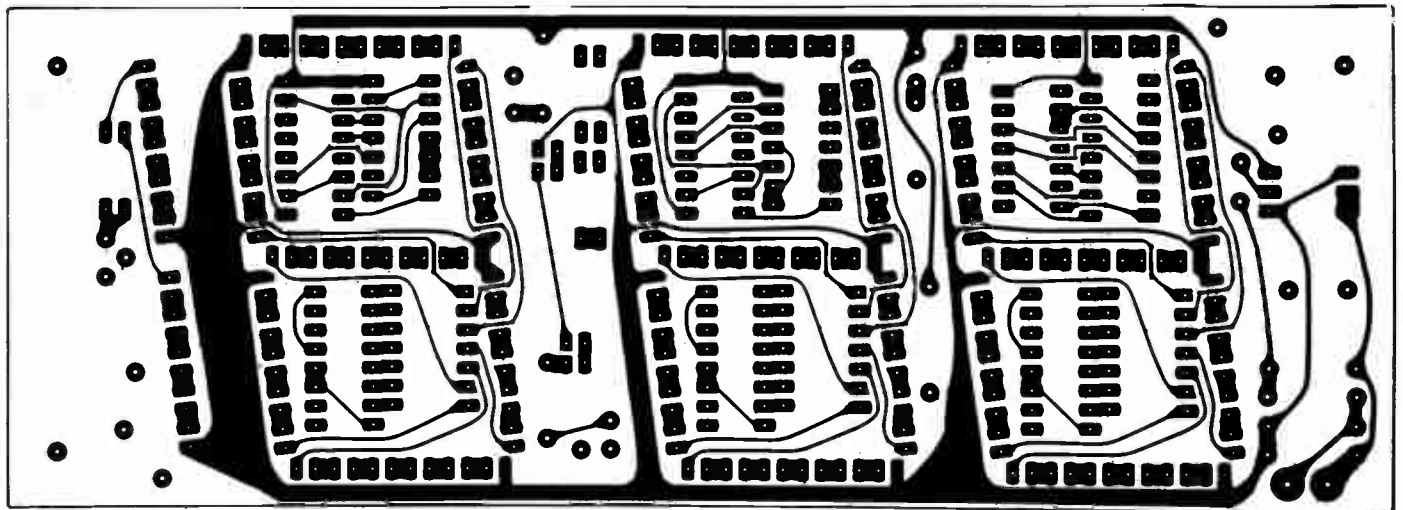
**TK Electronics**  
(ETI), 11 BOSTON ROAD  
LONDON W7 3SJ. 01-579 9794/2842

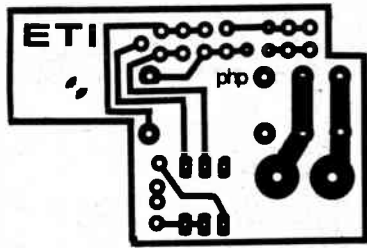


# PCB FOIL PATTERNS



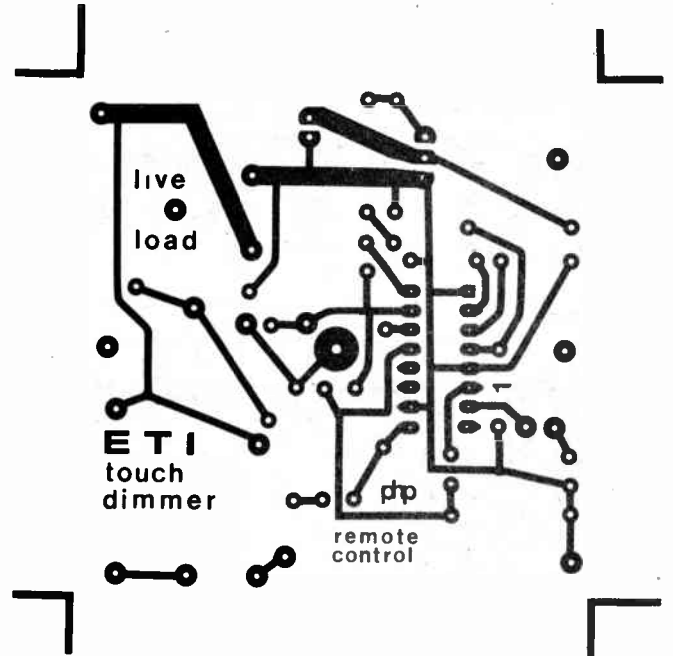
Above: The Remote Control preamp board.  
Right: Remote Control transmitter board.  
Below: The two sides of the Digital Clock PCB.





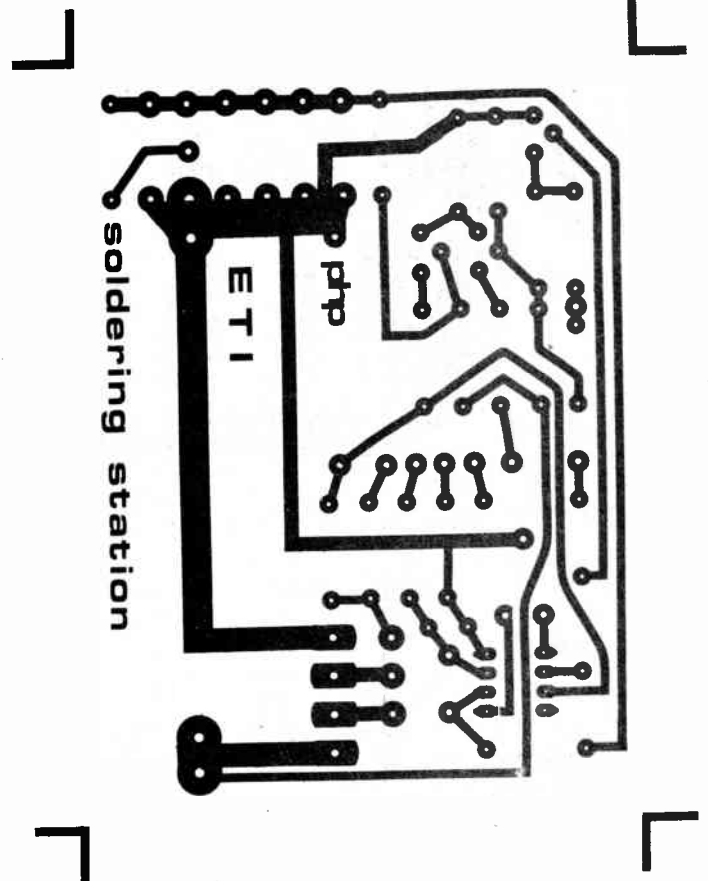
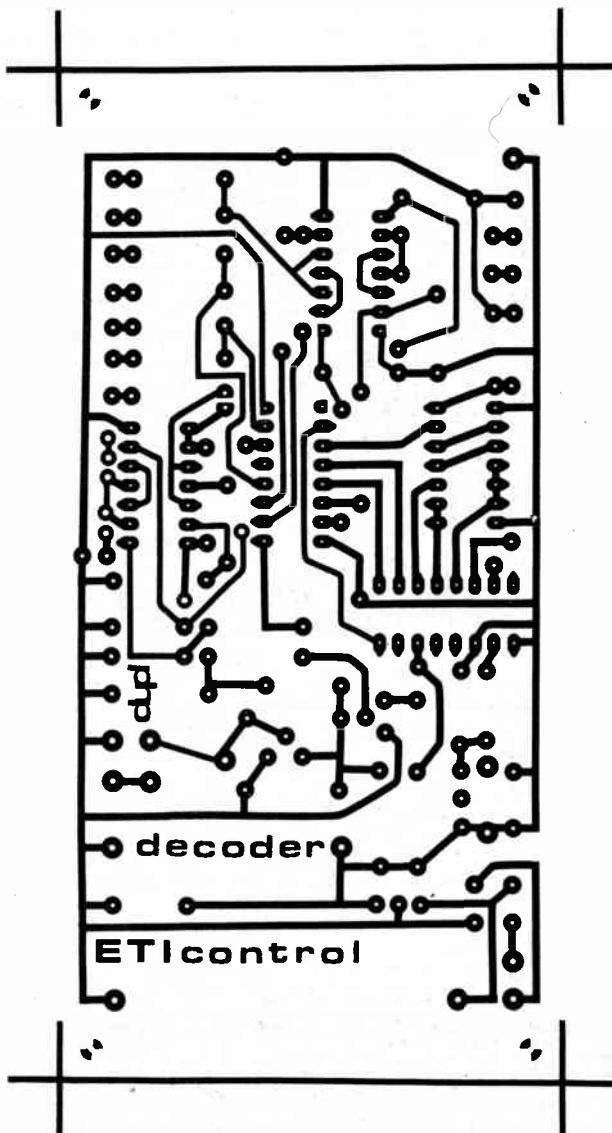
Above: Power switch foil pattern.

The foil patterns for the 1024 Composer are too large to fit into the magazine. You can obtain them by sending us a large SAE. Commercial firms should note that Powertran hold the copyright on the board.



Above: Touch dimmer PCB.  
Below: Foil pattern for the Microstation.

Below: The Remote Control decoder board.



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TM 352 L.C.D. hand held DMM	£57.44		

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DM 350 L.E.D. digital multimeter	£83.38	Bench Function Generator	
TM 353 L.C.D. digital multimeter	£96.60	TG 100 function generator	£90.85
DM 450 L.E.D. digital multimeter	£113.85	Fully Portable Oscilloscope	
TM 351 L.C.D. digital multimeter	£113.85	SC 110 Oscilloscope	£159.85

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PFM 200 frequency meter	£57.27	MON 1A 2" Video monitor	£109.25

Eprom Programmer		PKW 5000 Eprom Programmer	£918.85
------------------	--	---------------------------	---------

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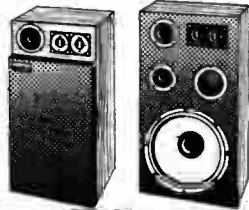
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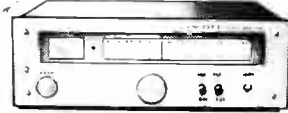


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ON DEMONSTRATION TO CALLERS



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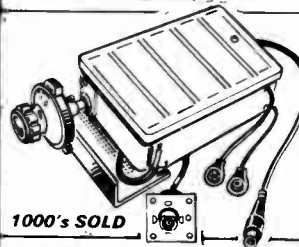
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- ★ HI-FI 403. 60/100 watt 3 speaker 10" system  
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- ★ HI-FI 603. 80/150 watt 3 speaker 12" system  
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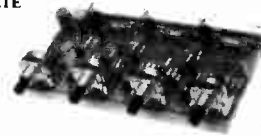
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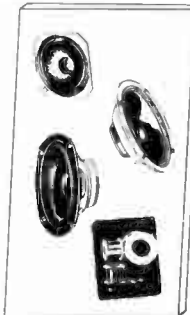
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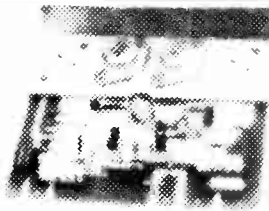
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Specification	PFA80	PFA120
Bandwidth	10Hz—	100KHz± 1dB
Output power	BOW (Vs = ± 50V)	120W (Vs = ± 55V)
RMS into 8Ω		
T.H.D.	< 0.008%	< 0.005%
from 1w to rated output at all audio frequencies		
SNR	120dB	120dB
Slew Rate	20V/μs	20V/μs
Gain	X22	X22
Rin	30K	30K
Vs max.	± 70V	± 70V
Cost (built)	£15.95	£22.85
(kit)	£13.95	£20.85



**PFA 120**  
(150W plus into 8Ω. 300W into 4Ω)

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### Specification

B.W. 20Hz-30KHz ± 1dB  
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SNR 85dB (ref. 5mV RIAA)  
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Vs Output 1V (clips at +20dB)  
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LM1458	40p	TBA120S	60p	TDA2560	150p
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MC1349	90p	TBA810S	80p		
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35p				TBA641B				7905				4043/4				99p				7475				28p				AC187/8				22p				BF183				34p				ZTX504				24p											
CERAMIC CAP (50V)				TBA800				7912/15				4047				105p				7476				30p				AC187K				30p				BF184/5				25p				ZTX504				24p											
4p				TBA810S				7918/24				4048				60p				7480				32p				AD149				40p				BF194/5				12p				2N698				20p											
4p				ZN414				OPTO/ELECTRONIC				4049				50p				7485				140p				AD161/2				28p				BF196/7				12p				2N706				14p											
5p				ZN1034E				SN75777				40508				50p				7486				18p				AF114				30p				BF198				10p				2N914				20p											
5p				DIODES				FND500				4066				60p				7490				28p				AF124				35p				BF200				23p				2N918				35p											
5p				OA47				SN76115N				4068/9				22p				7491				57p				AF125/6				35p				BF2248				14p				2N1302/3				35p											
5p				OA91				ORP12				4070B/1				22p				7492/3				30p				AF127				35p				BF2448				*22p				2N1304				35p											
5p				OA200				DL704				4072/3				22p				7494				50p				BC107/8				10p				BF258				28p				2N1306				30p											
5p				OA202				DL707				4081/2				26p				7495				40p				BC109				10p				BF259				40p				2N1308				35p											
5p				1N916				LEDs:				4086				80p				7496				37p				BC140				20p				BFR39				30p				2N1613				25p											
5p				1N916				0.125" & 0.2"				4510				100p				7497				200p				BC142/3				30p				BFR40				30p				2N1711				13p											
5p				1N4148				Red				45118				100p				74100				60p				BC147/8				10p				BFR79				32p				2N1893				25p											
5p				1N4001/2				Green				4516/8				105p				74105				43p				BC149				10p				BFR80				20p				2N2217				18p											
5p				1N4003				Yellow				4520/8				105p				74107				22p				BC157/8				12p				BFX29				25p				2N2219				23p											
5p				1N4004/5				Rect. Green				TTL				7400/1				16p				74110				40p				BC167				14p				BFX84				25p				2N2222A				23p							
5p				1N4006/7				0.125" Clip				7400/2/3				16p				74118				84p				BC171				10p				BFX85/6				20p				2N2369				17p											
5p				1N5400				0.2" Clip				7404/5				16p				74121				25p				BC173				8p				BFY52				22p				2N2646				46p											
5p				1N5400				DIL SOCKETS				7406/6				18p				74122				30p				BC177/8				16p				BFY52				22p				2N2904/5				21p											
5p				1N5401				8 pin				7407				25p				74123				50p				BC179				16p				BRY39				50p				2N2906/7				21p											
5p				1N5402				14 pin				7408				22p				74125/6				42p				BC182				10p				BSX19				12p				2N2926G				20p											
5p				1N5404				16 pin				7409				13p				74132				65p				BC182L				*8p				BSX20				22p				2N3053				20p											
5p				1N5404				18 pin				7410				13p				74141/5				46p				BC1838				10p				BCS205				150p				2N3054				30p											
5p				1N5404				22 pin				7411/2				17p				74150				85p				BC184				10p				BU208				210p				2N3055				45p											
5p				1N5404				28 pin				7413				30p				74151				65p				BC186				25p				MJ2955				110p				2N3442				140p											
5p				1N5404				40 pin				7414				45p				74153				43p				BC187				15p				MJE340				52p				2N3702 to				11p											
5p				BRIDGE				CMOS AE				7416				20p				74154				66p				BC207/9				13p				MJE3055				80p				2N3711				11p											
5p				RECTIFIERS				4000				7417				25p				74155				46p				BC212				10p				MPF102				45p				2N3772				*70p											
5p				W02M				40018				7420				15p				74156				42p				BC212L				*8p				MPF104/5				40p				2N3773				250p											
5p				W06M				4002				7421				30p				74157				38p				BC213L				10p				MPF106				45p				2N3819				21p											
5p				1A/50V				40068				7422				26p				74160				57p				BC214				10p				OC28/35				50p				2N3820				40p											
5p				1A/200V				4007				*16p				7427				20p				74161				55p				BC214L				*8p				TIP29				40p				2N3823				70p							
5p				1A/400V				4008				85p				7428				28p				74162/3				60p				BC238				18p				TIP29B				42p				2N3866				85p							
5p				1A/600V				4009				42p				7430				16p				74164/5				56p				BC2618				23p				TIP30				40p				2N3903/4				15p							
5p				1A5/75V				4010				48p				7432				28p				74166				95p				BC301/3				32p				TIP30B				42p				2N3906				18p							
5p				2A/50V				40118				20p				7433				38p				74173				110p				BC328				17p				TIP31				30p				2N4037				45p							
5p				2A/100V				4012				25p				7437				14p				74174/5				55p				BC461				40p				TIP31A				31p				2N4058				10p							
5p				3A/100V				40138				45p				7438				18p				74176/7				70p				BC477				35p				TIP32				40p				2N4059				10p							
5p				3A/600V				4014/58				80p				7440				13p				74180				35p				BC478				20p				TIP33				65p				2N4060				10p							
5p				THYRISTORS				4016				44p				7441				52p				74181				80p				BC479				23p				TIP33C				70p				2N4061				10p							
5p				4A/300V				4017				70p				7442				32p				74182				45p				BC547/8				12p				TIP34A				75p				2N4548				40p							
5p				4A/400V				4018				85p				7443				60p				74190				50p				BC549				12p				TIP358				200p				2N4549				40p							
5p				12A/100V				4019				50p				7444				100p				74191				90p				BC557/8				14p				TIP36A				200p				2N5257				30p							
5p				8A/400V				40208				100p				7445				64p				74192/3				50p				BC559				14p				TIP36B				210p				3N128				50p							
5p				4001B				4016A				7473				16p				ZD5V6				5p				BFY50				15p				CA3090AQ				70p				160 uF/25V				4p				W06				19p			
5p				4007A				4017A				7490				23p				ZD9V1				5p				TIP31A				22p				SN76115N				50p				.640 uF/16V				4p				S01				23p			
5p				4011B				7420				OA91				5.5p				1N5404				10p				TIP3055				22p				33uF/40V				4p				W005				16p				MANY MORE							

# 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!**  
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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



Panel size 19.0" x 3.5". Depth 7.3"

**NEW!**  
**COMPLETE KIT ONLY**  
**£64.90 + VAT!**

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 section powered by separate power supplies fed from a common toroidal transformer. Input sensitivity is 775mV.

Even simultaneously driven, each channel delivers over 100W rms into 8 ohms. The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.

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## 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%.

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!



## 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!**

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**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)



## Lights-on Reminder

If you are apt to forget to switch on the car lights at the onset of darkness, this indicator lamp should prove useful. It switches on when the ambient light level drops below a preset threshold value, unless the sidelights have been switched on already. If the lamp does come on, it is automatically cancelled when the sidelights are turned on.

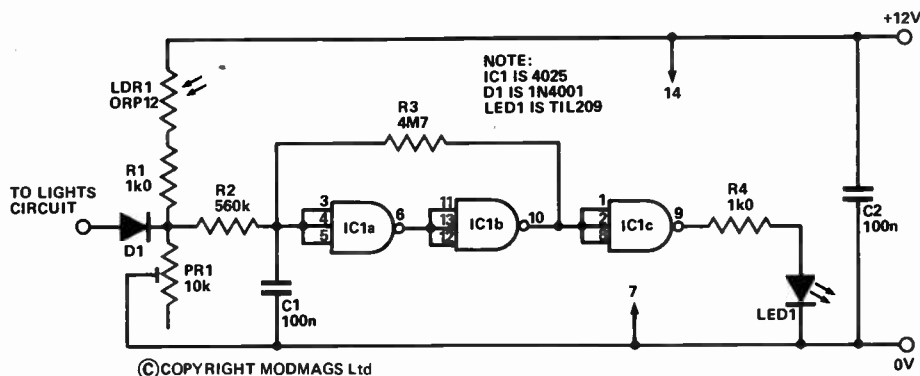
The circuit utilizes a CMOS 4025 IC, which is a triple three-input NOR gate. In this circuit the three inputs of each gate are connected together so that each gate actually operates as a simple inverter. IC1a and IC1b are wired in series and R2 and R3 provide positive feedback, giving a sort of Schmitt trigger action. IC1c is connected as an inverter/buffer stage at the output of the trigger circuit, and this drives indicator lamp LED1 by way of current limiting resistor R4. If the input voltage to the trigger circuit is more than about half the supply voltage

LED1 will be switched off, but it will be turned on if the input voltage falls below about half the supply potential.

The input of the trigger is fed from a potential divider circuit which consists of LDR1, R1 and PR1. When the light level becomes inadequate, the resistance of LDR1 increases and gives an input voltage to the trigger circuit sufficiently low to cause LED1 to switch on. The point at which this occurs can be adjusted by PR1.

D1's anode connects to the junction of the side lights and the switch that controls them. Assuming the vehicle is of the usual negative earth variety, D1 will be reverse biased when the lights are switched off and will not affect the circuit. When the lights are switched on it is forward biased and the input of the trigger circuit is taken to almost the full positive supply voltage. This ensures that LED1 is switched off and the photocell is rendered ineffective.

The circuit can only be used with positive earth systems if D1 and the connection to the sidelights are omitted, and LED1 will not then be muted by switching on the sidelights.



## Power Controller

This is a conventional diac-triac mains power controller which can handle loads of up to about 300 W or so (higher loads of up to about 1000 W can be controlled if the triac is fitted with a suitably substantial heatsink).

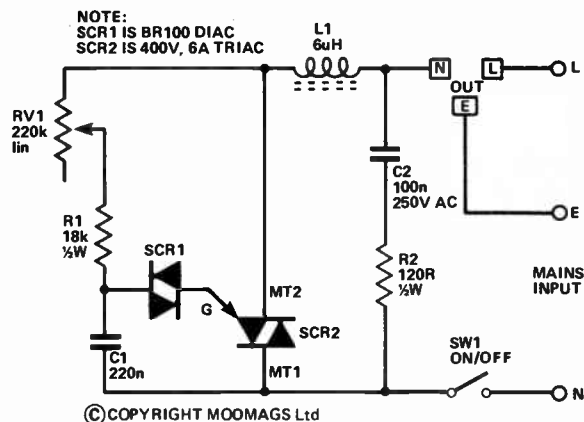
Circuits of this type operate by switching full power to the load for only part of each half cycle. For example, half power is obtained by switching power through the load for only the second half of each half cycle. Since the switching device (which is triac SCR2 in this circuit) is either switched fully on or off it dissipates little power, and good efficiency is obtained.

Full power is obtained with RV1 at minimum resistance, as the voltage on C1 is then virtually equal to the mains voltage. Thus the voltage on C1 reaches the trigger potential of diac SCR1 early in each mains half cycle, causing SCR1 to fire and switch on the triac for the major part of each half cycle. The triac switches itself off at the end of each half cycle when the current flowing through it falls to zero, so that it is ready to start afresh at the beginning of each new half cycle.

As RV1 is adjusted for increased resistance, the voltage on C1 lags further behind the mains voltage so the triac is not triggered until later in each half cycle, giving reduced output power. The triac will fail to trigger at all with RV1 set towards maximum resistance, giving zero output power.

Due to its fast switching time the circuit inevitably generates strong radio frequency signals, and L1, C2 and R2 are included to largely suppress these signals and prevent the unit from radiating RFI. Make sure that L1 has a sufficiently high current rating for the load in use.

In the interest of safety the unit should either be housed in an earthed metal case, or a plastic case should be used (with any exposed metalwork being earthed). RV1 should be a type having a plastic spindle and it should be fitted with a plastic control knob. Do not touch any of the wiring while the unit is plugged into the mains supply.



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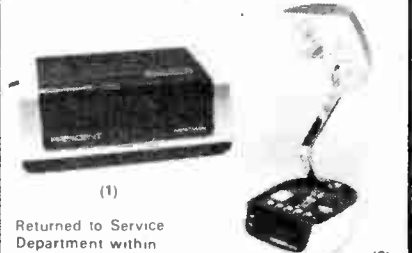
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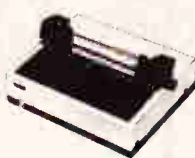
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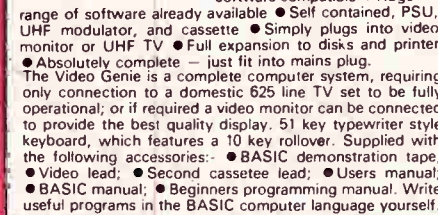
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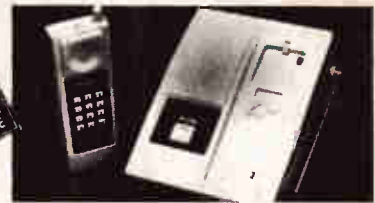
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