

electronics today

MARCH 1979

INTERNATIONAL

50p



STAGE LIGHTING CONTROLLER

Cellular Logic * Analogue To Digital

Visual Hi-Fi * Magnetic Amplifiers

... NEWS . . . PROJECTS . . . MICROPROCESSORS . . . AUDIO . . .

CHROMATHEQUE 5000

5 CHANNEL LIGHTING EFFECTS SYSTEM

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



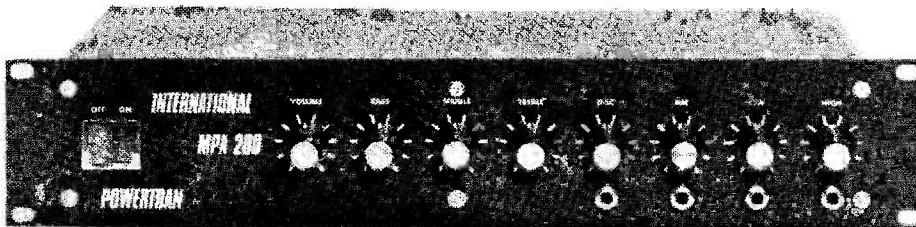
**COMPLETE KIT
ONLY
£49.50 + VAT!**

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!

LAST MONTH'S FRONT COVER FEATURE!

100 WATT (rms into 8Ω) MIXER/AMPLIFIER



**COMPLETE KIT
ONLY
£49.90 + VAT!**

Parts to build power amp module only. (PCB, res, caps, s/cs)

£10.60 + VAT

Custom designed toroidal transformer with mounting clamp

£10.50 + VAT

Parts for power supply only (caps, rects, fuses, F. holders)

£3.40 + VAT

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

TRANSCENDENT 2000

SINGLE BOARD SYNTHESIZER

LIVE PERFORMANCE SYNTHESIZER DESIGNED BY CONSULTANT TIM ORR (FORMERLY SYNTHESIZER DESIGNER FOR EMS LIMITED) AND FEATURED AS A CONSTRUCTIONAL ARTICLE IN ELECTRONICS TODAY INTERNATIONAL.

The TRANSCENDENT 2000 is a 3 octave instrument transposable 2 octaves up or down giving an effective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with both low and high pass outputs and a separate dynamic 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 between £500 and £700!



**COMPLETE KIT
ONLY
£172.00 + VAT!**

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!

POWERTRON

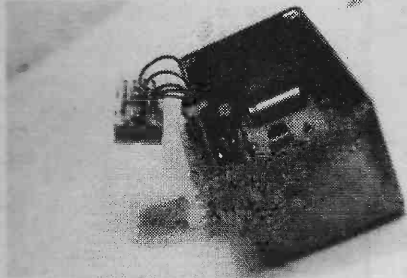
Cabinet size 24.8" x 15.7" x 4.8" (rear) 3.4" (front)

**ORDERING INFORMATION
AND MORE KITS ON PAGE 6**

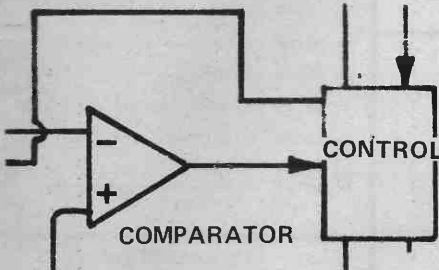
electronics today

MARCH 1979 VOL 8 NO 3

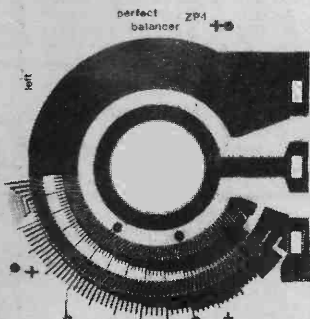
INTERNATIONAL



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p14



Gold in them hills p75

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OUR THANKS TO LAMBETH TOWN HALL FOR THE COVER PICTURE THIS MONTH, A SCENE FROM THEIR PRODUCTION OF TREASURE ISLAND.

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ALL PRICES IN PENCE EACH UNLESS OTHERWISE STATED

CAPACITORS				Electrolytic Can Type				Miniature Low Value					
Electrolytic Axial Leads -10% to +50% Tol				High Ripple, 1EC Grade 1, Low E.S.R. Supplied complete with Vertical Fixing Clip				Polystyrene, Axial, -1% Tol, > 63V D.C. Wkg					
μ F	V.d.c.	16	25	2200 μ F	16V	2.6A	3.6A	166	184	424	632	630	629
1.0				4700 μ F	16V	5.9A	5.1A	222	222	100	16	6	6
1.5				10000 μ F	16V	9.8A	12.7A	346	346	120	16	8	8
2.2				22000 μ F	16V	13.8A	18.7A	470	470	150	16	8	8
3.3				2200 μ F	25V	1.3A	1.8A	175	175	180	16	6	6
4.7				4700 μ F	25V	4.6A	6.4A	201	201	220	16	6	6
6.8				10000 μ F	25V	8.0A	11.2A	264	264	270	18	8	8
10				22000 μ F	25V	12.8A	17.9A	438	438	330	18	8	8
15				1000 μ F	40V	0.9A	1.2A	168	168	470	18	5	5
22				2200 μ F	40V	2.4A	3.3A	188	188	560	16	5	5
33				4700 μ F	40V	5.6A	7.8A	231	231	680	16	5	5
47				10000 μ F	40V	9.2A	12.8A	367	367	820	16	5	5
100				1000 μ F	70V	1.8A	2.5A	190	190	1000	16	5	5
150				2200 μ F	70V	4.0A	5.6A	235	235	1200	16	5	5
220				4700 μ F	70V	7.5A	10.5A	376	376	1500	18	6	6
330				10000 μ F	70V	12.8A	17.9A	438	438	1800	18	6	6
470				2200 μ F	100V	4.0A	5.6A	282	282	2200	18	6	6
680				4700 μ F	100V	7.8A	10.9A	346	346	2700	18	6	6
1000										3300	18	6	6
1500										3900	18	6	6
2200										4700	23	7	8

Tantalum Bead				Electrolytic Radial Leads				Polyester Radial Leads			
20% Tol				-10% to +50% Tol				Dipped Type, -20% Tol, > 250V D.C. Wkg, C280/352 Style			
μ F	V.d.c.	3.15	6.3	μ F	V.d.c.	6.3	10	μ F	V.d.c.	352	360
0.1				47				0.01		352	360
0.15				1.0				0.015		360	PHE280
0.22				1.5				0.022		360	PHE280
0.33				2.2				0.033		360	PHE280
0.47				3.3				0.047		360	PHE280
0.68				4.7				0.068		360	PHE280
1				6.8				0.1		360	PHE280
1.5				10				0.15		360	PHE280
2.2				15				0.22		360	PHE280
3.3				22				0.33		360	PHE280
4.7				33				0.47		360	PHE280
6.8				47				0.68		360	PHE280
10				68				1		360	PHE280
15				100				1.5		360	PHE280
22				150				2.2		360	PHE280
33				220				3.3		360	PHE280
47								4.7		360	PHE280
68								6.8		360	PHE280
100								10		360	PHE280

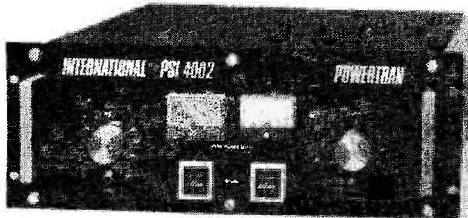
Professional Components for the Amateur

CASES				HARDWARE			
Small Desk Console - Boss Industrial Mouldings				D.I.L. Sockets			
Slope Front Console, Recessed Top				8 Pin Low Profile Socket Tin			
ABS Base, C/W Brass Bushes, In Orange				14 Pin Low Profile Socket Tin			
1mm Aluminium Top Panel Finished Grey				16 Pin Low Profile Socket Tin			
Order Code				24 Pin Low Profile Socket Gold			
W161, D96, H39 (57)	186	Case BIM1005 OR		28 Pin Low Profile Socket Gold			
W215, D130, H47 (73)	268	Case BIM1006 OR		40 Pin Low Profile Socket Gold			
Plastic Boxes - Boss Industrial Mouldings				Heatsinks			
Moulded Box and Close Fitting Flanged Lid				Individual Type for 1 x T05 50°C/W			
ABS Box, C/W Brass Bushes, and Lid in Orange				Individual Type for 1 x T06 10.5°C/W			
Order Code				Individual Type for 1 x T03 1.2°C/W			
L112 W62 D31	87	Case BIM2003 OR		Individual Type for 1 x T02 16°C/W			
L150 W80 D50	115	Case BIM2005 OR		Individual Type for 1 x T02 17°C/W			
L190 W110 D60	195	Case BIM2006 OR					
Instrument Case - Boss Industrial Mouldings				P.C.B. Components			
Covers Manufactured from 14SWG Aluminium				Data Pen, Blue Ink, Slow Drying			
Chassis Manufactured from 18SWG Mild Steel				Single Sided P.C.B. Pins .040" Diam 100 pcs			
Covers Finished Orange				Double Sided P.C.B. Pins .040" Diam 100 pcs			
Chassis Finished Matt Black							
Order Code							
W250 D167.5 H 68.5 (Chassis 153mm Deep)	F480	Case BIM3000 OR					
Plastic Boxes with Metal Lids - Boss Industrial Mouldings				Fuseholders			
Recessed Top Box				Suit 20mm x 5mm fuses.			
ABS Base, C/W Brass Bushes, In Orange							
1mm Aluminium Top Panel Finished Grey							
Order Code							
L85 W56 D29	97	Case BIM4003 OR		P.C.B. Mounting, Open Type			
L111 W71 D42	130	Case BIM4004 OR		Chassis Mounting, Open Type			
L161 W96 D53	182	Case BIM4005 OR		Panel Mounting, Screwdriver Slot			
Diecast Boxes - Boss Industrial Mouldings				Fuses			
Diecast Box and Flanged Lid				20mm x 5mm Glass.			
Aluminium Box and Lid in Natural Finish				Quick Blow, Range 100mA-5A			
Order Code				Slow Blow, Range 250mA-5A			
L113 W63 D31	104	Case BIM5003 NA					
L152 W82 D50	181	Case BIM5005 NA					
L192 W113 D61	280	Case BIM5006 NA					

RESISTORS				Skeleton Presets, Miniature			
Carbon Film, Fixed				0.1W, E3 Values, 100R-1M, Lin. Vertical Mounting			
0.25W, E24 Values IRO-10M, 5% Tol.	1.5 ea.	90p/100 (Mult 10/Value)	£7.90/1000 (Mult 100/Value)	Res RD1			
0.5W, E12 Values IRO-4M7, 10% Tol.	2 ea.	1.25p/100 (Mult 10/Value)	£10.10/1000 (Mult 100/Value)	Res RD5			
Metal Film, Fixed				Skeleton Presets, Standard			
0.5W, E24 Values, SRI-IM, 2% Tol.	6 ea.	3.80/100 (Mult 10/Value)	£32.40/1000 (Mult 100/Value)	0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting	10		
2.5W, E12 Values 10R-27K, 5% Tol.	13 ea.	7.50/100 (Mult 10/Value)		0.3W, E3 Values, 100R-4M7, Lin. Horizontal Mounting	10		
Metal Glaze, Fixed				Potentiometer, Rotary			
0.5W, E24 Values, IM-33M, 5% Tol.	10 ea.	5.40/100 (Mult 10/Value)		0.5W, E3 Values, 1K-2M2 Lin.	34		
				0.25W, E3 Values, 4K7-2M2 Log.	34		

POWERTRAN

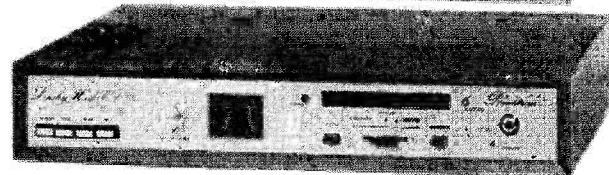
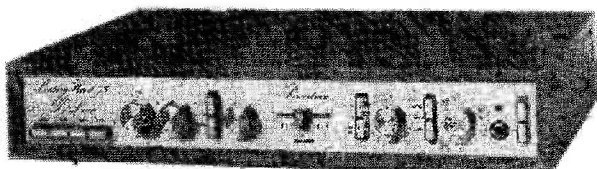
PSI 4002 STUDIO MODEL



cabinet size 17.2" x 17.2" x 6.7"

COMPLETE KIT ONLY £196.90 + VAT

**READ THE REVIEW
IN SOUND INTERNATIONAL DEC. '78 !**



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**.

POWERTRAN SFMT TUNER £35.90 + VAT

This is a simple low cost design which can be constructed easily without special alignment equipment but which still gives a first-class output suitable for feeding any of our very popular amplifiers or any other high quality audio equipment. A phase-locked-loop is used for stereo decoding and controls include switchable afc, switchable muting and push-button channel selection (adjustable by controls on the front panel). This unit matches well with the T20 + 20 and T30 + 30 amplifiers.

WWII TUNER £47.70 + VAT

This cost reduced model of our highly successful Wireless World FM Tuner kit was designed to complement the T20 + 20 and T30 + 30 amplifiers and the cabinet size, front panel format and electrical characteristics make this tuner compatible with either. Facilities included are pre-aligned front-end module, switchable afc, adjustable switchable muting, LED tuning indication and both continuous and push-button channel selection (adjustable by controls on the front panel).

COMPLETE KITS: Our complete kits really are complete. All of the projects shown on this page are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cables, nuts, bolts, etc., and full instructions — in fact everything!

All of the kits shown on this page are available as separate packs (except the Powertran SFMT Tuner) for those customers who wish to spread their purchase or perhaps make their own cabinets or metalwork. Prices are given in our FREE CATALOGUE.

PRICE STABILITY. Order with confidence irrespective of any price changes. We will honour all prices in this advertisement until April 30th, 1979, if the March, 1979, issue is mentioned with your order. Errors and VAT rate changes excluded.

EXPORT ORDERS: No VAT. Postage charged at actual cost plus 50p handling and documentation.

U.K. ORDERS. Subject to 12 1/2% surcharge for VAT* (i.e. add 1/2 to the price). No charge is made for carriage, *or at current rate if changed

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

SALES COUNTER: If you prefer to collect your kit from the factory, call at Sales Counter (at rear of factory). Open 9 a.m.-4.30 p.m. Monday-Thursday.

FOR ELECTRONIC KITS OF DISTINCTION

200 + 200 watt AMPLIFIER

As featured in Electronics Today International

400W rms continuous — 800W peak!

0.03% THD at FULL power!

PLUS all the following features too!

- * Each channel totally independent with its own stabilised power supply driven by custom designed TOROIDAL transformers!
- * Inherent reliability — monster heat sinks for cool running at the hottest venues — electronic open and short circuit protection!
- * Ultra low feedback (an incredible low 14dB overall!), super high slewing rate (20V/μs), 200W rms continuous to 4 ohm from EACH channel, input sensitivity 0.775V (0dB).
- * Professional quality components, sturdy 19" rack mounting chassis complete with sleeve and feet for free standing work too.
- * Easy to build — plenty of working space with ready access to all components, minimal wiring, extensive instruction suitable for both experience constructors and newcomers to electronics.
- * Value for money — quality and performance comparable with ready-built amplifiers costing over £600!

**DE LUXE EASY TO BUILD LINSLEY HOOD
75W STEREO AMPLIFIER £99.30 + VAT**

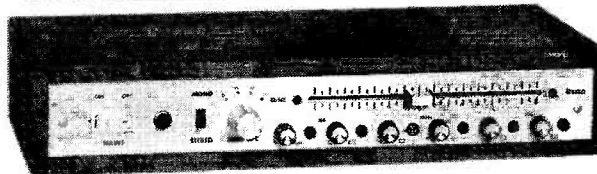
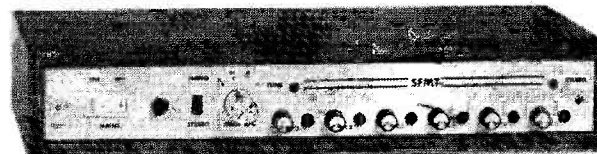
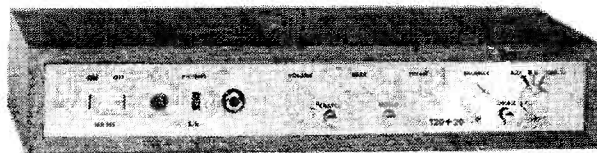
This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter,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

WIRELESS WORLD FM TUNER £70.20 + VAT

A pre-aligned front-end module makes this Wireless World published design very simple to construct and adjust without special instruments. Features include an excellent a.m. rejection, push-button station selection as well as infinitely variable tuning and a phase locked loop stereo decoder incorporating active filters for "birdy" suppression.

LINSLEY-HOOD CASSETTE DECK £79.60 + VAT

This design, published in Wireless World, although straightforward and relatively low cost provides a very high standard of performance. There are separate record and replay amplifiers and switchable equalisation together with a choice of bias levels are also provided. The mechanism is the Goldring-Lenco CRV with electronic speed control.



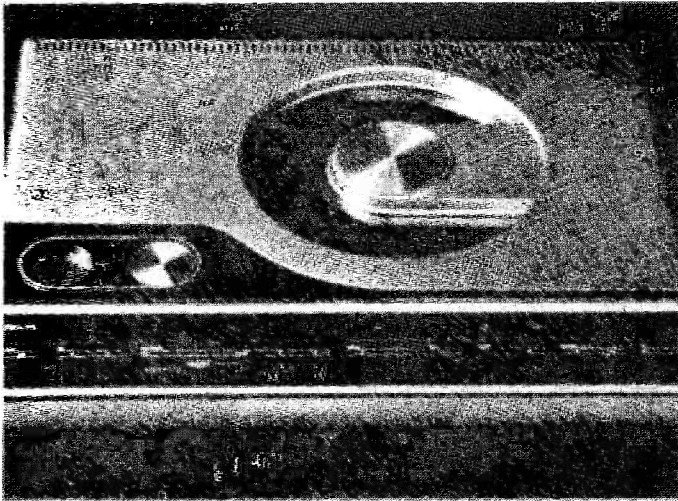
OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

POWERTRAN ELECTRONICS

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ANDOVER, HANTS SP10 3NM

ANDOVER
(STD 0264) 64455

news digest.....

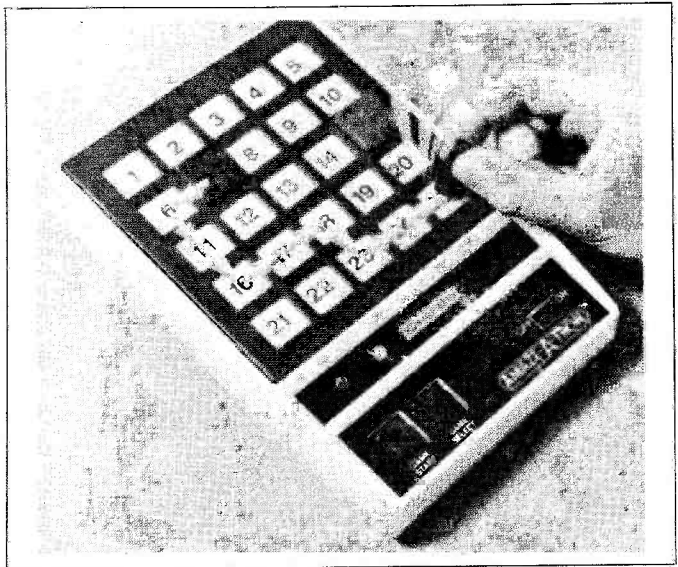


VIDEO DISC REVISITED

It looks like the video disc is rearing its domestic head again. Philips have introduced a 60

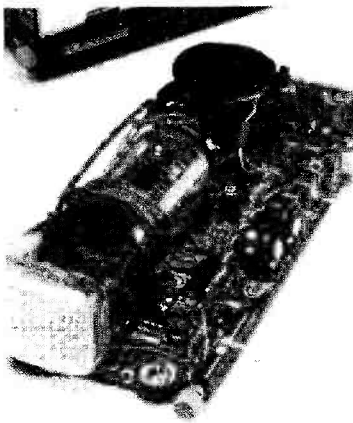
minutes per side system, release and price for UK market have yet to be announced, but be prepared for yet another compatibility war as other manufacturers join the fray.

HAND-HELD GAMES



After the inroads made into the leisure market by TV video games, a new generation of hand-held calculator-style games seem to be making their way across the Atlantic. The 'AMAZE-A-TRON' (groan) is a micro-based game specifically aimed at the 5 years and up age range. It is basically a maze game

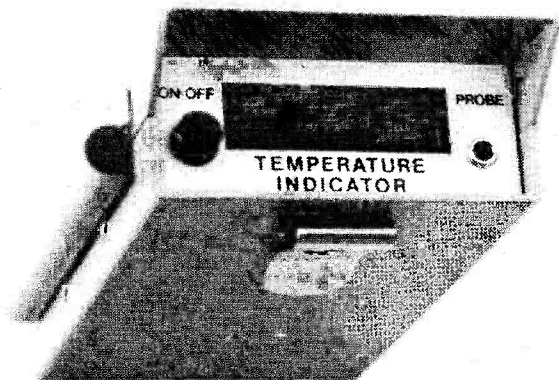
with a claimed one million variations. Also in the pipeline are 'ZAP' a missile game, 'DIGITS' a code game, and 'LIL GENIUS', a teaching type calculator. Prices will range from £9-£18 and will be marketed by Spectrum Electronic Games, 113-115 Gloucester Road, London SW7 4TE.



SINCLAIR ANNOUNCE UK MICROVISION

A 'UK only standard' version of the top selling Microvision has been developed by Sinclair Radionics. Outwardly it has the same dimensions as the International version, but fewer controls. Good news for bank managers too, it costs less than half the previous version at less than £100. Further details from Sinclair Radionics, London Road, St Ives, Huntingdon, Cambs. PE17 4HJ.

HOT STUFF



Details of a new pocket-sized thermometer, 'computerised' no less, have just arrived. Designated the ITS there are four models in the range, two over the range 0-110°C and the other two from -35°C to 149°C. The LED display can handle Fahrenheit as well as Centigrade. More

than 25 interchangeable probes are available for various applications, and its rugged high impact aluminium case is ideal for field use. Contact British Rototherm Co Ltd for further details at Kenfig Industrial Estate, Margam, Port Talbot, West Glam. SA13 2PW (South Wales).

STRIKE A BLOW

We are reliably informed that due to the industrial action within the transport industry, copies of ETI have not reached some areas for last month's (February) issue. We apologise to our readers for this and hop you'll bear with us through the trouble.

Owing to the continuing — as we go to press — troubles, this issue too may be delayed. In some cases this may well be severe. If you read this later than you would normally have done so — thank you for sticking it out, and we promise normal service will be resumed as soon as possible.

Ron Harris
Editor



A quality range of British made electrical accessories plus a "How to" book. Do your own home electrical work with complete confidence. See cat. pages 129 to 134



This superb organ — build the first working section for just over £100. Full specification in our catalogue.



A range of highly attractive knobs is described in our catalogue. Our prices are attractive too!



Mobile amateur radio, TV and FM aerials plus lots of accessories are described in our catalogue.



A pulse width train controller for smooth slow running plus inertia braking and acceleration. Full construction details in our catalogue.



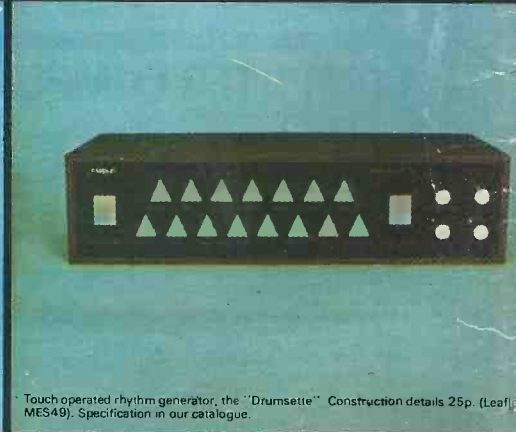
A wide range of disco accessories at marvellous prices. Our catalogue has all the details.



Add-on bass pedal unit for organs. Has excellent bass guitar stop for guitarists accompaniment. Specification in our catalogue.



The 3800 synthesiser. build it yourself at a fraction of the cost of one ready-made with this specification. Full details in our catalogues.



Touch operated rhythm generator, the "Drumsette" Construction details 25p. (Leaflet MES49). Specification in our catalogue.

MAPLIN

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 Westcliff-on-Sea, Essex.
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An attractive mains alarm clock with radio switching function and battery back up. Complete kit with case only £13.88 (incl. VAT & p&p) MA1023 module only £8.40 (incl. VAT)



A massive new catalogue from Maplin that's even bigger and better than before. If you ever buy electronic components, this is the one catalogue you must not be without. Over 280 pages — some in full colour — it's a comprehensive guide to electronic components with hundreds of photographs and illustrations and page after page of invaluable data.

Our bi-monthly newsletter contains guaranteed prices, special offers and all the latest news from Maplin.



A 63-key ASCII keyboard with 625-line TV interface, 4-page memory and microprocessor interface. Details in our catalogue.

Post this coupon now for your copy of our 1979-80 catalogue price 75p.

Please send me a copy of your 280 page catalogue as soon as it is published (8th Jan. 1979). I enclose 75p but understand that if I am not completely satisfied I may return the catalogue to you within 14 days and have my 75p refunded immediately. If you live outside U.K. send £1 or ten International Reply Coupons.

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ADDRESS _____

WATFORD ELECTRONICS

ILP MODULES 15-240 WATTS

We are now stockists for these world famous fully guaranteed (2 years guarantee on all modules) Pre amps, Amplifiers & Power Supplies.

- HY5** Preamplifier. Input, magnetic pickup 3mV, ceramic 30mV. Output: Mains 500mV RMS. Distortion 0.1% at 1KHz. Price: **£6.27**
- HY30** Amplifier Kit. 15 Watts into 8Ω, extremely easy to construct. Output 15W RMS. Distortion 0.1% at 15W Freq. 10Hz-16KHz. Supply + 18V. Price: **£6.27**
- HY50** Hi-Fi Amplifier Module. 25 Watts 8Ω. Input Sensitivity 500mV. Output 25W RMS. Distortion 0.04% at 25W. Freq. 10Hz-45KHz. Supply + 25V. Price: **£8.18**
- HY120** Amplifier Module — 60 Watts 8Ω. Input sens. 500mV. Output 60W RMS. Distortion 0.04%. Freq. 10Hz-45KHz. Power Supply + 35V. Price: **£18.98***
- HY200** Hi-Fi/Disco Amplifier Module — 120 Watts 8Ω. Input sens. 500mV 120W RMS. Freq. 10Hz-45KHz. Power Supply + 45V. Size 114 x 100 x 85mm. Price: **£27.99***
- HY400** (Big Daddy) Amplifier Module — 240 Watts 4Ω. Ideal for High Power Disco or P.A. Output 240 Watts RMS 4Ω. 114 x 100 x 85mm. Distortion 0.1%. Price: **£38.60***



- POWER SUPPLIES**
- PSU36 — Drives 2 x HY30s **£6.44**
 - PSU50 — Drives 2 x HY50s **£8.18**
 - PSU70 — Drives 2 x H120s **£14.58***
 - PSU90 one HY200 **£15.10***
 - PSU180 2 x HY200 or one HY400 **£25.42***

JACK PLUGS		SOCKETS		SWITCHES*		SLIDE 250V	
Screened chrome	Plastic body	open metal	moulded with break	TOGGLE 2A, 250V	1A DPDT	14p	15p
2.5mm 13p	10p	8p	11p	SPST	1A DPDT c/over	15p	15p
3.5mm 15p	10p	8p	12p	DPST	1/2A DPDT	13p	24p
MONO 25p	14p	13p	20p	DPDT	4 pole 2-way	14p	24p
STEREO 32p	17p	15p	24p	4 pole on/off	PUSH BUTTON	Spring loaded	
					SPST on/off	SPST c/over	60p
					SPST biased	DPDT 6 Tag	65p
					DPDT 6 tags	MINIATURE	85p
					DPDT centre off	Non Locking	
					DPDT Biased	Push to Make	15p
						Push Break	25p
DIN		PLUGS		SOCKETS		In Line	
2 PIN Loudspeaker	10p	7p	20p				
3, 4, 5 Audio	13p	8p	20p				
CO-AXIAL (TV)	14p	14p	14p				
PHONO		6p single	12p				
assorted colours	10p	8p double	69p				
Metal screened	15p	15p 4-way	20p				
BANANA							
4mm	11p	12p	—				
2mm	10p	10p	—				
1mm	6p	6p	—				
WANDER 3 mm							
DC Type	6p	6p	—				
AC 2-pin American	15p	20p	—				
	15p	15p	—				

TRANSFORMERS* (Mains Prim. 220-240V)

0-0.6V: 9.0 9V, 12.0-12V 100mA **95p**

8VA: 6V, 5A 6V, 5A 9V, 4A 9V, 4A, 12V, 3A 12V, 3A, 15V, 25A 15V, 25A **1.95p**

12V: 4.5V-1.3A 4.5V-1.3A, 6V-1.2A 6V-1.2A, 12V-5A 12V-5A, 15V-4A 15V-4A, 20V-3A 20V-3A **2.20p** (20p p&p)

24VA: 6V-1.5A 6V-1.5A, 9V-1.3A 9V-1.3A, 12V-1A 12V-1A, 15V-8A 15V-8A, 20V-6A 20V-6A **2.90p** (45p p&p)

50VA: 6V-1.5A 6V-1.5A, 9V-2.5A 9V-2.5A, 12V-2A 12V-2A, 15V-1.5A 15V-1.5A, 20V-1.2A 20V-1.2A, 25V-1A 25V-1A, 30V-8A 30V-8A **3.50p** (50p p&p)

100VA: 12V-4A 12V-4A, 15V-3A 15V-3A, 20V-2.5A 20V-2.5A, 30V-1.5A 30V-1.5A, 40V-1.25A 40V-1.25A, 50V-1A 50V-1A **6.50p** (60p p&p; (N.B. p&p charge to be added above our normal postal charge))

CRYSTALS*

- 100KHz **385**
- 455KHz **3.85**
- 1MHz **323**
- 3.2768MHz **323**
- 4.032MHz **323**
- 4.433619MHz **135**
- 5MHz **355**
- 8.08333MHz **275**
- 10MHz **323**
- 10.7MHz **323**
- 18.432MHz **323**
- 20MHz **323**
- 27.848MHz **323**
- 48MHz **323**

VOLTAGE REGULATORS*

1A TO3 +ve -ve

- 5V 7805 **145p** 7905 **220p**
- 12V 7812 **145p** 7912 **220p**
- 15V 7815 **145p** —
- 18V 7818 **145p** —

1A TO220 Plastic Casing

- 5V 7805 **80p** 7905 **90p**
- 12V 7812 **80p** 7912 **90p**
- 15V 7815 **80p** 7915 **90p**
- 18V 7818 **85p** 7918 **90p**
- 24V 7824 **85p** 7924 **90p**

100mA TO92 Plastic Casing

- 5V 78L05 **30p** 79L05 **65p**
- 6V 78L62 **30p** —
- 8V 78L82 **30p** —
- 12V 78L12 **30p** 79L12 **65p**
- 15V 78L15 **30p** 79L15 **65p**
- LM300H **170p** LM305H **140p**
- LM317 **350p**
- LM304H **150p** LM308K **135p**
- LM323K **625p**

COMPUTER HARDWARE*

- 2101 **99**
- 2102 **100**
- 2111 **175**
- 2114 **785**
- 2513 **595**
- 2516 **£29.50**
- 2532 **TBA**
- 2708 **775**
- 27108 **1095**
- 2716 **1650**
- 3064 **TBA**
- 4027 **250**
- 4047 **750**
- 74S188 **165**
- 74S262 **875**
- 74S287 **325**
- 74S470 **325**
- 74S475 **825**
- 81LS85 **99**
- 81LS96 **99**
- 9900 **£35**
- TMS6011 **325**
- 280 **1195**

OHIO SCIENTIFIC Superboard II **£263.84***

ETI CLICK Eliminator **£35** All parts available

CMOS*

333	230	4018	89	4046	128	4085	74	4450	295
330	218	4019	48	4047	87	4086	73	4451	295
335	215	4020	99	4048	58	4089	150	4452	
336	4021	4049	48	4089	85	4490F	695		
334	230	4022	88	4050	48	4490V	525		
343	150	4023	20	4051	72	4096	105	4501	17
344	144	4024	66	4052	72	4097	372	4502	120
345	180	4025	19	4053	72	4098	110	4503	69
346	182	4026	180	4054	110	4099	145	4506	51
347	182	4027	45	4055	128	4180	109	4507	55
348	182	4028	81	4057	2570	4161	108	4508	298
349	248	4029	99	4059	480	4162	108	4510	99
4000	15	4031	205	4063	110	4174	110	4512	98
4001	17	4032	100	4066	58	4175	99	4513	206
4002	17	4033	145	4067	380	4194	108	4514	265
4006	105	4034	196	4068	22	4408	720	4515	289
4007	18	4035	111	4069	20	4409	720	4516	125
4008	87	4036	325	4070	32	4410	720	4517	382
4009	50	4037	100	4071	21	4412F	1650	4518	102
4010	50	4038	108	4072	21	4412V	1380	4519	55
4011	18	4039	320	4073	23	4415F	795	4520	108
4012	48	4040	105	4075	23	4415V	795	4521	188
4013	12	4041	80	4076	85	199	280	4522	189
4014	96	4042	75	4077	40	4422	545	4527	152
4015	89	4043	94	4078	21	4433	1099	4528	99
4016	45	4044	88	4081	20	4435	825	4528	165
4017	89	4045	145	4082	21	4440	1275	4530	85

VDU Chip and MODULE for TV

Convert your TV into a VDU by using the new Thompson CSF using the new Thompson CSF SF F96364. 16 line by 64 characters text refreshment, Cursor management, Cursor management on screen, Line erasing. Compatible with any computing system.

- SF F96364E **£11.75***
- AY-3-1015 **£5.60***
- AY-5-1013UART **£4.50***
- 71301 ROM **£8.20***
- SF580102 RAM **£2.05***
- 74LS163 **£1.18***
- SN75450 **£1.20***
- SN75451 **70p***
- SN75452 **70p***
- SN75454 **£2.25***
- UHF Modulator **£2.50***
- Complete Module **£136.50*** (Send 30p stamps for full technical data)

..... news digest.....

LOST AND FOUND AT SEA DEPARTMENT

An interesting variation on the programmable calculator has sailed into our offices, Texas Instruments have introduced a T158, complete with brass handled, mahogany case and adaptor/charger. Software in-

cludes a 30 programme navigational package. It will tell you just about everything from where you are, to how fast you'll be going somewhere else. Want to know more, then contact: Texas Instruments Limited, European Consumer Division, Manton Lane, Bedford MK41 7PA.



ELECTRONIC SUMMER SCHOOL

The Department of Electrical Engineering Science at the University of Essex will be holding its annual electronics summer school for teachers during the week 9th-13th July, 1979. This year, as well as courses in linear circuit design and digital circuit design, a third course in electronic systems is also available which is closely related to the A.E.B. electronics systems A-level. Further information on the Summer School may be obtained from The Department of Electrical Engineering Science, University of Essex, Wivenhoe Park, Colchester CO4 3SQ.

ORIENTAL TELETXT

Sony are to launch a Teletext equipped receiver with infra red remote control. This is the first eastern set in a virtually all-European market. Costing about £800, it is likely to give the home TV industry some added headaches. The sets are to be built at the Bridgend factory.

CATALOGUE CORNER

This month's releases include the 1979 Marshalls catalogue, usual comprehensive assortment of components and hardware. Interesting to see they deal in KIM and PET, all in all not bad for value for your 40p.

Codespeed ELECTRONIC MAIL ORDER

All Full Spec. Devices

T03 HEAT SINKS!!! Two types of heat sink. Ex. equipment, but condition as new. Most still contain a power transistor (condition unknown). 'Christmas tree' type. 92x66x35mm **20p each**. Rectangular type 130x63x32mm **30p each**. Please add 25p per heat sink post and packing.

PACK M1. Contains two brand new multifunction calculator keyboards. Excellent key action. Only **£1.00**.

PACK T2. A high contrast 3½ digit Liquid Crystal wristwatch display with data. Don't miss out — only **£1.00**.

PACK T4. At a new low price, what a bargain. A 0.8" common cathode, 3½ digit, 12-hour clock display. Now offered at only **£3.95**.

PACK S1. 25 miniature glass 1N3470 germanium diodes (600mA, 35v). All brand new (at just 2p each how can you go wrong?). 25 diodes for **50p**.

PACK S2. 4 x MEU21 programmable unijunction transistors (P.U.T.). Lots of uses, long delay timers, oscillators and many more. All brand new. With data and usage sheet. 4 for **50p**.

PACK S3. 10 x 1N4151 high-speed switching diodes. Same as 1N4148, but has higher P.I.V. 10 for **35p**.

PACK P1. With this MM5330 digital voltmeter I.C. we include the data sheet and circuit diagram to build a high accuracy digital multimeter. Only **£3.95**.

PACK E2. Calculator style L.C.D. 8 digit with right-hand decimal points. Digit height 0.33". With data only **£2.95**.

PACK E3. The same as Pack E2, but has 0.5" high digits. **£4.25**. EVER THOUGHT of using 7 segment gas discharge displays as an alternative to LED's or LCD's? Gives a nice bright orange display and are comparatively very low in price. Requires 180v d.c. supply (easily achieved in mains-operated projects). All have right-hand decimal points and are supplied with data.

PACK E4. 0.3" high 1½ digit display. Now only **50p**.

PACK E5. A 0.3" high dual digit display. Now only **50p**.

PACK E7. A 0.25" high 12 digit display with free socket. **£1.50**.

PACK DM1. Want to buy 115 quality switching diodes for 50p? These 14 pin chips each contain 23 matrixed diodes. 5 chips for **50p**.

All Untested Packs

PACK M4 CALCULATORS!!! This pack contains a production line reject calculator. Either repair them (not much wrong with some of them) or strip them for spares. Lots of accessible goodies inside, approximately 25 transistors, 2 chips, display, case and detachable keyboard. Such a bargain, you can't go wrong. Only **£2.50**.

PACK MU1 (untested — so no guarantees). 2 x Upper half of hand held calculator case with integral keyboard. Ex-equipment, but believed to be O.K. A gift at only **50p** the pair.

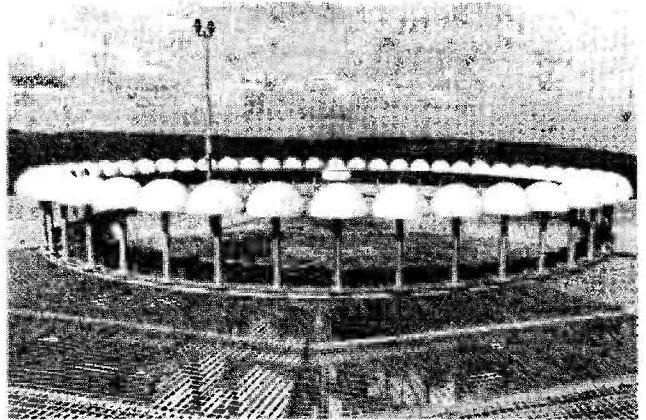
PACK DL1 (untested — so no guarantees). A bumper pack of 30 mixed I.C.'s. You test them and save £££'s. Could include anything linear or digital. A snip at only **£1.00**.

PACK E1 (80% guaranteed good). Contains 5 seven segment LED displays. Digit height 0.127" with right-hand decimal. Common cathode. Still only **£1.00**. Your satisfaction is guaranteed or return the complete pack for replacement or a refund.

For free catalogue send stamped addressed envelope. Postage and packing please add 25p (overseas orders add 60p).

CODESPEED, P.O. Box 23, 34 Seafield Road, Copnor, Portsmouth, Hants, PO3 5BJ

..... news digest.....



This is apparently same sort of aircraft navigation aid, but secret sources indicate it is in fact the British Home Stores Lampshade farm.

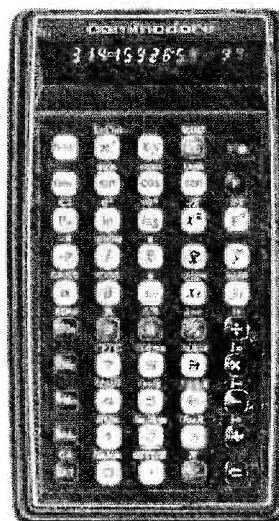
BBC TV TRANSMITTER OPENS AT LOCH NESS

We couldn't resist this one, the transmitter is sited at Wester Erchite, opposite Urquhart Bay. We hear the installation is O.K. so far, but they have had a few teething troubles with programmes like 'All Creatures Great and Small,' something to do with frequency lock.

LCD POCKET TV

Matsushita have developed a pocket TV with better resolution than any previous LCD type. 57,600 elements are arranged in a 240x240 matrix which measures 2.4 inches (presumably diagonally). But even though CMOS circuits are used the TV consumes 1.5 W.

LANDLUBBER'S CALCULATOR



For those of us who are land-based, and taking O/A or degree level studies, Commodore have introduced an updated version of their successful 4190R, designated the SR9190R. It has nine memories with over 100 scientific functions at only £30. It has all the usual features, 10 + 2 LED display, rechargeable batteries and a 1 year guarantee. Your local calc. shop should be able to show you it in action.

NEW CASES FROM VERO

New Eurocard-sized cardframes have just been announced by Vero. The frames, called the KM6, are available from Vero Electronics Ltd, Industrial Estate, Chandlers End, Eastleigh, Hampshire SO5 3ZR.

MAINS OPERATED ELECTRONIC DIGITAL ALARM CLOCK

IMMEDIATE DELIVERY

£8.95

INCL V.A.T. POST PAID

THREE FOR £26.00 POST FREE

E.T.I. RECOMMEND THIS MODEL

BARCLAY ACCESS

Just phone in number

- Hanimex HC-1100
- Large Bright LED display
- White case with red display on black background
- Adjustable dim/bright control
- Silent operation, all electronic
- Space age technology L.S.I. circuitry
- Alarm and 9 minute snooze repeater
- P.M. indicator
- Hour and minute display
- Size 100mm x 130mm x 60mm high
- Fully guaranteed



HENRY'S RADIO

HENRY'S RADIO
404 Edgware Rd. London W2
PHONE: 01723 1008 ENGLAND

STEVENSON

Electronic Components

METAL FILM RESISTORS

A range of high precision, very high stability, low noise resistors. Rated at 1/4W. 1% tolerance.

Available from 51 ohms to 330K in E24 series. Any mix

	each	100+	1000+
1/4W 1%	4p	3.5p	3.2p

Special development pack consisting of 10 of every value from 51 ohms to 330K (a total of 930 resistors) £23.75

BRIDGE RECTIFIERS

Type	PIV	I	Type	PIV	I
W005	50	1A	2KBB10	100	2A
W01	100	1A	2KBB20	200	2A
W02	200	1A	2KBB40	400	2A
W04	400	1A	BY225	200	4.2A

REGULATORS

78L05	30p	79L05	70p	LM309K	110p
78L12	30p	79L12	70p	LM317	220p
78L15	30p	79L15	70p	LM323K	530p
7805	60p	7905	80p	LM723	35p
7812	60p	7912	80p		
7815	60p	7915	80p		

SWITCHES

Subminiature toggle. Rated at 3A 250V.

SPDT	65p	SPDT centre off	70p
DPDT	75p	DPDT centre-off	90p

Standard toggle.

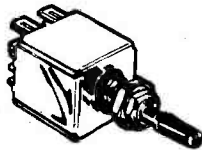
SPST	34p	DPDT	48p
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Wavechange switches.

1P12W, 2P6W, 3P4W or 4P3W
all 37p each.

Miniature switches (non-locking)

Push to make	15p	Push to break	20p
--------------	-----	---------------	-----



THYRISTORS AND TRIACS

Plastic cased Thyristors. Texas.

	4A	8A	12A
100V	36p	45p	62p
200V	42p	53p	68p
400V	51p	66p	86p

Plastic cased Triacs. Texas.

All rated at 400V

4A	70p	12A	90p	20A	185p
8A	80p	16A	95p	25A	215p

We now have an express telephone order service. We guarantee that all orders received before 5pm. are shipped first class on that day. Contact our Sales Office now! Telephone: 01-464 2951/5770.

ORDERS
DESPATCHED
BY RETURN
POST

Quantity discounts on any mix TTL, CMOS, 74LS and Linear circuits: 25+ 10%. 100+ 15%. Prices VAT inc. Please add 30p for carriage. All prices valid to 30th April 1979. Official orders welcome.

BARCLAYCARD AND
ACCESS WELCOME.



TRANSISTORS

AC127	17p	BCY71	14p	ZTX109	14p
AC128	16p	BCY72	14p	ZTX300	16p
AC176	18p	BD131	35p	2N697	12p
AD161	38p	BD132	35p	3N1302	38p
AD162	38p	BD135	38p	2N2905	22p
BC107	8p	BD139	35p	2N2907	22p
BC108	8p	BD140	35p	2N3053	18p
BC109	8p	BF244B	36p	2N3055	50p
BC147	7p	BFY50	15p	2N3442	135p
BC148	7p	BFY51	15p	2N3702	8p
BC149	8p	BFY52	15p	2N3704	8p
BC158	9p	MJ2955	98p	2N3705	9p
BC177	14p	MPSA06	20p	2N3706	9p
BC178	14p	MPSA56	20p	2N3707	9p
BC179	14p	TIP29C	60p	2N3708	8p
BC182	10p	TIP30C	70p	2N3819	22p
BC182L	10p	TIP31C	65p	2N3904	8p
BC184	10p	TIP32C	80p	2N3905	8p
BC184L	10p	ZTX107	14p	2N3906	8p
BC212	10p	ZTX108	14p	2N4058	12p
BC212L	10p			2N5457	32p
BC214	10p			2N5458	30p
BC214L	10p			2N5459	32p
BC477	19p	1N914	4p	2N5777	50p
BC478	19p	1N4001	4p		
BC479	19p	1N4002	4p		
BC548	10p	1N4004	5p		
BCY70	14p	1N4006	6p		

DIODES

1N4148	3p
1N5401	13p
1N5402	15p
1N5404	16p
1N5406	18p
BZY88 series 2V7 to 33V	8p each.

LINEAR

A SELECTION ONLY!
DETAILS IN CATALOGUE.

709	25p	LM324	50p	NE556	60p
741	22p	LM339	50p	NE565	120p
747	50p	LM380	75p	NE567	170p
748	30p	LM382	120p	SN76003	200p
CA3046	55p	LM1830	150p	SN76013	140p
CA3080	70p	LM3900	50p	SN76023	140p
CA3130	90p	LM3909	60p	SN76033	200p
CA3140	70p	MC1496	60p	TBA800	70p
LM301AN	28p	MC1458	35p	TDA1022	650p
LM318N	125p	NE555	25p	ZN414	75p

OPTO

LEDs	0.125in.	0.2in.	
Red	TIL209	TIL220	9p
Green	TIL211	TIL221	13p
Yellow	TIL213	TIL223	13p
Clips	3p	3p	

DISPLAYS

DL704	0.3 in CC	130p
DL707	0.3 in CA	130p
FND500	0.5 in CC	100p



RESISTORS

Carbon film resistors.
High stability, low noise 5%.

E12 series. 4.7ohms to 10M. Any mix:

	each	100+	1000+
0.25W	1p	0.9p	0.8p
0.5W	1.5p	1.2p	1p

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res.)
0.5W £7.50. 0.25W £5.70

CAPACITORS

HERE ARE JUST
A FEW OF THE
CAPACITORS STOCKED

TANTALUM BEAD	each
0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 & 2.2uF @ 35V	9p
4.7, 6.8, 10uF @ 25V	13p
22 @ 16V, 47 @ 6V, 100 @ 3V	16p
MYLAR FILM	
0.001, 0.01, 0.022, 0.033, 0.047	3p
0.068, 0.1	4p
RADIAL LEAD ELECTROLYTIC	
63V	0.47 1.0 2.2 4.7 10 5p
	22 33 47 7p
	100 13p
	220 20p
25V	10 22 33 47 5p
	100 8p
	220 10p
	470 15p
	1000 23p
10V	220 5p
	470 9p
	1000 13p
	2200 23p

74LS

LS00	16p	LS95	65p
LS01	16p	LS123	56p
LS02	16p	LS125	40p
LS03	16p	LS126	40p
LS04	16p	LS132	60p
LS08	16p	LS136	36p
LS10	16p	LS138	54p
LS13	30p	LS139	50p
LS14	70p	LS151	50p
LS20	16p	LS153	50p
LS30	16p	LS155	80p
LS32	24p	LS156	80p
LS37	26p	LS157	45p
LS40	22p	LS164	90p
LS42	53p	LS174	60p
LS47	70p	LS175	60p
LS48	48p	LS190	80p
LS54	16p	LS192	70p
LS73	29p	LS193	70p
LS74	29p	LS196	80p
LS75	44p	LS251	60p
LS76	35p	LS258	55p
LS78	35p	LS266	40p
LS83	60p	LS283	60p
LS85	70p	LS290	55p
LS86	33p	LS365	45p
LS90	45p	LS367	45p
LS93	45p	LS368	45p
		LS386	35p
		LS670	180p

TTL

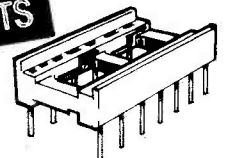
7493	34p
7494	52p
7495	52p
7496	50p
74100	25p
74101	33p
74102	40p
74103	35p
74104	35p
74105	50p
74106	56p
74107	90p
74108	70p
74109	50p
74110	52p
74111	52p
74112	70p
74113	70p
74114	125p
74115	68p
74116	58p
74117	72p
74118	72p
74119	64p
74120	64p
74121	55p
74122	55p

CMOS

FULL DETAILS
IN CATALOGUE

4001	15p	4029	60p
4002	15p	4040	68p
4007	15p	4042	54p
4011	15p	4046	100p
4013	35p	4049	28p
4015	60p	4050	28p
4016	35p	4066	40p
4017	55p	4068	20p
4018	65p	4069	16p
4023	15p	4071	16p
4024	45p	4075	16p
4026	95p	4093	48p
4027	35p	4510	70p
4028	52p	4511	70p
		4518	70p
		4520	65p

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CD4016	0.48	CD4040	0.97	CD4070	0.48	CD40104	1.10	CD4527	1.43
CD4017	0.79	CD4041	0.75	CD4071	0.20	CD40105	1.06	CD4532	1.21
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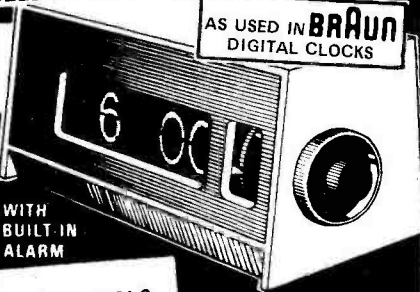
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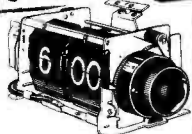
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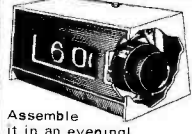
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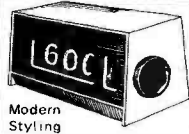
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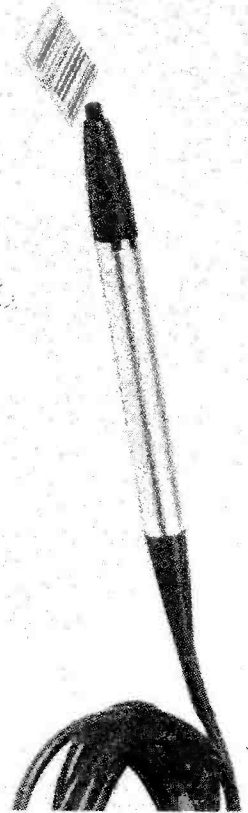


DELIVERY FROM STOCK

.....news digest.....

FIBRE OPTIC LIGHT PEN

Light pens have never figured very greatly in the amateur market, but this device from Optronic Fort Ltd hopes to change that, particularly with the tremendous interest in mini-computers. It is TTL compatible and uses a pin-photodiode, weighs only 35 grammes and can be yours for only £175. Call them at Cambridge Science Park, Milton Road, Cambridge CB4 5BH.



VIDEO DISC 2

Further to the Philips video disc launch, news has just arrived about the RCA 'Selecta Vision' video disc system, pioneered in the USA. The RCA system uses a grooved disc, with diamond-stylus. The disc rotates at 450 rpm, and has one hour's playing time per side. Again only drawback is you can't record your own material, but just think, you will be able to buy your own copy of Star Wars or even Emmanuel, if your that way inclined, and you can see the good bits over and over again, Cor.

BREADBOARD '79

What! already. Well this year there are two dates to put into your Letts Electronic diaries. The Midlands show will be at Bingley Hall, Birmingham, on May 23rd-26th, and the London show is at the Royal Horticultural Hall, Westminster, December 4th-8th. Figures show over 10 000 people attended the first show, and that's a fantastic response for the first ever home electronics exhibition, indeed the Birmingham show is due entirely to response from contributors and visitors, we'll see you there.

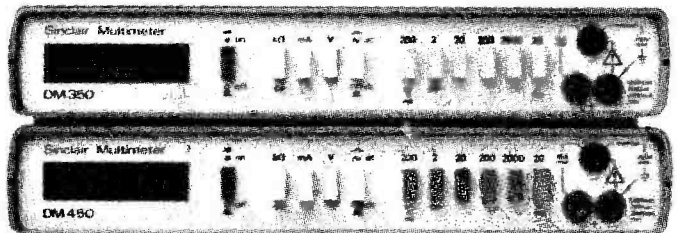
MEMORIAL FUND

Following the tragic death of John Miller Kirkpatrick a memorial fund has been established for the benefit of his family. Those wishing to make a donation should send this to: John Miller Kirkpatrick Memorial, Lloyds Bank Ltd, 39 Threadneedle Street, London EC2.

SINCLAIR AGAIN

Two new laboratory quality multimeters are promised for 1979. As usual you can expect the Sinclair innovations in cost and features. These instruments which rejoice

under the titles of DM450 (4 1/2 digit 5 function) and DM350 (3 1/2 digit, 34! ranges). They both have good technical specifications and accessories. See the Microvision article for Sinclair's address.



SAVE MONEY! SAVE TIME!

If you continually solder and de-solder when building, testing and trying out modifications on circuits, you're wasting money. Heat damage and solder build-up waste boards and components faster than anything.

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In both cases you're wasting time too.

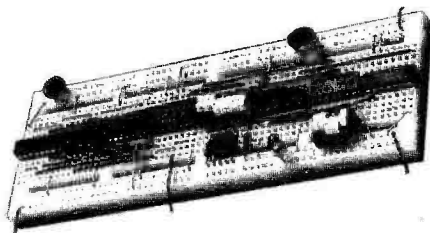
Breadboards are fully re-usable and avoid these losses — you only need to hard wire your circuit to keep the final design.

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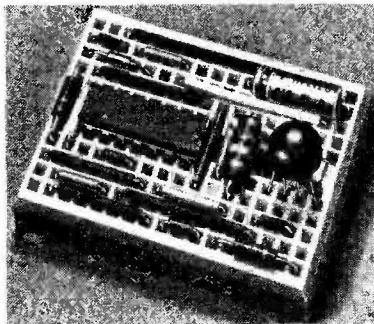
Further, LEKTROKIT breadboarding is expandable to match whatever configuration you require. All boards are ready prepared for mounting with screws or adhesive backing.



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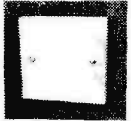
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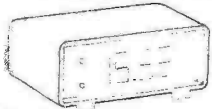
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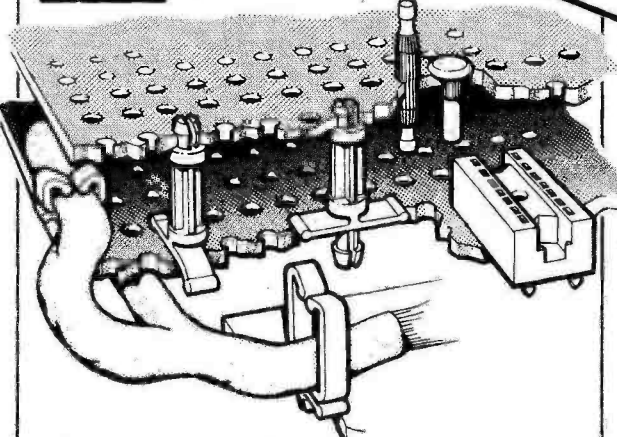
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DIGITAL TO ANALOGUE TECHNIQUES

Digital to Analogue conversion (DAC) is a fast growing section of electronics. Tim Orr explains some of the more practical applications.

ELECTRONICS HAS CHANGED enormously in the past ten years, having swung away from valves, germanium transistors, even from discrete devices themselves. The trend is towards more and more complex integrated circuits, complete systems in a chip, large scale integration (LSI). Also the trend has swung heavily towards digitally based systems rather than analogue ones, partly because the IC manufacturers can get a greater success rate from making digital devices and partly because there are very many applications which can only be contemplated with a digital device. Such examples as pocket calculators and microprocessors spring immediately to mind. However there are several areas where analogue techniques present the only realistic solution (at this moment in time), such as tone controls in an audio amplifier. In fact, good cases can be made out for both analogue and digital systems and there are many examples where both are needed. In these it will be necessary to change from the analogue to the digital world or vice versa and to do this, some sort of conversion process has to be practised.

Digital to Analogue Conversion.

The job of a digital to analogue converter (DAC) is to convert a binary code (a digital data word) into an analogue voltage. The data word is a digital representation of that analogue voltage. Thus if we presented the DAC with a digital word that was linearly increasing in magnitude, the output would be a linearly increasing analogue voltage. This digital word would be the output of a binary counter driven by a constant clock frequency. The analogue output is a linear ramp, or rather a linear staircase where the step size is controlled by the "size" of the DAC. If the DAC is an 8 bit device, ie it can accept data words 8 bits wide, then it can generate a possible 2^8

discrete output level. Now 2^8 is 256, so therefore an 8 bit DAC could generate a staircase with 256 steps in it. The resolution of the DAC is thus 1 part in 256, or rather a change of one LSB (least significant bit) in the data word will make the output voltage change by $1/256$ th of the full scale output.

To get really fine resolution then a high performance DAC is needed. DAC prices seem to be almost linearly proportional to their resolution. I have got several DAC's amongst my collection of bits. There is an 8 bit DAC costing about £4, a 12 bit DAC costing about £35 and a 16 bit DAC costing just over £200. It is now possible to buy a monolithic (a single IC) DAC with a bit size of 6, 8, 10 and 12, but above this the devices are usually modular.

Size And Resolve

Fig 2 shows the relationship between DAC size and resolution. Notice that a 16 bit DAC with a 10 V full scale output is made up of a staggering 65,536 discrete

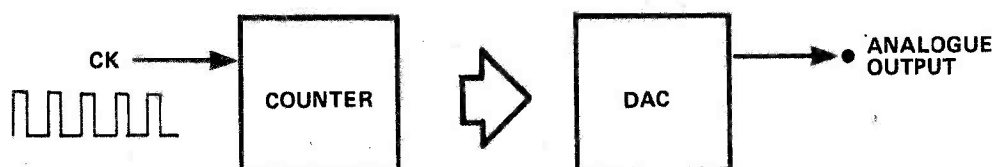
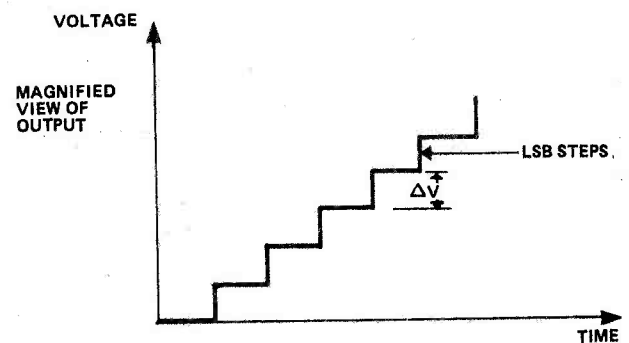


Fig 1. Converting binary code to analogue voltage.

WORDLENGTH n	RESOLUTION 1 PART IN 2^n	MAXIMUM THEORETICAL DYNAMIC RANGE	BIT SIZE ASSUMING FULL SCALE = 10V
1	2	6dB	5.0V
2	4	12dB	2.5V
3	8	18dB	1.25V
4	16	24dB	0.625V
5	32	30dB	0.312V
6	64	36dB	0.156V
7	128	42dB	78.1mV
8	256	48dB	39.1mV
9	512	54dB	19.5mV
10	1024	60dB	9.7mV
11	2048	66dB	4.8mV
12	4096	72dB	2.4mV
13	8192	78dB	1.2mV
14	16384	84dB	610uV
15	32768	90dB	305uV
16	65536	96dB	152uV

Fig 2. Relationship between size and resolution.

levels each $152 \mu\text{V}$ in size. (There is also available an 18 bit device, costing a small fortune. The larger the bit size of the DAC, the larger is the dynamic range (best signal to noise ratio) of its output. This increases by 6 dB per bit. Thus a 10 bit DAC can give a best range of 60 dB.

The human anatomy has developed over the last few million years to respond to its environment. This has resulted in the following performance figures. The sensitivity of the eye to colour is not that good. Colour television transmission doesn't give much of its bandwidth to the colour part of the signal. Have a look at a TV and see how well defined the colour is; it is usually just "sort of smeared around" the subject. Thus it is possible to get quite good digital video using only 4 bits for the colour. The eye sensitivity to resolution is somewhat better, but even so an 8 bit oscilloscope memory will look fairly continuous, giving little indication that it is made up of discrete steps.

Ear Lead

However the ear can still outperform present day technology. Using a 16 bit high quality audio system a trained ear can still detect the difference between the digitally processed sound and the original. Thus, when using DAC's in professional audio equipment great care has to be taken to eliminate all types of aberrations in the system. These digital aberrations don't just worsen

the signal to noise ratio (as an analogue system might), but they produce discordant harmonic distortion, sidebands like those obtained from ring modulation and other little funnies.

Figure 3 shows a DAC system in operation. The output of the DAC is meant to produce nice clean square wave steps, but the leading edges of these steps always have small spikes (glitches), caused by the switching times associated with the DAC's internal workings. These glitches are not regular in nature and so filtering cannot eliminate them. The glitches give the sound a "dirty" quality, or, if the system is an oscilloscope display it produces fuzzy pictures.

The glitches can be removed with a little module called a DEGLITCHER, fig 4. This is a logic controlled sample and hold which holds during the glitch period, but otherwise tracks the signal from the DAC. Thus the glitches are ignored. The output from the deglitcher then passes through a low pass filter and this removes the "stepped" quality of the signal and produces a smooth analogue output. The cut off frequency of this filter is very important and is related to the data rate of the DAC. The rule of thumb is that the filter cut off frequency should always be less than half of the data rate frequency.

Buying And Building

DAC's can be bought fairly cheaply as complete IC's or they can be constructed out of generally available parts, fig 5. This circuit uses precision buffers (a CD4041 will do), E24 resistors and a FET op amp. The buffers are run from a +10 V supply and their purpose is to provide high (+10 V) and low (0 V) output with low source resistance. They are driven by a 6 bit data word, the MSB (most significant bit) thus drives the 7k5 resistor, the LSB (least significant bit) the 240k resistor. So, when the MSB changes, the output of the op amp will move by a large amount (5 V), but when the LSB changes the output will only change a little (0V156). Going from the MSB down to the LSB, each bit has only half the effect of its predecessor. This is obtained by doubling the resistor values (7k5, 15k, 30k, 60k, 120k, 240k).

A 6 bit DAC can produce 2^6 discrete output levels. Now 2^6 is 64 and so the overall resistor tolerance should be ± 1 part in 2×64 , which comes out at $\pm 0.8\%$. This type of DAC is known as a resistance ladder DAC, but in its presented form it is rather limited. For instance, a 10 bit device would require a resistor range of 1024 to 1 and a tolerance of 0.05%.

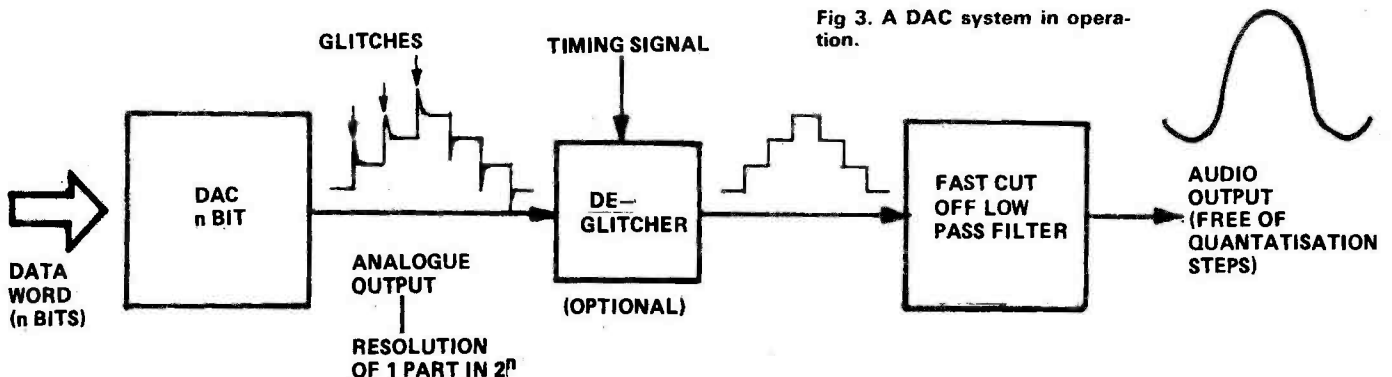


Fig 3. A DAC system in operation.

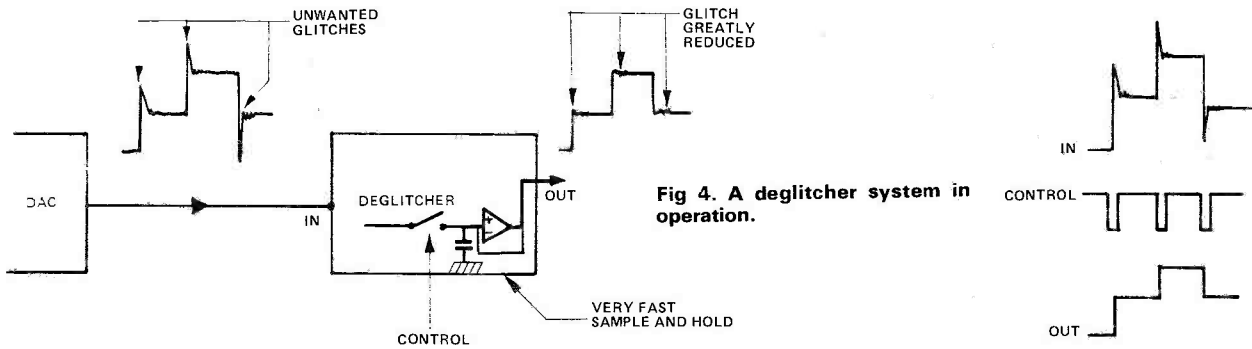


Fig 4. A deglitcher system in operation.

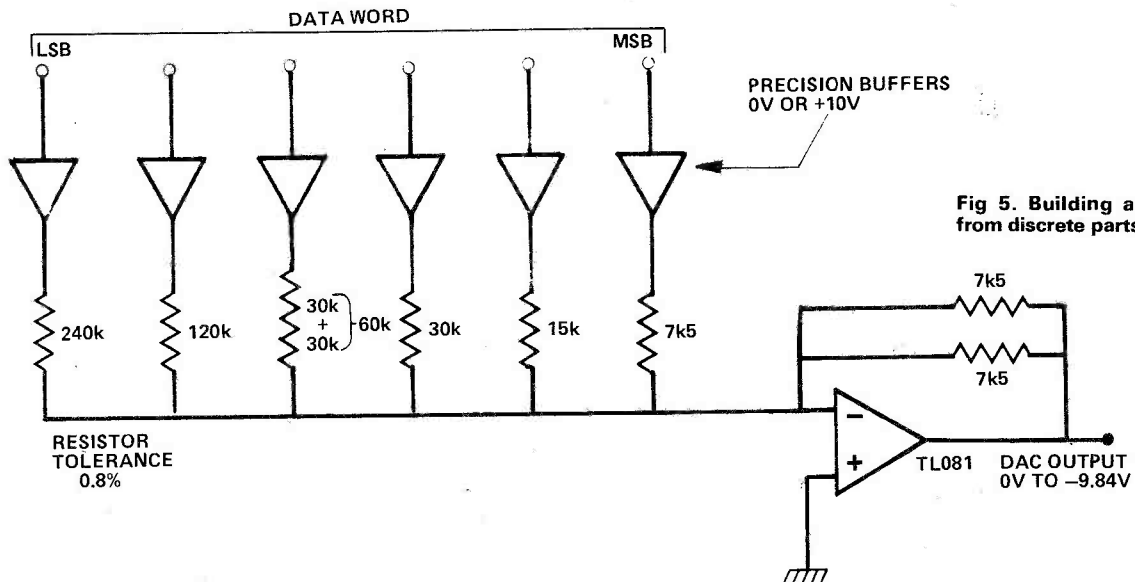


Fig 5. Building a DAC circuit from discrete parts.

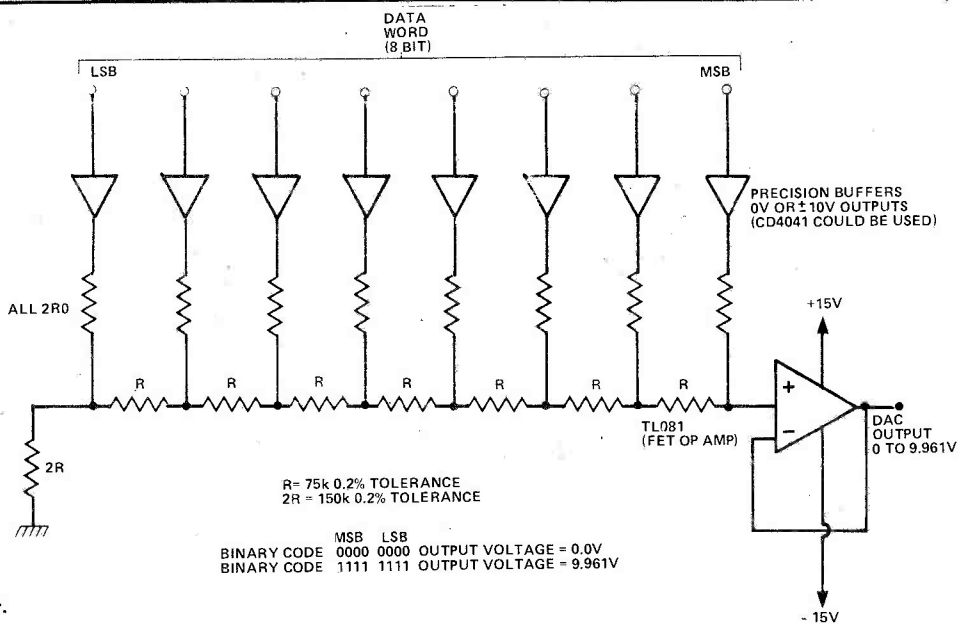


Fig 6. An R-2R ladder.

Multiple Choice

The DAC shown in Fig 6 overcomes the problem of multiplicity of resistor values; only two are needed. The resistor tolerance

still applies. Also the ratio between the resistor value and the buffer ON/OFF resistance is important. The 2R resistors connected to the buffers should ideally be 2R — (the buffer output resistance).

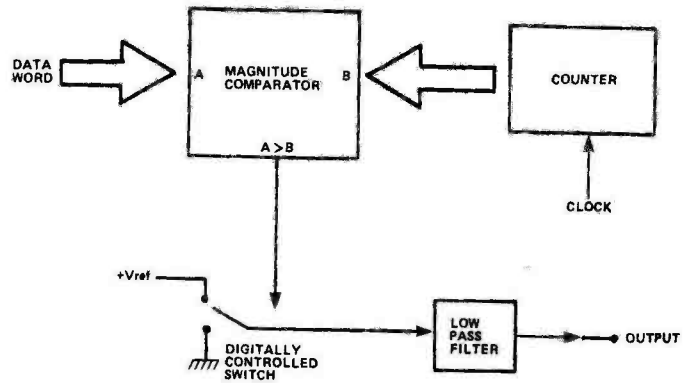
Counting On This

A "counting" type ADC is composed of a fast comparator, a gate, a counter and a DAC. This is why ADC's always cost more than DAC's, the ADC uses a DAC to do the conversion. Assuming that the analog input is positive, and the DAC produces a positive output, the conversion operation is as follows:

1) The signal "start conversion" is generated. This resets the counter to all zero's, the DAC output goes to zero, the comparator output goes high and so the clock is allowed to enter the counter. Thus the count proceeds and the DAC generates a positive going staircase.

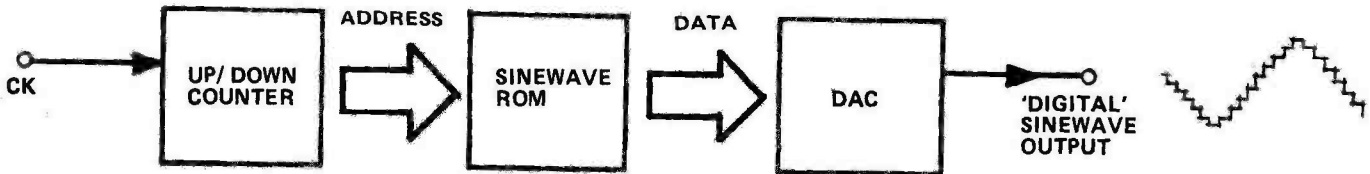
2) When the DAC output exceeds the level of the analog input the comparator output goes low, the counter stops. This is the end of the conversion, and the data that is held on the counters output is the data output. It would then be transferred to some latches, and held there until the next conversion is finished.

This data word describes as precisely as is possible the magnitude of the analogue input. Although simple to operate, this method has a major disadvantage, it is slow. Imagine that the ADC is a 10 bit device and the clock frequency is 500KHz,



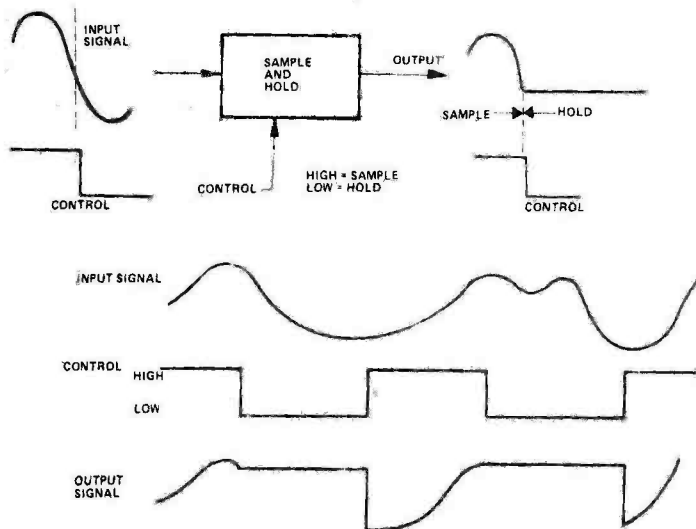
then the longest conversion time will be 1024 counts at 2 μ Sec per count which is 2.048mSec, this means that the conversion rate will be less than 500 per second.

Memory Planning



The data that drives DAC's can come from several sources. It could be generated by computation or read from a programmed memory as shown. In this example a ROM (read only memory), has been programmed with the data necessary to produce a

sinewave. An updown counter provides the address for the ROM and the data is converted into an analog output by the DAC. The clock frequency divided by the size of the counter determines the sinewave frequency.

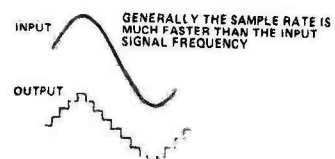


Data Lining

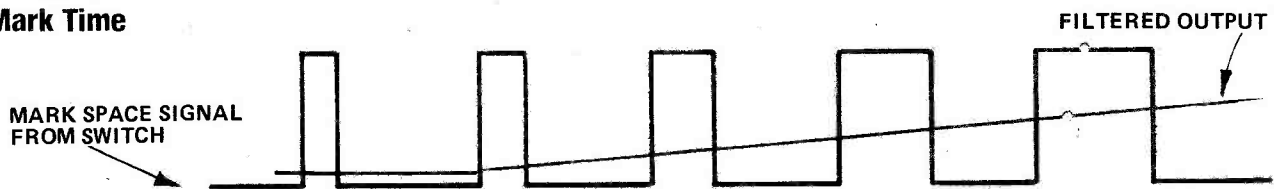
Another method of generating data is to convert analogue information into digital words. The signal must first be passed through a low pass filter, the cut off frequency of which must be less than half of the conversion frequency. The signal is then "held" in a sample and hold unit so that the ADC can do its conversion on a static signal. Control logic sends commands to the ADC giving it various instructions. The sequence of events is:

- 1) Tell sample and hold to HOLD.
- 2) Tell ADC to start conversion (SC).
- 3) Conversion finished, generate end of conversion signal (EOC).
- 4) Tell sample and hold to SAMPLE.

The process then repeats itself. The sample and hold mechanism is shown below. Generally, in one period and the input signal several ADC conversions will be done. The data generated is then stored, processed or transmitted.



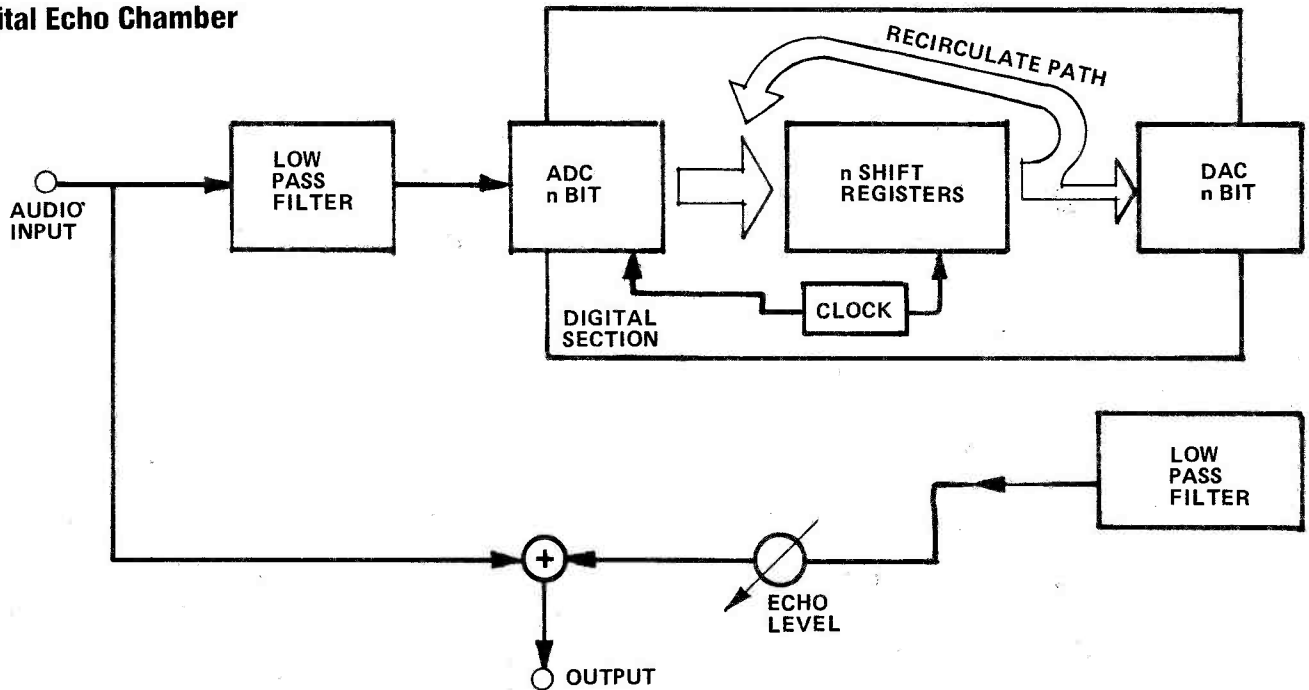
Mark Time



Yet another type of DAC, a mark space modulation DAC is shown above. The data word is presented to one side of a magnitude comparator, the output from a fast running counter to the other. When the counter is greater than the data word the A>B output goes low. The output is a mark space waveform the ratio of which is linearly proportional to the magnitude of the

data word. The mark space signal operates a precision switch, the output of which is lowpass filtered, providing a smoothed DC output. This type of DAC requires a fast running counter, but gives a relatively low bandwidth output signal. It is a good solution for a system where lots of slow moving outputs are required, because the counter can be common to all the DAC's.

Digital Echo Chamber



There are several professional echo chambers that are all digital. The audio input is converted into a digital word and then put into a parallel set of shift registers. A 10 bit system would use 10 sets of registers. The clock that starts the ADC conversion also shifts the data along the shift registers. The data coming out of the shift registers is then converted back into an analogue voltage by the DAC. It is then filtered and mixed with the original signal.

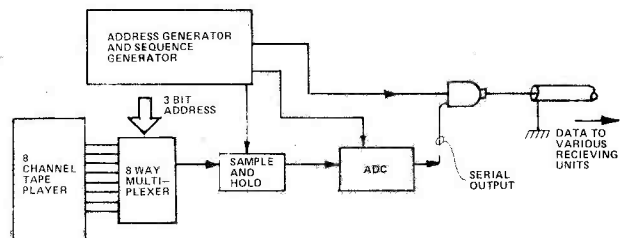
The echo can be made to repeat indefinitely by using the digital recirculate path around the shift registers. The amount of

digital storage required is rather large. Let us assume that we want a good quality echo. This would be a 10kHz bandwidth, 60 dB dynamic range which implies a clockrate of about 25kHz and a 10 bit system. Thus to store 1 second of sound (to give one second delay), we would need 10 x 25,000 bits of memory, 0.25 Mbits!

The usual solution to this dilemma is to get longer delays at the expense of bandwidth. Thus a 1 second delay would be 1kHz bandwidth, a 0.1 second delay would be 10 kHz bandwidth. This would only require 25K of memory.

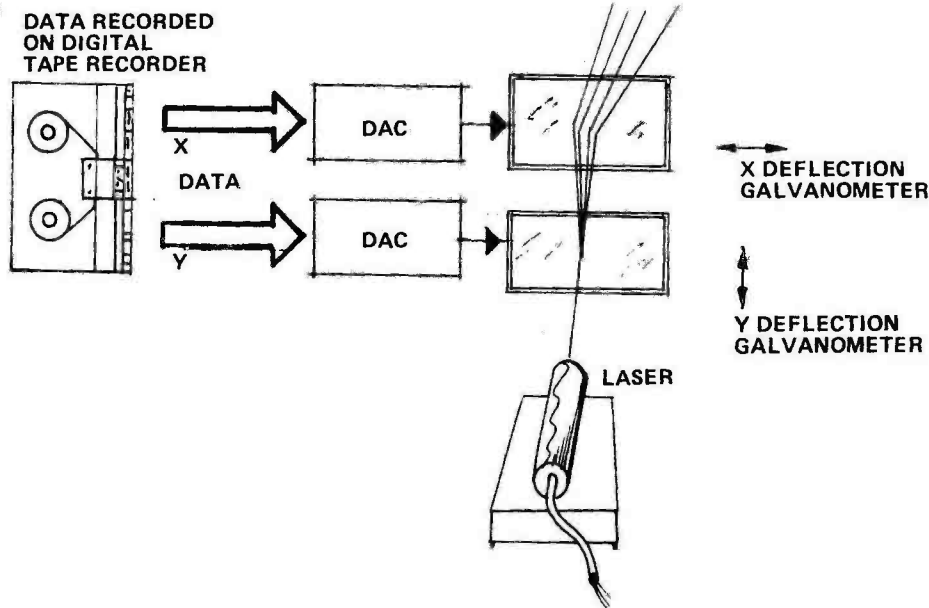
Multiplexed Sound System

Next time you are on an aircraft with a multichannel music system, it is quite possible that the sound you are hearing via your stethoscope is digitally generated. The sounds are usually stored on a multichannel tape player and each channel is connected to a multiplexer. This is a digitally controlled rotary switch and it is continually scanning all the audio channels. The output of the multiplexer is then fed to the ADC. Thus each channel is converted to a digital code. This digital code is then transmitted in serial mode and mixed with a sync pulse. The transmitted information is a series of serial data words, each representing a small piece of the eight music channels, plus some synchronisation data which passes down a two wire system to each receiving unit. This saves wire weight, there is less crosstalk and low pickup due to the high noise immunity of digital systems.



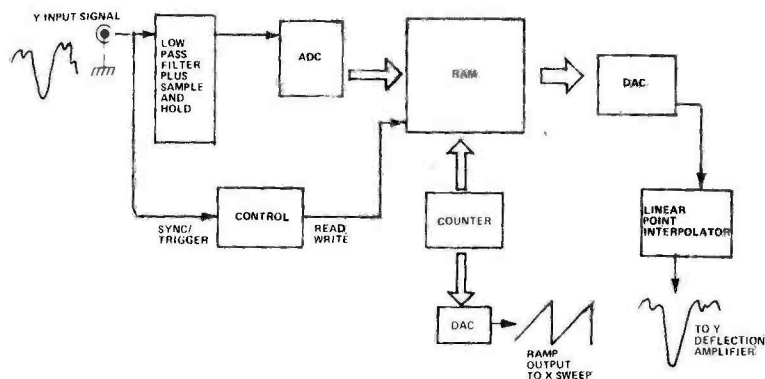
Laser Light Show.

One of the recent laser light shows in London used a digital tape recorder to store the data for the show. Two outputs were produced which were converted into control voltages by DAC's. These voltages were then used to manipulate the X and Y Co-ordinates of the laser. Thus it was possible to draw pictures and cartoon characters with a moving laser beam.



Digital Memory for an Oscilloscope.

There are several products on the market that enable an ordinary oscilloscope to store waveform information. This is particularly useful if you are trying to capture non-repeating events. The system is very similar to the digital echo unit, there is an ADC, a memory and a DAC. Also there is a trigger circuit so that one shot events can be captured and a ramp generator to produce the Xsweep. The output of the DAC is rather interesting, because it is not low pass filtered, but it uses a linear point interpolation device. Basically, what this does is to join up the dots, so that a waveform that is represented by only a few points, can be made to look like the original signal. The visual results of interpolation are very good indeed.



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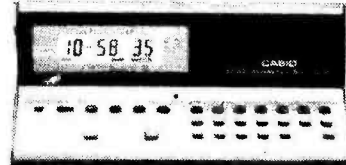


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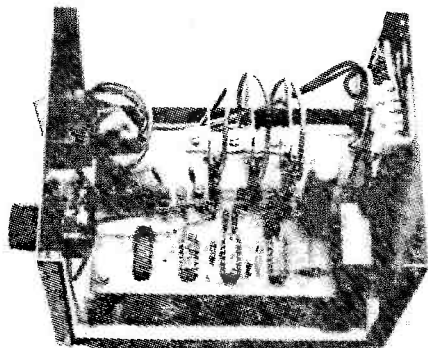
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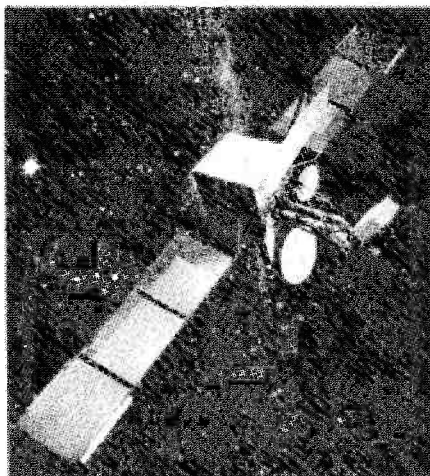
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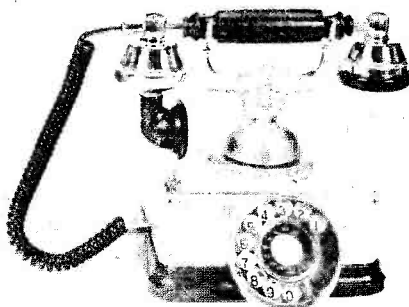
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Communications Satellites



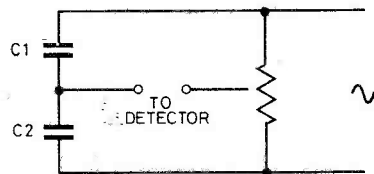
Speak to someone on the phone outside Europe and the chances are that your voice will spring out into space for thousands of miles on the way. The commercial ends of the space programme are described.

Telephones



Do you know how the phone, one of the most widespread pieces of electronics, works? Lots of exciting things are happening on this front; we pull back the curtain and take a peep next month.

Crossing your Bridges



The Wheatstone Bridge is one of the commonest circuit configurations in electronics. Next month K. T. Wilson examines the theory of this and describes the variations that we now use.

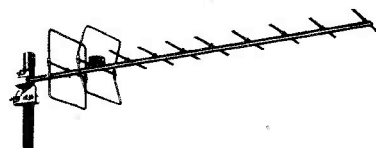
Experimenters Power Supply

Second in our series of test gear projects is a 0-20V, 1A bench power supply, stabilised of course as well as short circuit protected.

Workshop Test Gear

The HE project team have prepared a feature giving their views about what you need in the way of test gear in your workshop. It's a thoroughly practical approach and continually bears in mind the limitations of finance.

How TV Signals are Propogated



Put up an aerial in most areas of Britain and you'll have no trouble in getting a good signal but that's only because the broadcast engineers have taken into account a multitude of factors. We take a look at this subject in the March issue.

The March issue will be on sale February 9th

The items mentioned here are those planned for the next issue but circumstances may affect the actual content.

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5 FUNCTION LCD

Hours, mins, secs, month, date, auto calendar, back-light, quality metal bracelet.

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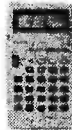
- * Calculator with % / & memory.
- * Continuous clock with
- * Hrs, mins, secs, day, month, day of week
- * Alarm
- * Stop-watch with 1/10 secs to 10 hours + lap and split-time modes, 1st and 2nd.
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- * Dimensions 1 1/4" x 2 3/4" x 4 3/4" in.
- * Complete with leatherette wallet.

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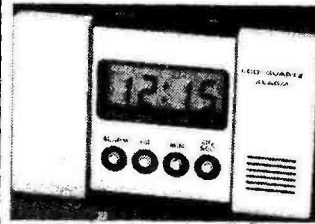
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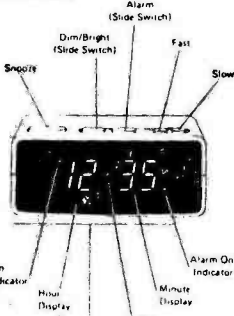
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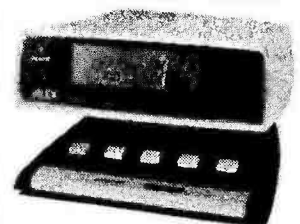
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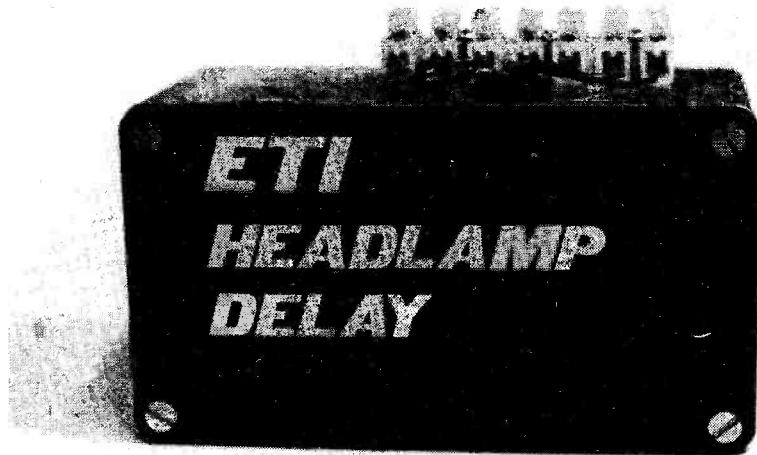


HEADLIGHT DELAY

Use your car headlights to give post-parking illumination with this simple unit.

THIS SIMPLE LITTLE UNIT lets you use your car head or spot lights to illuminate your pathway for a pre-set period of about 50 seconds after you have parked the vehicle. At the end of this period the unit turns the lights off automatically.

The unit thus enables you to avoid walking into dustbins or tripping over junk that may be obstructing your private driveway, and helps you avoid stepping into various nasty bits that may be laying on the public sidewalk. The unit is easy to install in the vehicle.



Construction and Use

Construction of the unit should present no problems at all. The relay can be any 12V type with a coil resistance of 120ohms or greater, and with two or more sets of N.O. contacts that are rated at 3 amps or greater.

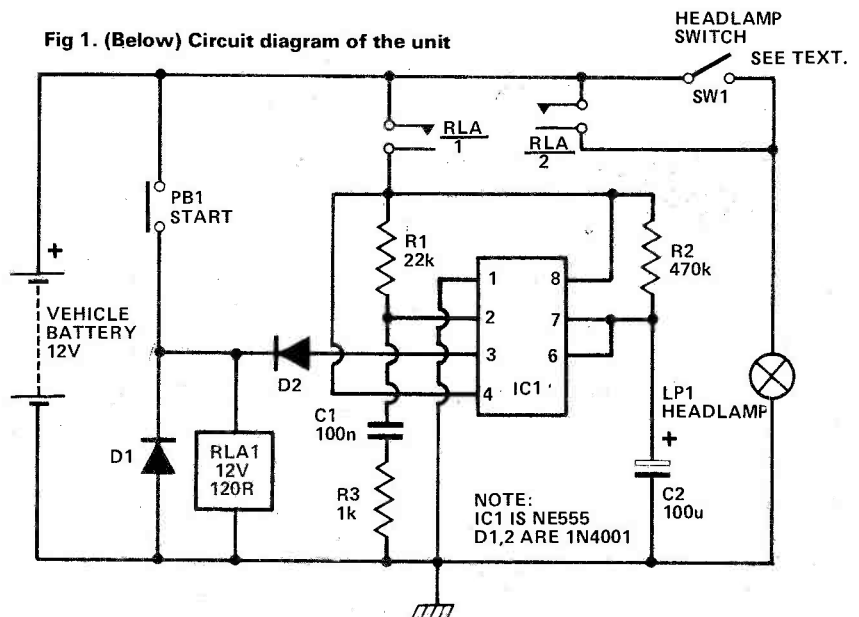
When it comes to installing the unit, note that two methods of connection to the vehicle are possible. On some vehicles the headlight switch is connected directly to the battery so that the headlights operate even when the ignition is turned off (see Fig 2a). In this case take connection 4 of the 5-day terminal block directly to the live side of headlamp switch SW1, and connection 5 to the headlamp side of SW1.

The alternative connection is shown in Fig 2b. Here, the headlight switch is wired in series with the vehicles ignition switch, so that the headlights only operate when the ignition is turned on. If your vehicle uses this type of connection, take connection 4 of the 5-way terminal block to the live side of the ignition switch, and take connection 5 to the headlamp side of SW1. ▶

BUYLINES

With the small number of components involved, it would be surprising if there were any problems in obtaining them.

Fig 1. (Below) Circuit diagram of the unit



HOW IT WORKS

The unit is designed around a type-555 timer i.e., with a relay output. The relay has two sets of normally-open contacts. Normally, START switch PB1 and the relay contacts are open, so zero power is fed to the timer circuit and (assuming that HEADLIGHT switch SW1 is open) the headlights are off. Circuit Action is initiated by briefly closing push-button switch PB1.

When PB1 is momentarily closed power is fed directly to the relay coil, and the relay turns on. As the relay turns on contacts RLA/2 close and apply power to the headlights and contacts RLA/1 close and apply power to the timer circuit, but pin 2 of the IC is briefly tied to ground via C1 and R3 at this moment, so a negative trigger

pulse is immediately fed to pin 2 of the IC and a timing cycle is initiated. Consequently, pin 3 of the IC switches high at the moment that the relay contacts close, and thus locks the relay on irrespective of the subsequent state of switch PB1.

The 555 is wired as a one-shot timer or monostable with a timing period of about 50 seconds (determined by R2 and C2). Thus, the relay and headlights are held on for the duration of this 50 second timing period. At the end of the timing period pin 3 of the IC switches to the low state, so the relay turns off and contacts RLA/1 and RLA/2 open, removing power from the timing circuit and the headlights. The operating sequence is then complete.

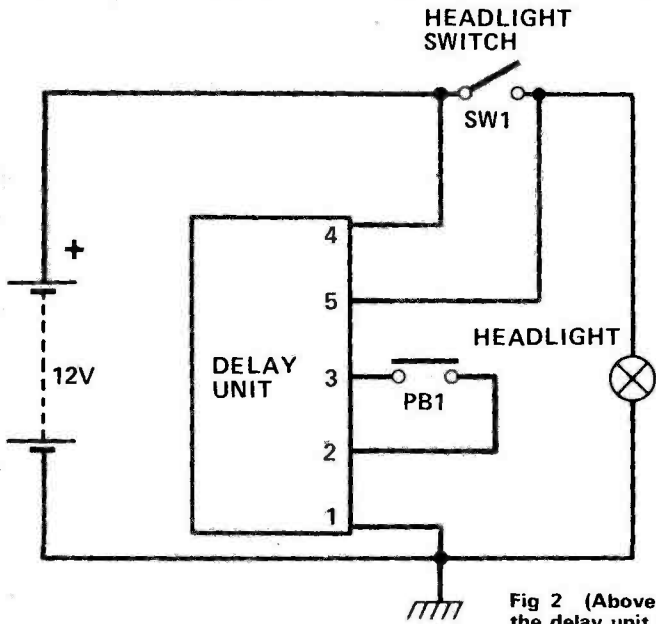
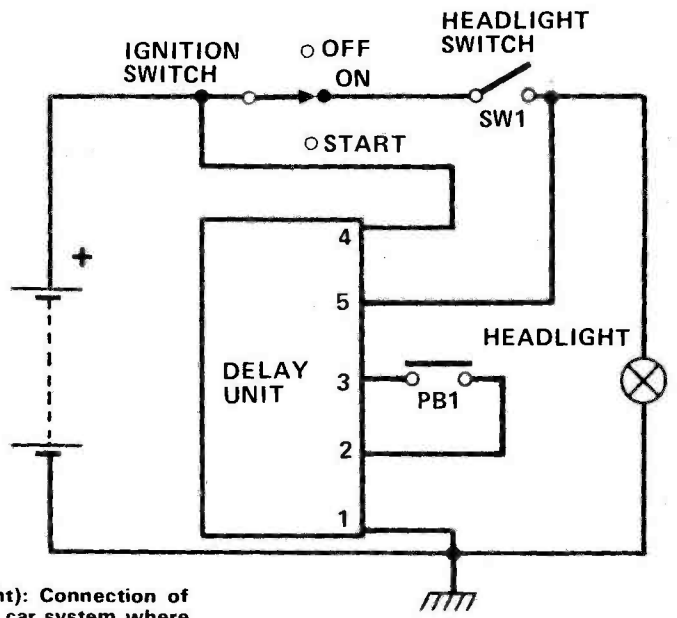


Fig 2 (Above right): Connection of the delay unit to a car system where the headlights are independent of the ignition switch.



(Above Left): Connection to all other systems!

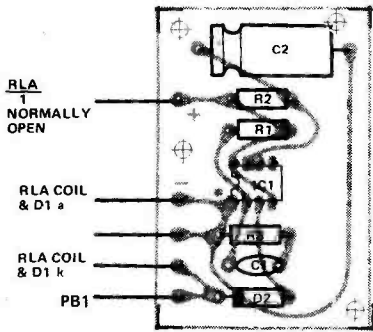


Fig 3. (Left): Component overlay for the delay unit

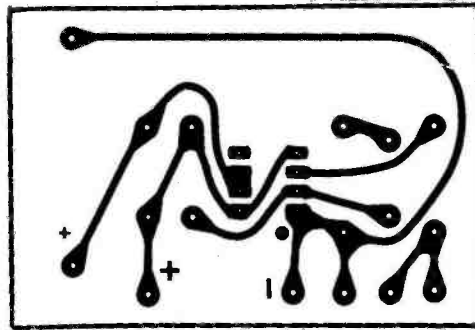


Fig 4. (Left): Wiring of the delay unit to a 5 terminal connection block

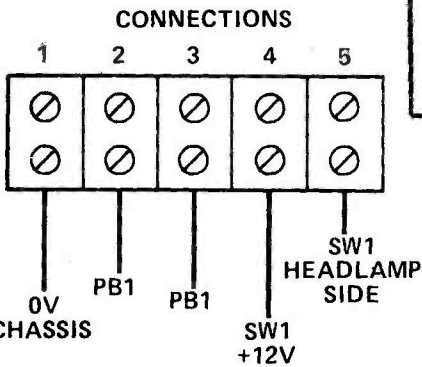


Fig 5. (Above): Full size foil pattern of the headlight delay PCB.

Fig 6. (Below right): The relay and DI wiring.

PARTS LIST

RESISTORS

R1,	22k
R2,	470k
R3,	1k

CAPACITORS

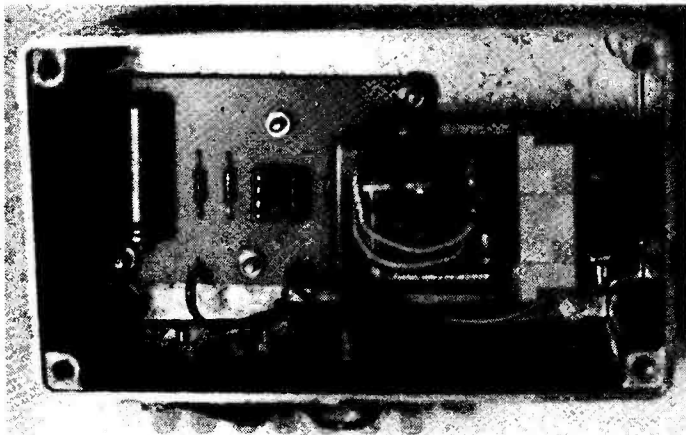
C1	100n polyester
C2,	100u elect.

SEMICONDUCTORS

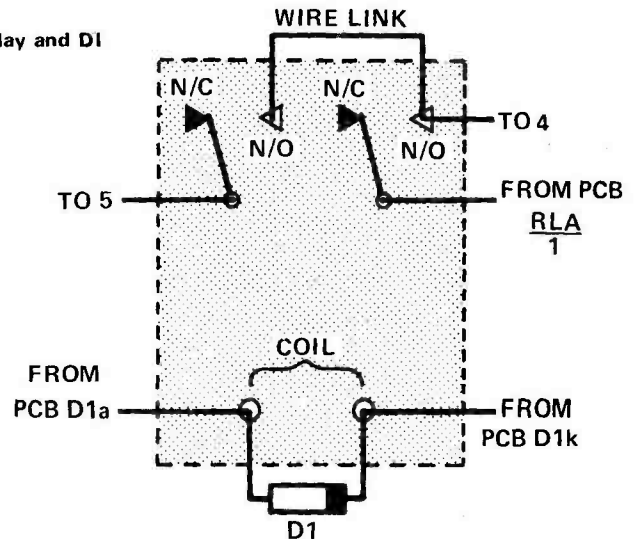
IC1	NE555
D1, 2	IN4001

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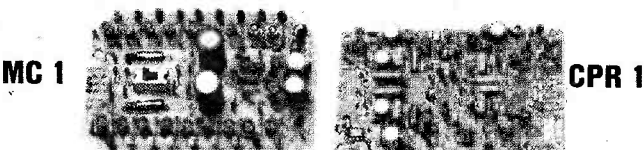
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THE NEW EAGLE INTERNATIONAL CATALOGUE IS AVAILABLE ON REQUEST containing Audio, In-car, and test equipment, etc.

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 BC148 NPN SILICON, 4 for 50p.
 BC158 PNP SILICON, 4 for 50p.
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 SCR4 400V at 3A, stud type, 2 for £1.00.
 TIP295S Silicon PNP power transistor, 60V at 15A, 90 Watts. Flat pack type, 2 for £1.50.
 GERMANIUM DIODES, approx 30 for 30p.
 1N4148 (1N914) diodes 10 for 25p.

VALVES
 QVQ03/20A (ex. equipment), £3.00.
 QVQ03/10 (ex. equipment), 75p or 2 for £1.20.
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 All the above valves are untested, except for heaters, and no guarantee of percentage of emission is given.
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REFERENCE

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PRINTED CIRCUIT BOARDS and KITS FOR ETI PROJECTS

ADDITIONAL PRINTED CIRCUIT BOARDS

Pcbs are available for all projects from September 1976 (except where copyright restrictions exist).

Mag. Issue	Project	Kit. Ref.	P.C.B.	Kit.	Kit. contents (see key)
Sep. 77	*Graphic Equaliser	601	1.75	20.28	BFGH
Sep. 77	*Graphic Equaliser P. S. U.	602	55	1.94	BFGH
Oct. 77	*Watchdog	604	90	18.40	BEGHL
Oct. 77	*Watchdog P. S. U.	605	75	6.14	BEH
Aug. 77	*Sweep Oscillator	606	2.90	36.41	BFGHL
Sep. 77	*Stereo Simulator	607	70	5.77	BEGHL
Dec. 77	*Freezer Alarm	608	.55	7.07	BFHL
Nov. 76	*General Purpose Preamp	609	70	3.83	BEG
Jul. 77	*GSR Monitor	612	30	16.55	BEGHL
Apr. 77	*Burglar Alarm	613	.70	9.00	BEGH
Feb. 77	*Bench Amplifier	615	80	11.10	BEGHL
Nov. 77	*Comander	617	1.75	23.30	BEGHL
Mar. 77	*50 watt High Power Amp	618	1.45	7.91	BE
Mar. 77	*100 watt High Power Amp	619	1.45	10.61	BE
Mar. 77	*High Power Amp P. S. U.	620	1.20	14.75	BEJ
Oct. 77	*Digital Thermometer	621	1.40	19.70	BFGHL
Feb. 77	*LED Dice	624	60	5.83	BEGHL
	*Active Crossover (2 pcbs)	625	2.40	12.70	BFGHL
	*Marker Generator	626	90	6.97	BEGHL
	*Skeet	627	1.75	18.37	BEGHL
	*Flash Trigger	628	.75	5.07	BEGHL
	*Pink Noise Generator	629	3.30	21.94	BFGJ
	*541 Train Controller	T001	80	15.86	BEHL
	*444 5 watt Stereo (2 pcbs)	T002	2.15	26.47	BEGK
	*448 Disco Mixer	T003	1.75	16.36	BEJ
	*Clock B.	T004	2.30	13.61	BEGH
	*House Alarm A.	T005	2.20	25.68	BEHM
	*House Alarm B.	T006	.95	3.99	BE
	*Metal Locator Mk. II	T007	1.05	19.10	BEHL
	*Frequency Shift: P. S. U.	T008	.75	4.99	BE
	*Frequency Shifter	T009	1.65	21.04	BEJ
	*L.C.D. Meter	T010	1.10	25.72	BEG
	*Light Dimmer	T011	.65	7.17	BEH
	*Gas Monitor	T012	90	13.96	BEHL
	*Star Trek Radio	T013	.95	7.97	BFH
	*Stars & Dots	T014	2.00	22.28	BEHL
	*Spectrum Analyser (2 pcbs)	T015	9.75	66.53	CCHM
	*Wein Oscillator	T016	1.00	14.86	BEHL
	*Torch Finder	T018	.55	1.82	BE
	*Temperature Meter	T019	1.10	25.51	BEG
	*Etiket Plant Waterer	T020	1.00	5.03	BEGH
	*Cross Hatch Generator	T021	1.40	12.64	BEGHL
	*Stac Timer	T022	2.30	23.26	BEJL
	*Wheel of Fortune	T023	1.35	8.36	BEHL
	*Complex Sound Generator	T024	2.95	21.88	BEH
	*R.F. Power Meter	T025	1.20	12.94	BEHL
	*Power Bulge	T026	.70	2.98	BEHL
	*Telephone Bell Extender	T027	1.00	9.65	BEHL
	*Proximity Switch	T028	1.95	13.11	BEGH
	*Ultra Sonic Receiver	T029	.70	9.03	BEH
	*Ultra Sonic Transmitter	T030	.55	4.57	BEH
	*Cus Cassette Interface	T031	2.25	12.76	BEH
	*Audio Oscillator (2 pcbs)	T032	2.90	33.74	BEHL
	*Car Alarm (2 pcbs)	T033	1.80	5.52	BEJ
	*Wine Temperature Meter	T034	1.10	5.79	BEHL
	*Curve Tracer	T035	1.00	9.31	BEHL
	*Erom Programmer	T036	2.25	20.21	BEH
	*Erom Programmer P. S. U.	T037	1.30	5.09	BE
	*Car Tachometer	T038	1.75	10.00	BF
	*Digital Module A & B (2 pcbs)	T039	1.80	19.77	BE
	*Digital Dial (Excl. T039)	T040	1.25	7.60	BE
	*Log Converter	T041	3.50	23.66	BE
	*Tape Slide Synchroniser	T042	2.10	17.47	BEHL
	*Tape Noise Limiter	T043	.70	3.04	BEHL
	*Light Activated Tachometer	T044	2.10	31.99	BEH

*Top Projects No. 6. Photocopy of any of above projects — 30p

1976	Audio Level Meter	1.20	June	Digital Freq. Meter (Set 4)	3.40
Mar	Audio Exp/Compressor	3.95	Mar	Bass Enhancer	2.70
May	560 ABC VDU (Set 3)	5.00	Jul	081 Tachometer	.60
Sep.	710 Zm Power Amp	1.00		Micro Amplifier	.55
	241 Double Dice	1.50		Alarm Alarm	.60
Oct.	252 1-2 Hour Timer	.60	Aug	Moisture Indicator	.75
	152AB TV Pattern Gen (Set 2)	3.15		Bongas	.75
Nov.	543AB STD Timer (Set 2)	2.20	Sep	Egg Timer	.70
Dec.	544 Heart Rate Monitor	1.10		Loud Hailer	.70
	447 Audio Phaser	1.80	Oct	Continuity Tester	.60
	446 Audio Limiter	1.35		Spirit Level	.95
				3 Channel Tone Control	.80
				Clock A	1.15
				Rev. Monitor	1.10
				CMOS Switched Pre Amp (Set 2)	3.80
1977	570 Reaction Tester	1.60	Nov.	132 Experimenters P.5	1.00
Jan	549 Metal Locator I	.95		555 Timer pcb	.70
	Patch Detector	.60	Elect		
	Heads or Tails	.60			
	448A Headphone Amp	.60	1978		
	449 Balanced Pre-Amp	.75	Jan	Hammer Throw (Set 3)	5.25
	449A VU Meter	1.10		Race Track	1.35
	Door Bell	.75	Feb.	Acc. Beat Metronome	.75
	155 ABCD Digital Voltmeter (Set 4)	4.30		Porch Light	.80
	Drill Controller	.70		586 Shutter Timer	1.30
	Function Generator	.95	Mar	RMS Meter	1.10
	Temperature Alarm (Set 2)	1.40		Line Follower	.70
	Fuzz	.60	Apr.	Rain Alarm	1.10
	630 Hex Display	.70	May	Electronic Ignition	1.05
	P.S.U.	.60		Helping Hand (Set 2)	2.20
	804 TV Game	1.70	1979		
	Metronome (Simple)	.60	Jan.	Digital Module A	1.10
	Inject Tracer	.80		Digital Module B	.70
				Digital Module C	.75
			Feb	VCT	1.55
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SYSTEM 68

631	2.75
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SPECTRUM ANALYSER

June '78 Ref. T015
Includes: 2 x Pcbs with component screened layout. Components. switches. Electret Microphone, etc. Screen printed End Plate. Screen printed Case.
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HOUSE ALARM

Jan. '78 Ref. T005/6
Control Console for complete house protection. Kit includes Vero 'G' range brushed aluminium instrument case with black front panel screen printed. Price including VAT £2967 P.&P. 30p

KEY TO KIT CONTENTS

- A. Vero-board(s).
- B. Printed Circuit Board(s).
- C. With Screen printed component layout.
- D. Tag strip.
- E. All Resistors, potentiometers, capacitors, semi-conductors.
- F. As E but with exclusions. Please ask for details.
- G. Di and/or transistor sockets and/or soldercon pins.
- H. Hardware includes switches, knobs, lamps and holders, fuses and holders, plugs and sockets, microphones, transformers, speakers, meters, relays, terminal blocks, battery connectors, etc. BUT excludes nuts, bolts, washers, connecting wire, batteries and special miscellaneous items.
- J. As H but with exclusions. Please ask for details.
- K. As H but including connecting wire.
- L. Suitable cases(s).
- M. Suitable case with screen printed fascia.
- N. Full kit to magazine specified standards.
- P. Kit with professional finish — incorporating all prime features including screen printed pcb and case where appropriate.

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COMPUTER COMPONENTS

CELLULAR LOGIC IMAGE PROCESSING

At University College, London, there is a research group working on a method of image processing which could prove to be the link between the human eye and the TV camera. Computing Today's Phil Cohen talked to Dr. Michael Duff about Cellular Logic Image Processing.

CELLULAR LOGIC IMAGE PROCESSING was first proposed in 1958 by S. Ungar in the States. It was suggested that the cells of the human eye do a lot of the processing *before* what we see is fed up the optic nerve to the brain.

What exactly do we mean by image processing?

Generally, it means processes like perimeter-finding — producing the outline of an object, or skeletonising — finding a set of lines which are unbroken and follow the object's shape.

This sort of process can be used in such diverse applications as fingerprinting, character recognition (OCR) or even intruder detection (spotting movement on a TV picture) but perhaps the two most useful areas will be biomedical scanning — chromosome counting or looking for abnormalities on X-ray plates — and production line quality control.

Parallel Processing

The model of the human eye previous to 1958 was of a simple camera — the point-by-point information was fed to the brain, which did all the clever processing.

However, it was pointed out that for processes such as edge-finding it was much more efficient to use a

parallel processing system.

The essential difference between serial and parallel processing schemes is that in a serial scheme the data is processed bit by bit in a central unit (CPU) and the intermediate results are stored in memory. In parallel processing the data is fed in as an array and the processing takes place all at the same time — *there is one processor for each data element*. The intermediate results are passed from processor to processor as the calculations continue.

In the human eye, then, the question is: could a number of cells just behind the light-detecting ones be the parallel processors, responding to commands from the brain to find the edges of objects, or detect movement? Certainly it is known that the edges of the field of vision are extraordinarily good at spotting movement — could this be because the structure of the eye is different there?

The Processors

Going back to the CLIP machine, in this sort of application the type of processor we are talking about is in no way as complex as a modern MPU. The sort of data it receives are single-bit inputs from the image sensor

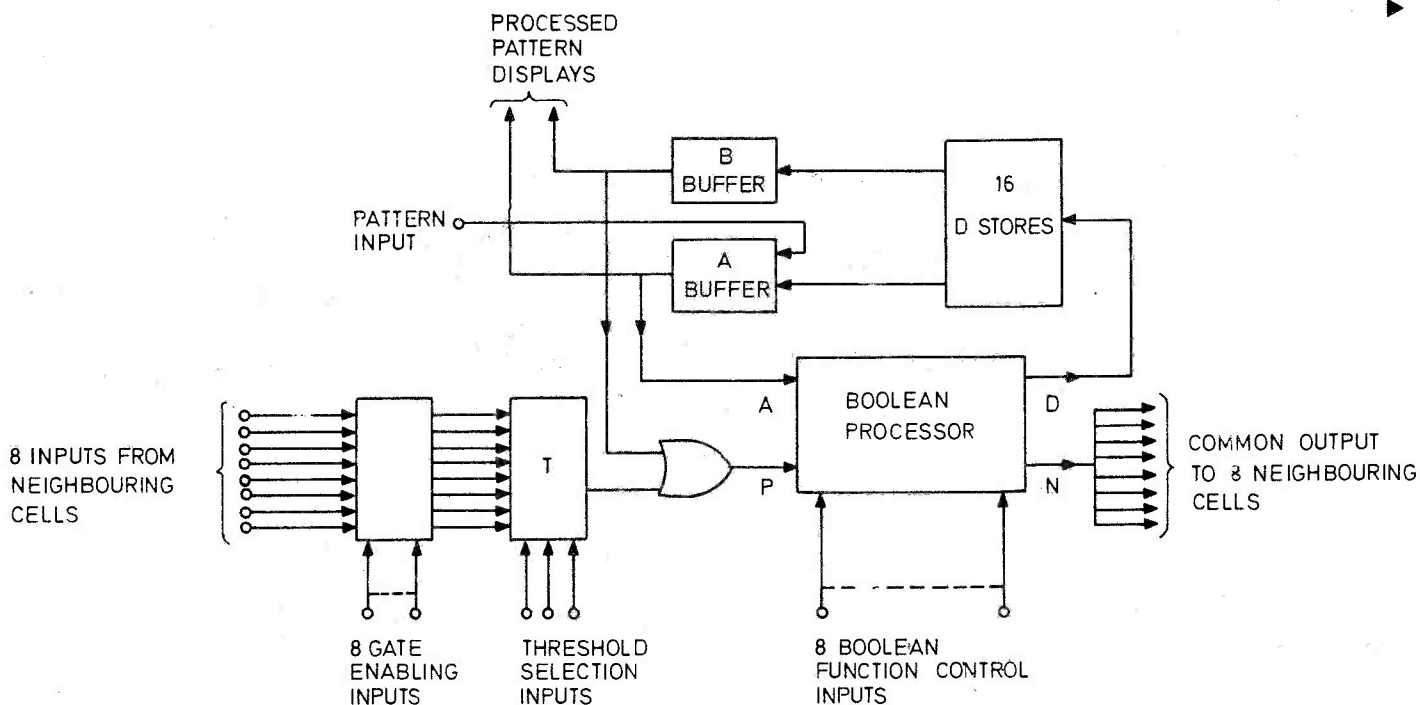


Fig. 1: The block diagram of one of the processors.

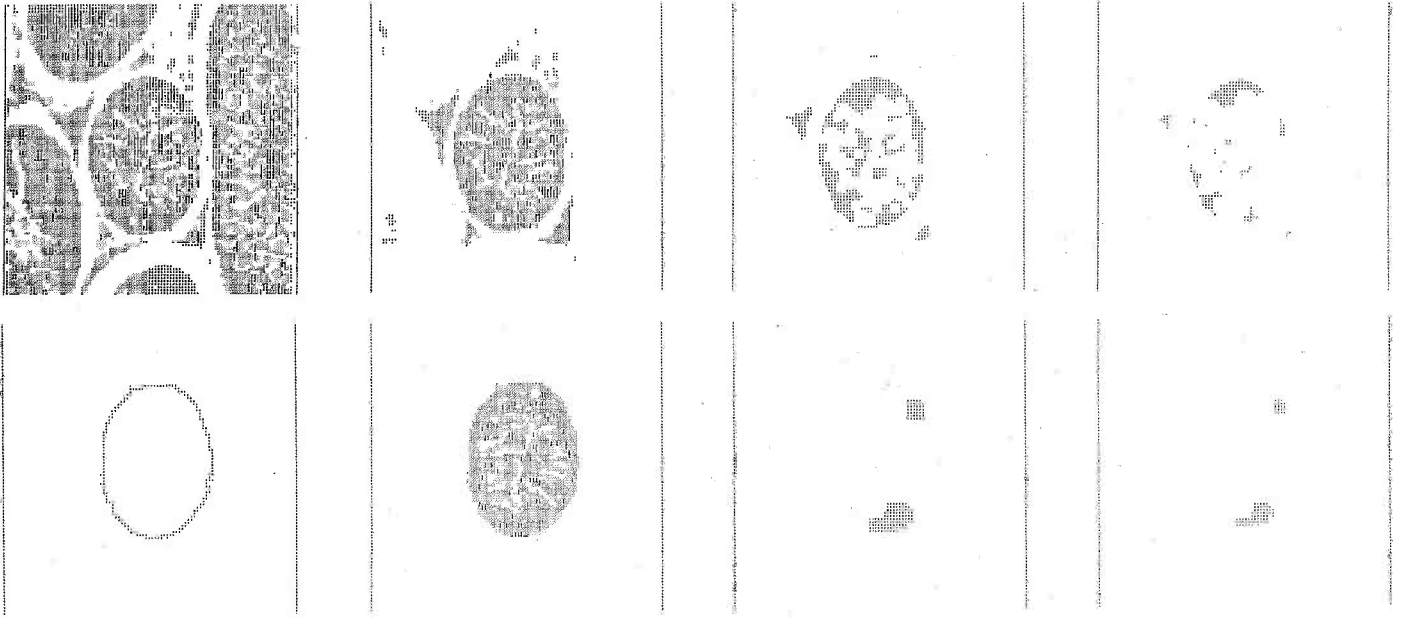


Fig. 2: Stages in the processing of a microscope picture of part of a rat's anatomy.

associated with it and one bit each from the eight nearest processors' outputs.

Why eight? Well, this provides an optimum "connectivity" — too few and the processing becomes slow, too many and the cost of connecting the processors together becomes enormous.

The sort of operation the processor would have to perform would be to give an output if any of its neighbours gave an output *and* the image bit fed to it was a "0".

The program example (in PET BASIC) given shows the usefulness of this sort of process. Of course, we cannot perform parallel processing directly in BASIC — the program has to scan the image bit by bit, simulating the action of each processor in turn.

The important thing about using this sort of scheme for image processing is that the outputs of the units will change in "waves", travelling at speeds dependant on the propagation delay of the devices involved. This means that, by having four "edge registers" which are not connected to the image input, we can do things like finding the outer edge of an object by starting a signal from the edge registers and programming the processors to stop propagating it at the edge of the object. The program example carries out this sort of process.

Structure

In the CLIP machine, the processors each have the structure shown in Fig 1. Each is connected to its eight neighbours and its output fans out to the same neighbours. There is also a "pattern input" for connection to the picture signal (which is derived from a TV camera and multiplexed to provide each processor with a 1-bit signal from one point of the camera's image).

The gate enabling threshold selection and function control inputs are from a programming bus common to all processors.

The gate enabling inputs allow instructions like "If the output from the processor to the left is '1' . . ." The threshold selection inputs allow "If more than three inputs are '1' . . ."

Combining the two allows very comprehensive processing of the inputs — "If any two of the processors to the left give and output . . ." for example.

There are also various buffers for more complex instruction types.

The boolean processor itself can be programmed via the function controls to "look" like any combination of memory-less logic gates.

Implementation

The processors come in custom-built ICs, each chip containing eight units. The CLIP 4 machine contains an array of 96 x 96 processors.

CLIP 4 is the product of ten years of research at University College. It's a commercially viable product — it fits into one 7-foot instrumentation rack, including power supplies and controller. The cost? In the region of £30-40 thousand.

The processors themselves are based on NMOS technology and the control circuitry (the part that acts as a "conductor" — in the musical sense — directing all of the processors) is implemented in hardware — an MPU would be too slow!

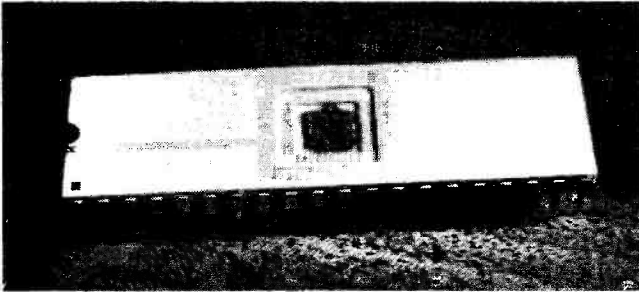
The input signal is from a TV camera (only part of the picture is used — 96 lines x 96 points). This is encoded either as a black and white picture with no grey or as a grey-scale image. CLIP can handle grey-scale pictures, performing processes such as smoothing.

The output from the system would be to a video monitor or, in some applications, just a few bits of data to another peripheral, such as a warning indicator in the case of intruder detection.

Software

The software for the system consists of a series of inputs for the function-definition bus of the processors and a loop structure which is linked to the processor outputs.

Looking at Fig. 2, the machine is trying to find the outline of the largest isolated mass of black in the input pattern.



One of the chips in the CLIP — each contains eight processors.

The original input is shown in the top left. The first instruction propagates white from the edge registers through all connected black. This leaves the pattern second from the left on the top line. The program then "erodes" the image by removing all black dots not surrounded by black and then removing their neighbour black dots as well.

It repeats this erosion until one more step would cause all black to vanish completely. This leaves the image as it is at the end of the top line.

The program then surrounds each black by eight blacks. It does this twice. It then recalls from the original input pattern the part which is "connected" to the current pattern. The last step finds its outline.

Naturally, this sort of software cannot be written in a conventional language — the group have developed what is effectively an assembler for the system and all the groups working on image processing worldwide are due to meet this spring to discuss a suitable high-level language.

Applications

One very interesting application mentioned earlier is production line control. CLIP can tell the difference between an object which has been correctly punched out of metal and one with the wrong surface area or the wrong number of holes, etc.

The amazing thing is that it can do this fifty times a second! In fact, the machine can perform 1500 parallel processes per TV frame period.

The machine could be fitted to the "reject" solenoid on a production line so that badly produced pieces could be pushed off the line.

Another area in which the machine could be useful is in microscopic counting. There are systems available already which will count the number of items in a picture, or even the number between certain size limits, but the inherent flexibility of CLIP make it invaluable for complex tasks such as red blood cell deformity checking and other applications where previously a human operator was the only alternative.

One slightly more frightening possibility is the use of such a system in facial recognition — enabling authorities to keep track of every individual automatically.

When the system was first proposed about ten years ago, the device which was envisaged was a pair of super-binoculars, with photo-diodes at one end and LEDs at the other, modifying images so that only moving objects, or even more selectively, only enemy tanks would be seen! This is some way from the present state of the art but in a few years . . . who knows?

We would like to thank Dr Michael Duff and University College in general for their help. ETI

CLIP SIMULATION PROGRAM

The following program simulates the action of the CLIP machine by pretending to be each processor in turn in a 10 x 10 array. It's very slow to run (several minutes) and this shows the advantage which a parallel processing system has over a serial one.

10 S=10

S is the dimension of the 2-dimensional square processor array.

20 DIM A(S, S), B(S, S)

A is the image input to the system. B represents the processor outputs. Load the image into the system:

```
30 FOR I=2 TO S-1
40 FOR J=2 TO S-1
50 READ A(S, S)
60 NEXT J
70 NEXT I
```

The outer layer of processors represent the edge register, in which we can initialise processing 'ripples' (see text).

```
80 DATA 0,0,0,0,0,0,0
90 DATA 0,1,1,1,1,1,1,0
100 DATA 0,1,0,0,1,0,0,0
110 DATA 0,1,1,0,1,1,0,0
120 DATA 0,1,1,0,1,1,1,0
130 DATA 0,1,1,1,1,1,0,0
140 DATA 0,0,0,0,0,0,0,0
150 DATA 0,0,0,0,0,0,0,0
```

Now for the 'seed' which will propagate during processing. Note that it's in the edge register:

1010 B(S, S)=1

Now print the results so far:

```
1014 GOSUB 2000
1015 F=0
```

F is set to 1 if any changes are made.

```
1020 FOR I=2 TO S-1
1030 FOR J=2 TO S-1
```

```
... For each processor
1040 FOR K=-1 TO 1
1050 FOR L=-1 TO 1
... For each of the eight 'connected' processors
1055 IF L=0 AND K=0 THEN 1090
... Except the one we're simulating
1060 IF B(I+K, J+L)<>1 OR A(I, J)<>0 THEN 1090
skips the next bit unless the image is zero at this point and one of
the neighbours outputs is one.
1070 IF B(I, J)=0 THEN F=1
B(I, J) is going to be set to 1. F is set to 1 if this represents a change.
1080 B(I, J)=1
1090 NEXT L:NEXT K:NEXT J:NEXT I
1130 IF F=1 THEN 1014
1140 STOP
```

repeats the process until the output is stable (ie there were no changes during this pass).

The following subroutine prints the results:

```
2000 REM PRINT
2010 PRINT " " : REM CLEAR SCREEN CHARACTER
2020 FOR I=1 TO S
2030 FOR J=1 TO S
2040 IF A(I, J)=1 THEN PRINT "A";:GOTO 2060
2050 PRINT " ";
2060 NEXT J
2070 PRINT " ";
2080 FOR J=1 TO S
2090 IF B(I, J)=1 THEN PRINT "B";:GOTO 2110
2100 PRINT " ";
2110 NEXT J
2120 PRINT
2120 NEXT I
2140 RETURN
```

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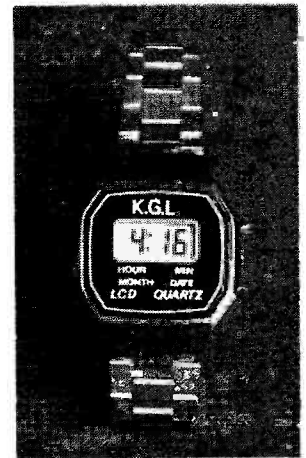
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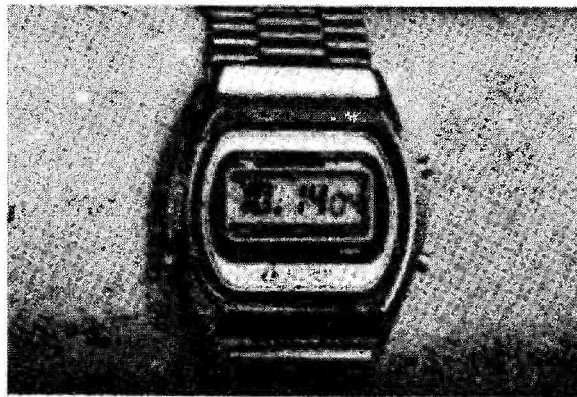
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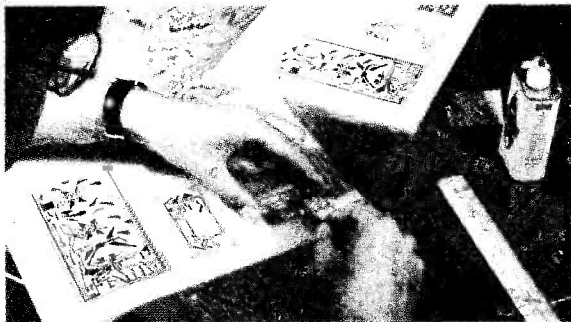
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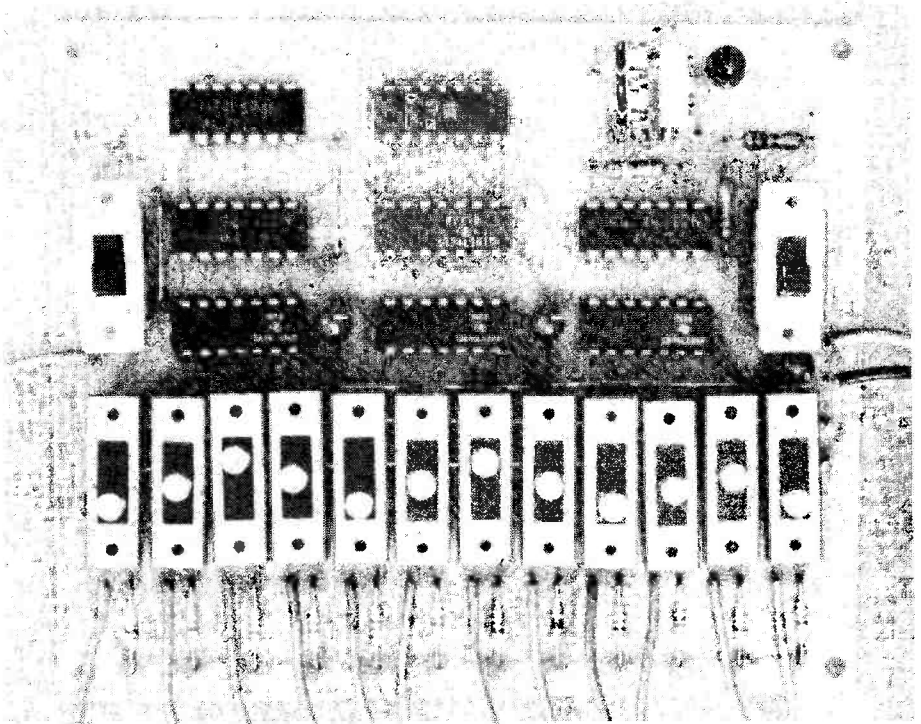
003	Race Track Game	Jan 78
	Hammer Throw	Jan 78
	Freezer Alarm	Dec 77
004	Metal Locator Mk II	Feb 78
	Ultrasonic Tx / Rx	Feb 78
	5 Watt Stereo Amp (modified)	Jan 77
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005	Op-Amp Supply	
	Frequency Shifter	Mar 78
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	General Preamp	Project Book
	Flash Trigger	Six
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	Active Crossover (2 PCBs)	
012	Disco Lightshow	Project Book
	Stereo Simulator	Six
	Digital Thermometer	
013	Amplifier Module	Project Book
	Amplifier PSU	Six
	Equaliser	
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	Sweep Oscillator	Six
	Burglar Alarm	
	GSR Monitor	
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	Torch Finder (twice)	July 78
	Etiwet (twice)	Aug 78
016	Stac Timer	
	Xhatch Gen	Sept 78
	Wheel of Fortune	
017	Complex Sound Gen	
	Tele Bell Extender	Oct 78
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018	RF Power Meter	Oct 78
	Proximity Switch	Oct 78
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LOGIC TRIGGER

No need to be in the dark any more, see your pulses, doing their stuff before your very eyes.

WHEN USING AN oscilloscope to examine or fault find digital circuitry, it is often desirable to see what happens just before a pulse or edge occurs. An example of this is when measuring the propagation delay in a ripple counter. Here it is easy to trigger on the last output but the edge of the counter input which initiated the change in the output may have occurred over 100 ns earlier. Even with the delay line built into modern oscilloscopes the edge is too early to see.

Triggering on the input waveform allows this edge to be seen but if the output pulse occurs only once every thousand or so pulses it will not be seen. With this unit, the output of all the stages in the divider can be examined and a pulse can be generated anywhere in the cycle. By selecting a pulse very close to, but before, the edge in question and using it to trigger the oscilloscope (use ext trigger) both the clock waveform and output waveform can be seen.



SPECIFICATION

Modes	Asynchronous or synchronous
No. of inputs	12 address, 1 clock
Loading address clock	0.4 UL (TTL) 0.4 UL (TTL)
Pulse extension mono	10 ms
Pulse indication	LED
Minimum pulse detectable	<40 ns
Propagation delay	<45 ns
Trigger (synchronous)	positive or negative edge of clock input
Set up time (synchronous) address to clock	<40 ns
Output	logical "1" when input agrees with switch setting and/or clock (synchronous only)
Power requirement	+5V @ 50 mA

With the advent of microprocessors it has become increasingly difficult to fault find as things happen (e.g. the CE input to a memory may go low) only when a particular address is given. As the address bus is always in motion it is almost impossible to trigger the scope on any one address. Again with this unit the address bus is interrogated along with the necessary write or read lines, and its output can be used to trigger the oscilloscope only when the correct sequencer is received.

Construction

We mounted all the components on the board including the switches. The only difficult (fiddly) bit is the writing of the three position slide switches which have to be preassembled before fitting to the pcb. The wiring is shown in fig. 3.

To aid this we have provided 12 holes in the pcb the size of the toggle of the switches; if the

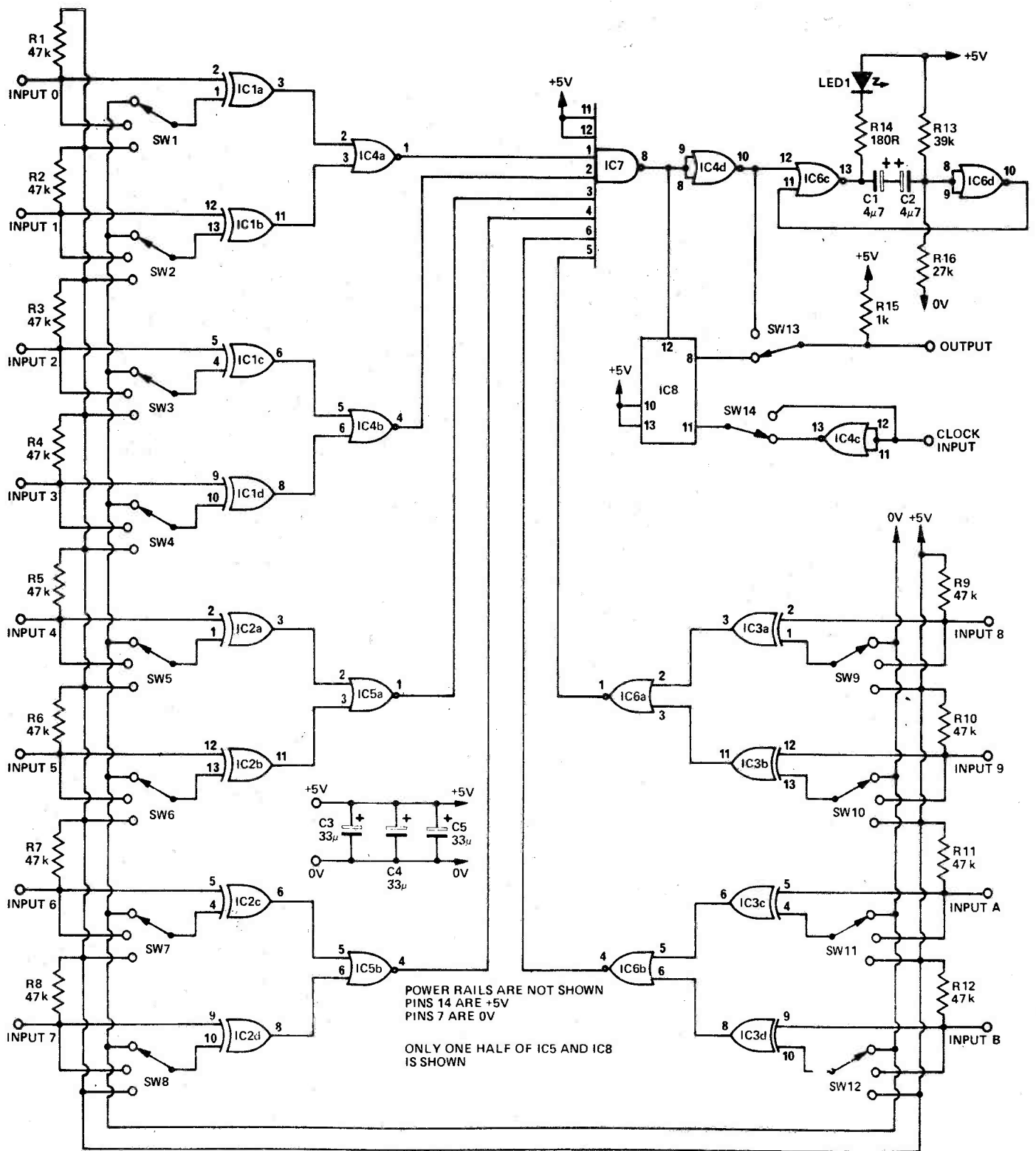
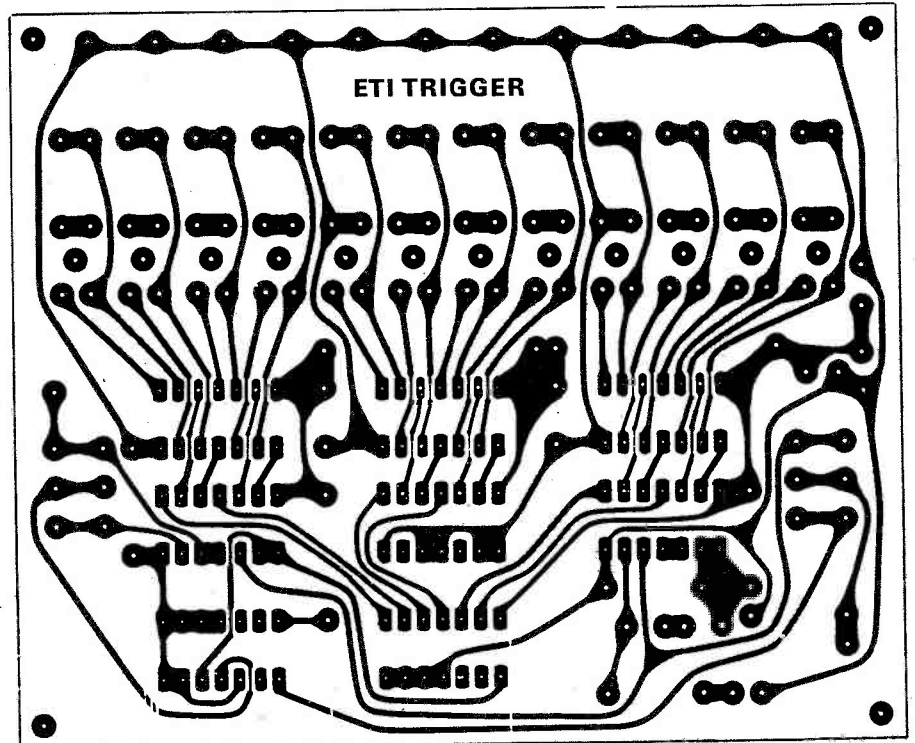


Fig 1. Full circuit diagram of the logic unit.

PARTS LIST

RESISTORS		all 1/2W, 5%
R1-R12		47k
R13		39k
R14		180R
R15		1k
R16		27k
CAPACITORS		
C1-2		4μ7 25Velectro
C3-C5		33μ 16V tantalum
SEMICONDUCTORS		
IC1-IC3		74LS86
IC4-IC6		74LS02
IC7		74LS30
IC8		74LS74
LED1		Red LED
MISCELLANEOUS		
PC board ETI 141		
Twelve 3 position slide switches		
Two 2 position slide switches		
Front panel		
Box to suit		

Fig 2 (right): Foil pattern shown full size.



HOW IT WORKS

The twelve inputs are compared to the levels set on the slide switches SW1-SW12 by the exclusive OR gates IC1-IC3. These ICs have a high output only if the two inputs differ. If they are the same, either both low or both high, the output will be low. If the two inputs are joined together, as when the switches are in the don't care position, the output will always be low.

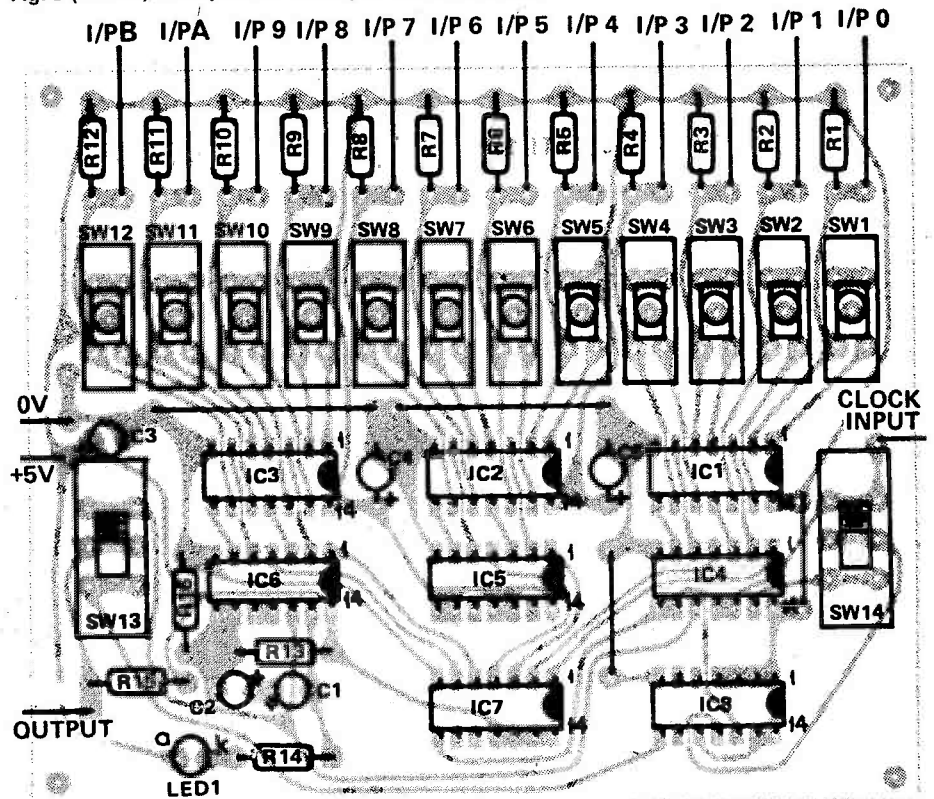
The outputs from the exclusive OR gates are combined in pairs by the NOR gates IC4-IC6. If the 12 input signals match the preset selection, the output of all 6 NOR gates will be high. If any one is not in agreement with the selection one or more of the NOR gates will have a low output.

These NOR gate outputs are combined by IC7 which is an eight input NAND gate. The output of this gate will low only if all 12 inputs match. The output of this IC is inverted by IC4/d to provide the asynchronous output.

This output also triggers the monostable formed by IC6/c and IC6/d. This gives a 10 ms long pulse of light the LED indicating a pulse was received. If it is a steady state signal the LED will stay on.

The output of the NAND gate, IC7, also joins the data input of IC8 (D type flip flop). This IC is toggled on the positive edge of the clock waveform transferring the data to the output. This is the synchronous output. To allow for either positive or negative synchronization an inverter is used on the clock input and either polarity can be selected by SW13.

Fig. 3 (Below) Component overlay of the logic trigger



switches are initially placed upside down in these holes the board will act as a template to provide the correct spacing. We have also used two wires of the switch to provide mechanical support. While only a single pole switch is needed the

only ones readily available are two pole.

The switches can now be mated to the PC board with the two longitudinal wires being terminated in the holes provided at the end of the switch bank.

ETI

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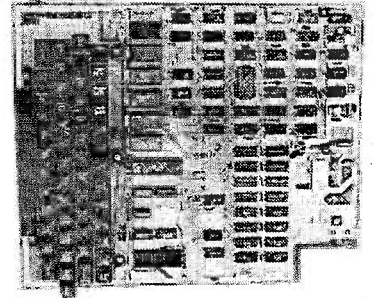
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ELECTRONICS TODAY INTERNATIONAL — MARCH 1979

Commands

CONT	LIST	NEW	NULL	RUN	
Statements					
CLEAR	DATA	DEF	DIM	END	FOR
GOTO	GOSUB	IF...GOTO	IF...THEN	INPUT	LET
NEXT	ON...GOTO	ON...GOSUB	POKE	PRINT	READ
REM	RESTORE	RETURN	STOP		

Expressions

Operators
-, +, *, /, ↑, NOT, AND, OR, >, <, <>, >=, <=, =
RANGE 10⁻³² to 10⁺³²

Functions

ABS(X)	ATN(X)	COS(X)	EXP(X)	FRE(X)	INT(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)	SGN(X)	SIN(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)	USR(I)	

String Functions

ASC(X\$)	CHR\$(I)	FRE(X\$)	LEFT\$(X\$,I)	LEN(X\$)	MID\$(X\$,I,J)
			RIGHT\$(X\$,I)	STR\$(X)	VAL(X\$)

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ETI 3

TRANSISTORS

Table of transistor specifications including part numbers (e.g., AC107, BC117, BC206), current gains (hFE), and other technical details.

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Table of TTL (Transistor-Transistor Logic) components with part numbers and associated values.

CMOS

Table of CMOS (Complementary Metal-Oxide Semiconductor) components with part numbers and values.

RESISTORS

Table of resistor specifications including values, tolerances, and power ratings.

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Table of diode specifications including part numbers and technical parameters.

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Table of triac specifications including current ratings and voltages.

ORDERING information section with contact details for Norman Inskip.

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WHO NEEDS ELECTRONICS?

K. T. Wilson explores the all too frequently ignored and misunderstood field of Magnetic Amplifiers.

THINK OF AMPLIFICATION, and you automatically think of transistors. Perhaps if you're a bit longer in the tooth you remember valves. Have you ever thought of large amounts of power gain being obtained without using either transistors or valves? It's power gain we're talking about, too, not just voltage gain. A transformer will give voltage gain, up to 100 times, but at the expense of current, so that the power out is never quite as much as the power in. There's no *power* gain there, but a device called the magnetic amplifier, which looks very like a transformer, can give very large values of power gain, can control AC power into a load very smoothly, and is used in the sort of applications where thyristors would be a natural choice for many.

The magnetic amplifier has been used in industrial control for decades, yet has never really caused any stir of interest anywhere else. Perhaps it's because it's always a ready-made item, but then so is an IC amplifier, and everyone seems to make use of those. Perhaps it's just because so very few people outside the ranks of professional engineers know just what a magnetic amplifier is. Let's remedy that!

Induced Knowledge

To start with, we need a pretty clear idea of what happens inside an inductor. A simple inductor has a winding which consists of insulated wire wound round a core of a soft magnetic material. Soft doesn't mean that you can spread it on your bread, but that the material magnetises easily, and demagnetises just as easily. Take a piece of this material, hold a magnet near it, and it's magnetised. Take a magnet away and it's demagnetised. This material we use for the cores of inductors, transformers, electric motors, relays etc.

An inductor makes use of this 'soft' magnetism. The winding has an alternating current flowing in it. This alternating current (changing smoothly from a peak in one direction to a peak in the opposite direction and back) causes the core of the inductor to magnetise. The magnetism isn't steady like a bar magnet, but alternating, which is the point of using soft magnetic material. A graph of the magnetism (called flux density) of the core plotted against time would, ideally, have exactly the same shape as that of the waveform of the AC applied.

So far so good — it's an alternating magnet. But we've known for about 150 years (or someone has) that

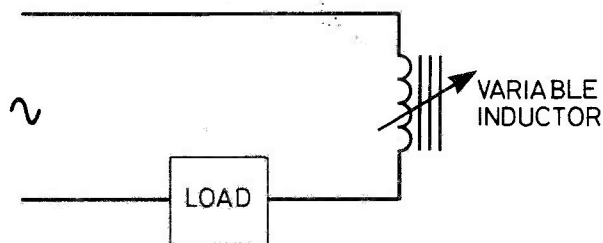


Fig. 1. Control of a load using a variable inductor, this configuration has very little power lost as heat, unlike a resistive controller.

wherever there's an alternating magnetic field, any piece of wire or other metal will have an alternating voltage induced.

Stick a piece of wire near your alternating magnet and you'll find an alternating voltage across the ends of the wire. The voltage is small if you use just a few centimetres of straight wire, but if you wrap several metres or wire round the core, so that all the magnetism of the core is at the centre of the coil of wire, then you find quite a respectable amount of AC. Recognise it?, a transformer.

Laying Down the Laws

The laws of Electricity are very consistent, though, *Any* coil of wire around a core that has an alternating magnetic field will have an AC voltage induced. That means that if we have only one coil, and we send AC through to generate the magnetism, it will *also* have an AC voltage induced in it. This voltage which the text books call a "back EMF", opposes the current which causes the magnetism which causes the voltage.

Result?

It's a darn sight more difficult to pass AC through an inductor than it is to pass DC!

When we use an inductor in a DC circuit, then apart from some effects at the moments of switch-on and switch-off the thing behaves like a resistance, good old Ohm's Law and all the rest, and a fairly low value of resistance at that.

Now you might think that it should pass the same amount of current for AC as for DC, but it doesn't.

Imagine that the resistance is $2R$, so that 10 V DC passes 5 A. Apply 10 V AC and the current's nothing like 5 A. It's not because Ohm's law stops working, it's because of the induced voltage. We're trying to push AC ▶

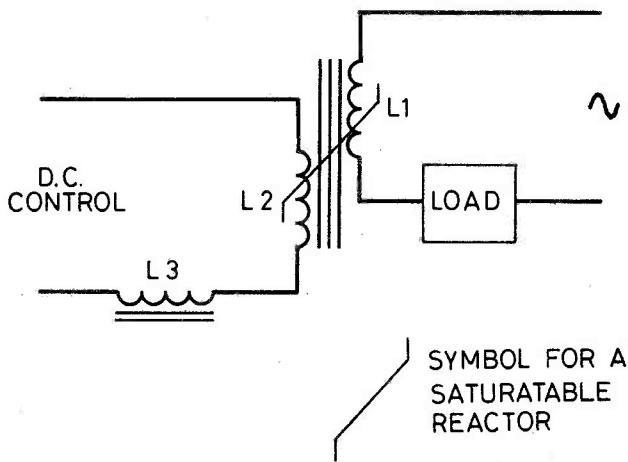


Fig. 2. Simple magnetic amplifier circuit, showing DC control winding.

through with one voltage, and the induced voltage is opposing our efforts. It's only the difference between the two voltages that has any effect at all.

Impedance Impediment

Suppose for example, that with 10 V AC applied, the induced voltage is 9V9. This makes the difference equal to 0V1, and the current is

$$\frac{0.1}{2} = 0.05 \text{ A, (by Ohm's Law)}$$

Now these are calculations we seldom bother to make. Instead we measure a quantity called the self-inductance, L , of the coil and use this quantity and the resistance value to calculate impedance, which is the ratio

$$\frac{\text{AC voltage}}{\text{AC current}}$$

for the coil. In our example, 10 V causes 0.05 A to flow, making the impedance $10 / .05 = 200 \text{ R}$, not a particularly large impedance, but much greater than the resistance of 2 R.

The useful thing about an impedance is that there's practically no loss of power in it. Pass a current through a 200 R resistor, and you lose energy in the form of heat the amount of heat lost per second is $200 \times (\text{current})^2$ joules for a 200 R resistor. The same current through the inductor in our example doesn't look anything like this — only its resistance loses heat, and that's only $2 \times (\text{current})^2$ joules, because the resistance is only 2 R.

We can therefore use an inductor to control the flow of AC in a circuit (see Fig. 1) with none of the power loss that a resistor would cause. Now if we could just have a variable inductor, we could be very neatly control the flow of current in that circuit. Of course, we could use an inductor with tapped turns and slide contacts, built like a potentiometer, and we make use of just such a device, the familiar Variac. It's possible though, to control the inductance of a winding with no mechanical movement at all, and what makes it possible is the effect called saturation.

Control-A-Coil!

When we send a current, AC or DC, through a coil of wire which is wound round a magnetic core, we can't pass as much current as we like and expect the magnetism to keep pace. At some stage in the game the core saturates, which means that it's as magnetised as it's ever going to be, no matter *how* much current is used. Now when a core is saturated like this, a change of current doesn't cause a change in the magnetism, so there's no more induced voltage. In other words, the inductance is no more and the impedance is practically zero.

Let the AC flow to it's load through an inductor whose core we can cause to saturate. How? By passing DC through another winding, by making the core of material which saturates easily, and the making the core continuous with no air gap.

That's our recipe for a magnetic amplifier.

Amps For Amps

Figure 2 shows a simple magnetic amplifier circuit. The inductor L1 has a large inductance when the core is not saturated, because of that, its impedance is very large, enough to make the current in the circuit very small. Now let DC flow through the second winding L2, and the core saturates.

If we can keep the core saturated for the whole of the AC cycle, then the inductance of L1 is almost zero, and the full amount of AC current flows through the load.

We don't of course, have to switch between saturation and no-saturation. We can adjust the control current so that the core saturates only on half of the AC cycle, or in peaks so that the average current through the lead is controlled.

Self Satisfied

Even such a simple magnetic amplifier has a lot of advantages, such as low power dissipation and high power gain, but better results are possible by using what is called a self-saturating design. Self-saturation is a form of positive feedback, using some of the signal current to assist the DC control current. Fig 3 shows a half-wave self-saturating circuit. The rectifier D1 ensures that only one direction of current flows through the coil L1 and the rated load current will cause the core to be close to saturation. The DC control current in winding L2 need only be quite small to cause the core to saturate on peaks, so that less power is needed to control the load current, and power gain is much higher.

Only half cycles are passing into the load, however, so that a full wave version is more desirable.

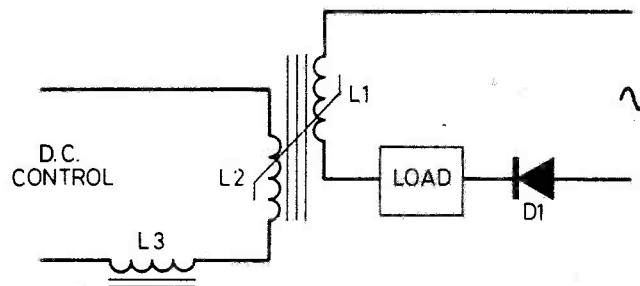


Fig. 3. Half-wave control using self-saturation.

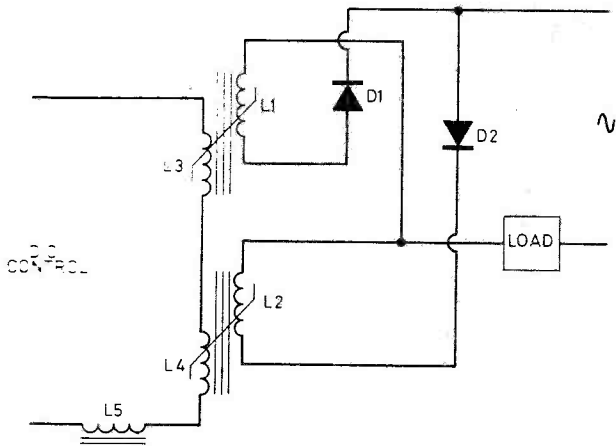


Fig. 4. Full-wave amplification with self saturation, by positive feedback.

A full-wave self-saturating magnetic amplifier is shown in Fig 4. Two sets of windings are used, each handling half of the wave, with rectifiers ensuring that

the AC wave is split into its two halves.

In all these circuits, an additional inductor is used in the DC control line to prevent AC appearing in the control circuit because of transformer action.

Going Straight

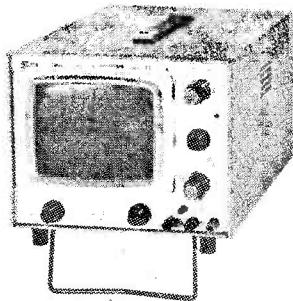
DC amplification? Simple enough, just rectify the output of the magnetic amplifier — the self-saturating full wave type already has two rectifiers included in the circuit and only two more are needed. More sensitivity? Add another winding to pass DC bias current, and the sensitivity increases because the bias can be set so that the core is very close to saturation.

Nothing could be *that* perfect, there has to be a snag somewhere, and response time is it for magnetic amplifiers. Being slow beasts a sudden change of control signal may not cause much change in the output current until several cycles of AC have passed through. Nevertheless for stabilising AC supplies, for control of large AC loads and for high power gains magnetic amplifiers are not so easily displaced by electronics. There's not much to go wrong, they can be built to order, and they can be repaired.

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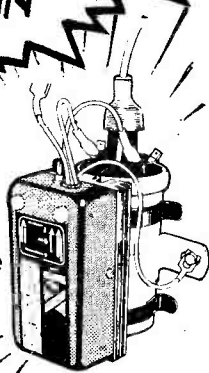
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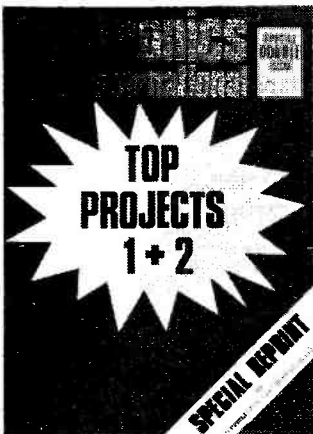
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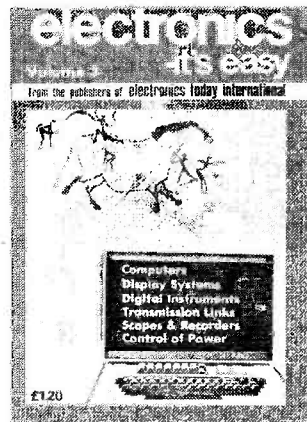
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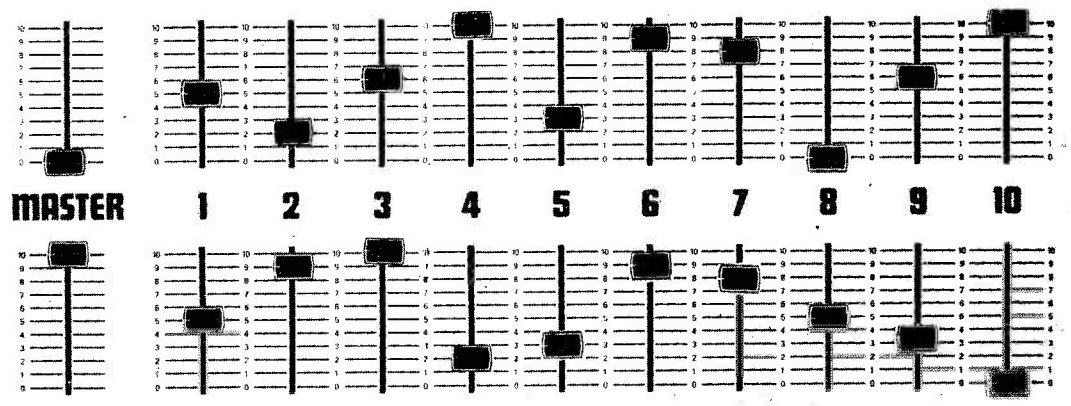
SINCE THE EARLY DAYS of the theatre the need for lighting has been all-important. Just as important has been the need for control of that lighting. This ranges from very crude initially to very sophisticated today, often with a computer doing the controlling in the creation of special moods and effects.

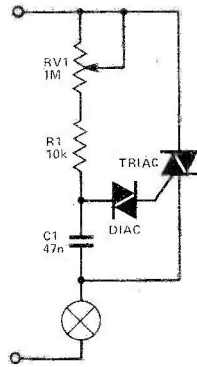
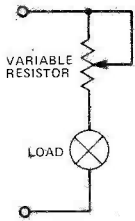
The first types of dimmer used, of which there are still some examples in older theatres, was a variable resistance type which used either a variable or switched power resistor in series with the load. With small loads a wire wound resistor or a carbon pile was used while larger loads used a tank of saline solution with a central

electrode which was raised or lowered in the liquid, effectively changing the resistance. This type of dimming, while reasonably effective, dissipated a lot of power which made life uncomfortably hot for the operator, since to minimise mechanical linkages the dimmers themselves were often in the control room. ▶



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Electronics

With the advent of electronics, life was a little bit easier. The use of phase controlled dimming using thyratrons and later SCRs and Triacs reduced the heat dissipation dramatically (if you'll excuse the pun) and also allows the control to be physically separate from the dimmer. Besides being easier for the operator performances were greatly enhanced by the much better control available.

Today the use of phase control is almost universal as it is simple, reliable and cheap. Another method in use today is by magnetics; this type has the advantage of generating no RFI but unfortunately is expensive.

The problem of RFI is common to all phase control circuits, but can usually be reduced to acceptable levels by the use of a choke and several capacitors. For RFI the choke need not be very large, but one other effect of phase control is the audible rattling of the lamp filament (especially with the larger globes) which is due to the sudden application of power, and the magnetic field so produced, each half cycle. This can be cured by reducing the rate of the rise of current by using a larger choke.

Type Casting

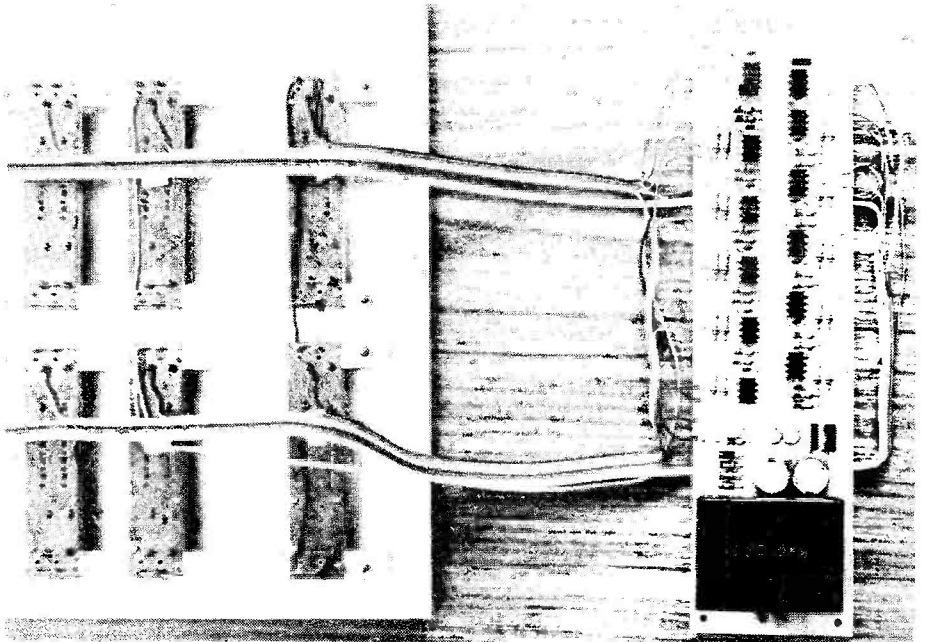
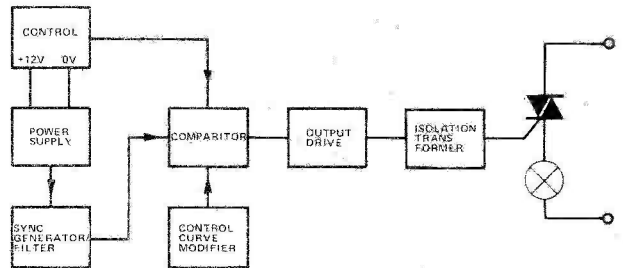
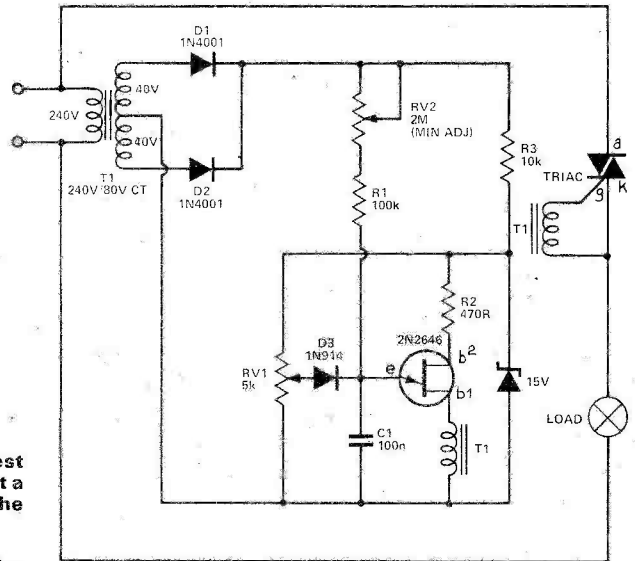
We have given some schematic diagrams of types of dimmers which have been used previously. Fig. 1 is the oldest type comprising simply a variable resistor in series with the load. The second (Fig. 2), probably the most common type in use today (mainly in homes) is very simple but lacks the versatility needed for theatrical work.

The third type (Fig. 3) is in common use and while still very simple does have many good features. These include having the

Fig 1. (Far left). The earliest type of dimmer employing just a variable resistor controlling the load.

Fig 2. (Left). Common! The most usual kind of light dimmer in use today.

Fig 3. (Right). A more refined realisation of the art, which at least has the control isolated!



control potentiometer isolated from the mains voltage and also a modified control curve to give a better input-output voltage relationship. Synchronization is referred to the zero crossing of the mains voltage, making the unit more suitable for driving inductive

(fluorescent) loads; this also eliminates hysteresis which occurs with the simple dimmers.

The dimmer to be described here is more complex than most but a great deal of effort has been taken to ensure that *all* problems have been solved. A low pass filter, with phase ▶

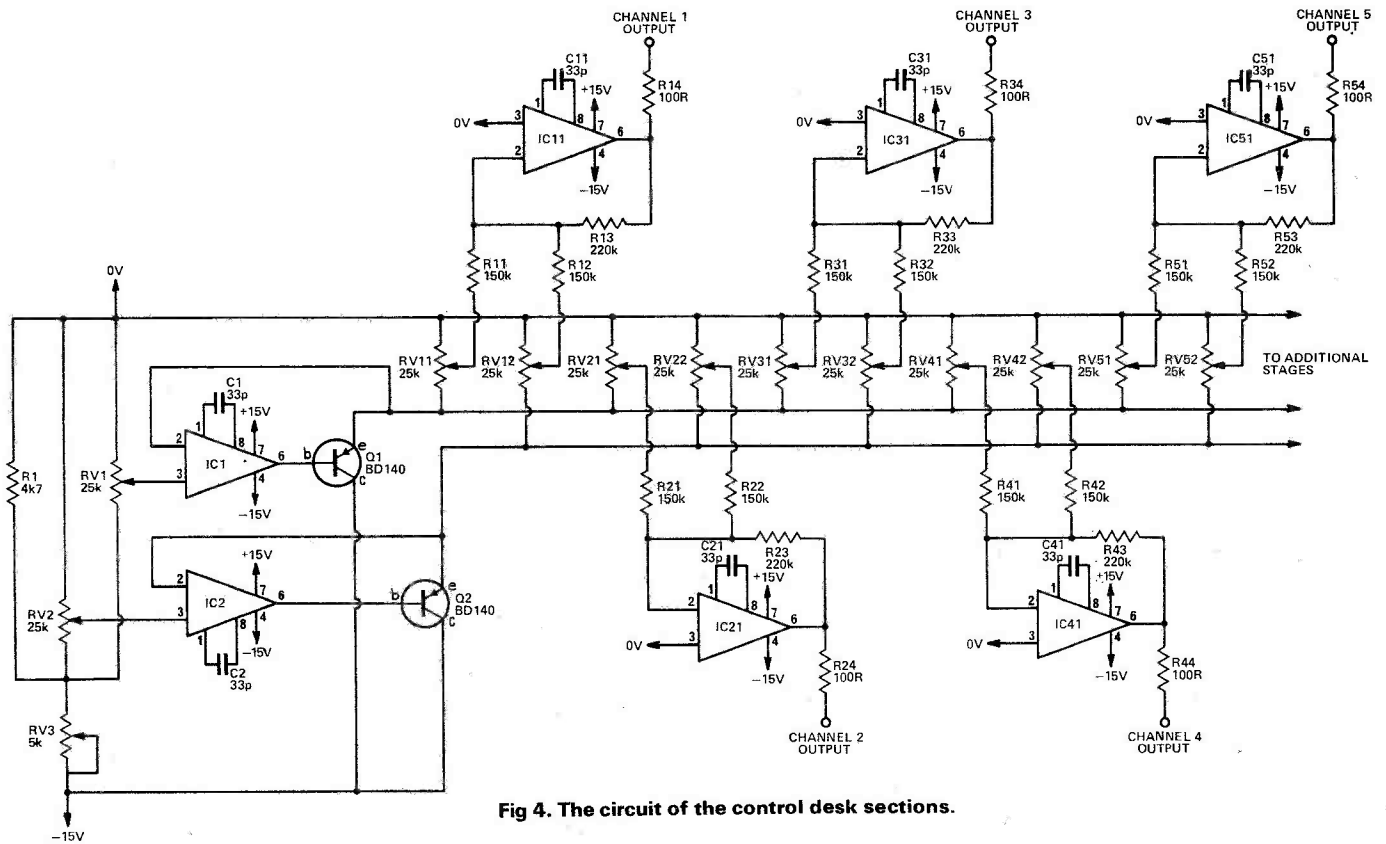


Fig 4. The circuit of the control desk sections.

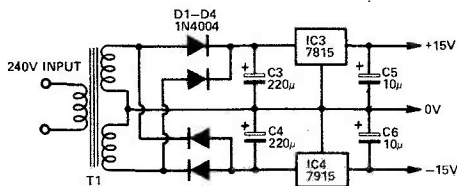


Fig 5. Power supply circuit

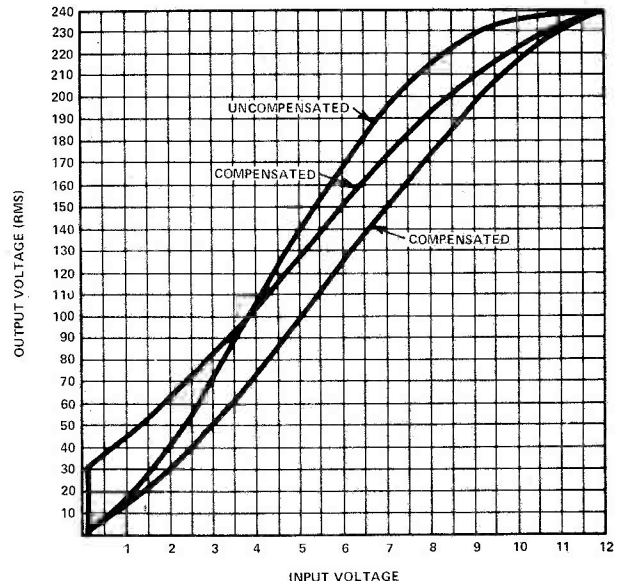
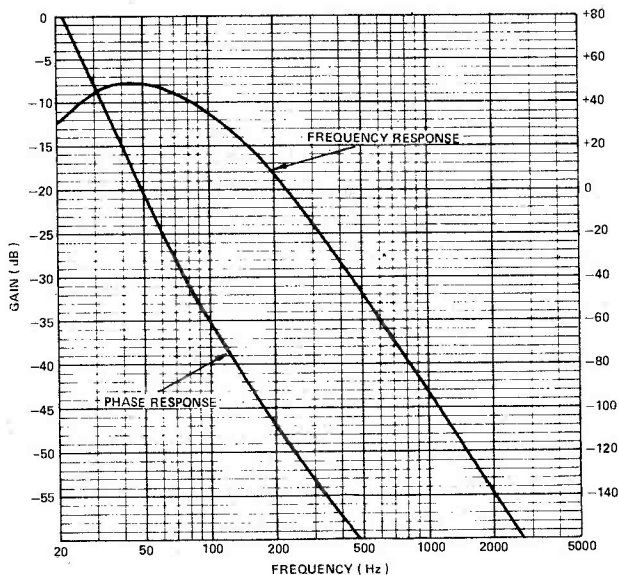
HOW IT WORKS - CONTROLLER

There are two controls for each dimmer along with two master controls. The master controls vary the voltage on the individual level control potentiometers from 0 V (no light) to -8 volts (full light). Normally one master will be at maximum and the second at zero. The outputs of the two controls for each dimmer are added by an operational amplifier, referred to 0 V. As one set of potentiometers has 0 V on both of its ends it

can be varied without changing the output allowing it to be set for the next scene. By varying the master controls together, but in opposite directions, the complete lighting set up can be smoothly varied from one scene to the next.

As we need +12V out to drive the dimmers the supply voltage of the control desk is ± 15 volts.

Fig 6. (Below). Showing the phase v frequency responses effect of compensation upon response



PARTS LIST

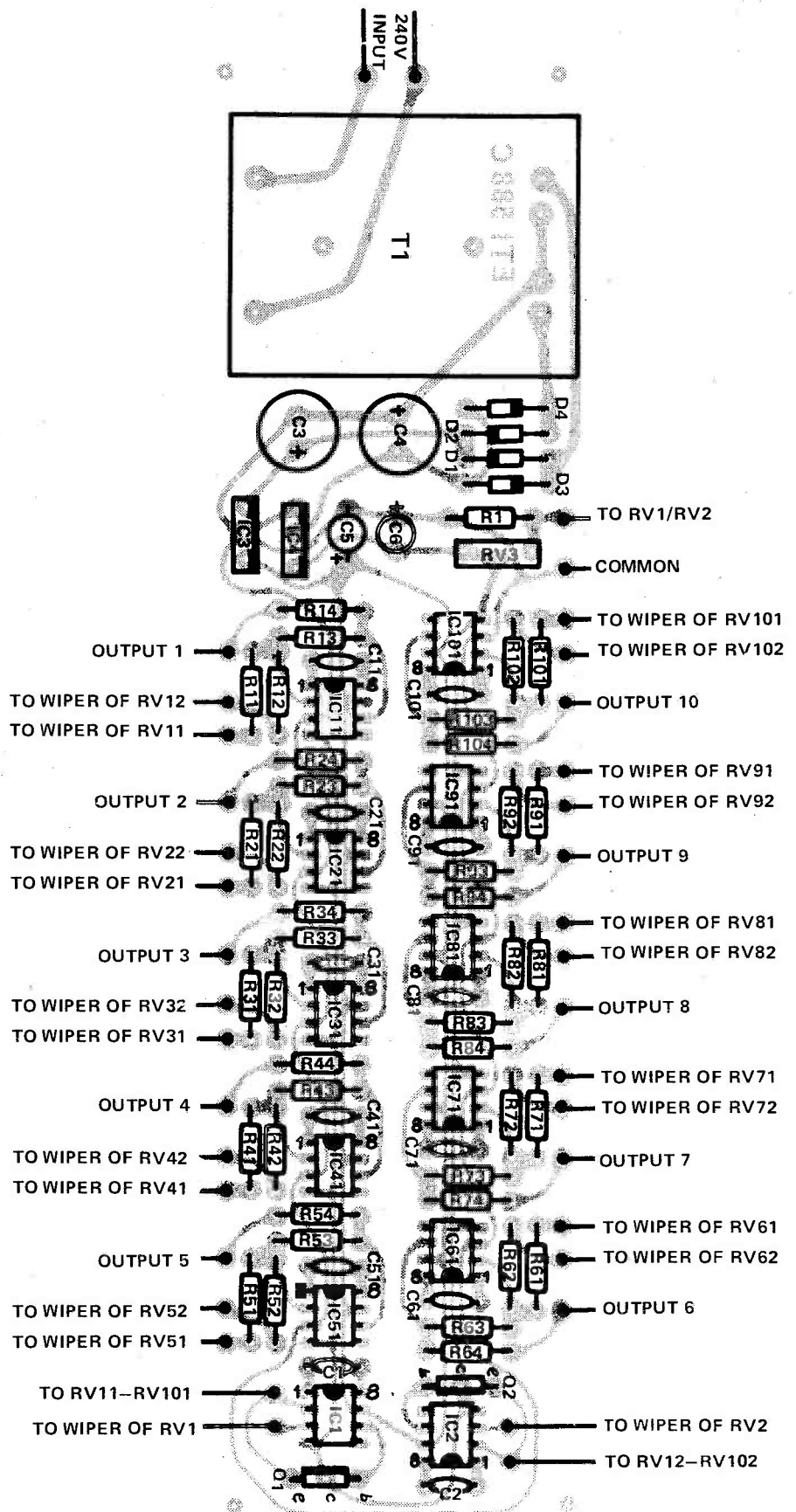
Resistors all 1/2W 5%		
R1		4k7
R11,12,21,22,31		
32,41,42,51,52,		
61,62,71,72		
81,82,91,92,101,102		150k
R13,23,33,43,53		
63,73,83,93,103		220k
R14,24,34,44,54,		
64,74,84,94,104		100R
POTENTIOMETERS		
22 off	25k 1in. 60mm slide	
RV3	5k trimmer	
CAPACITORS		
C1,2	33p ceramic	
C3,4	220u 50V	
C5,6	10u 25V	
C11,21,31,41	33p ceramic	
C51,61,71,81	33p ceramic	
C91,101	33p ceramic	
SEMICONDUCTORS		
IC1,2	301A	
IC3	7815	
IC4	7915	
IC11,21,31,41	301A	
51,61,71,81		
91,101		
Q1,2	BD140	
D1-D4	1N4001	
MISCELLANEOUS		
Transformer	30V	
Box and front panel	5W	
Knobs to suit		

Fig 7. (Right): Component Overlay for the Controller Module.

BUYLINES

Apart from the pulse transformer T1 — for details of which see Table One — none of the components in this (admittedly huge) project should tax your local supplier overmuch. If you send us an SAE we will send you the foil patterns for the PCBs used here, as they were simply too big to print full size.

Any 400V ten or twenty amp triac will probably serve if you can't find the specified type easily.



correction, is used to ensure accurate synchronization. The control curve is also modified to give a subjectively more linear response and it has the ability to drive a fluorescent load without requiring a ballast resistor. Both the maximum and minimum light levels are adjustable without interaction giving reliable and predictable output. This is especially necessary if a dimmer fails for some reason and is replaced by a spare unit.

The Protection racket

The protection of SCRs and Triacs, especially Triacs, is usually difficult as they tend to fuse faster than the fuse purportedly protecting them. The use of a cheap Triac which requires an expensive fuse to protect it is false economy. We have used a large rugged Triac (40 A device for the 20 A dimmer) which allows economical fuses to be used, especially for the 10 A version.

On the control side we will be describing a panel with two sets of long sliders per dimmer with two master controls which allow the next scene to be set up then faded in when required. A digital memory which can 'prerecord' scenes and recall them on demand may be published later.

Dimmer Module — Construction

Assemble the boards with the aid of the overlay. The heatsink should be drilled and tapped for the triac to allow easy replacement if ever necessary. Note that the mounting of the fuse is different for the 10 and 20 A dimmers.

The choke is bolted onto the PCB using the long clamping bolts, preferably using rubber grommets in the holes in the board (they may have to be drilled out to do this). The leads from the choke should be bent such that they go into the holes provided without going near the mounting bolts which are at earth potential. The leads can now be soldered (both sides on the 20 A unit).

The pulse transformer can now be added according to Table 1. Be careful when winding this transformer not to damage the insulation on the wire as there is 240 V between windings. We also recommend some epoxy between the transformer and the board.

The printed circuit boards for the two versions of the dimmer board are identical in layout and differ only in that the connector end of the 20 A board is double sided to present a greater area of contact with the connectors.

Controller-Construction?

The component numbering system used on the controller drawings is designed to indicate which channel a particular component is part of. The printed circuit board drawing for the dimmer board is too large to publish in the magazine at full size; however, the pattern is available from our offices for the cost of an SAE — a large SAE!

If the dimmer modules are not required to be connected through sockets, the total cost can be reduced by connecting directly to the modules and mounting them in a box. In the 20 A unit the heavy wires should be bolted on to the appropriate pads to ensure contact to both sides of the board.

One more modification to the control desk is the addition of a black-out switch which allows all lights to be blacked out without moving the master control. This is simply done by switching the supply voltage on the master potentiometers from the 8 V supply as set by RV3 to 0V. RV3 should be adjusted such that with one master at maximum, the second at minimum and one

individual control at maximum that its output voltage should be +10 volts.

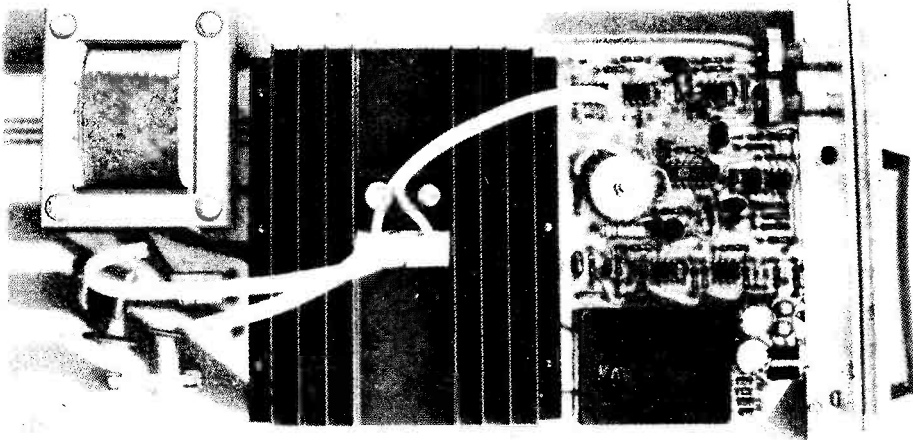
Setting up

With the dimmer module the trim potentiometer has to be adjusted so that the output pulse from IC7 occurs at the very end of each half cycle. This is easiest set using an oscilloscope although an approximate setting can be made without one.

If the dimmer is connected up to a reasonably heavy load and adjusted for about 1/3 level it will probably be found that with RV3 at one end the light level is not stable and tends to flash. This is caused by the sync pulse occurring after the end of the half cycle and the trigger pulses from the previous half cycle triggering the next. The trim potentiometer RV3 should be turned back about 1/4 turn from the position at which this effect stops.

Max and Min

When adjusting the maximum and minimum levels the minimum should be adjusted first. Note that the control potentiometer must be slightly up off zero to get any light and minimum should be adjusted at this point. The maximum should be adjusted with both the master and individual control at maximum and set to the point where the light level is just starting to drop. ▶



Shown above is a completed dimmer module

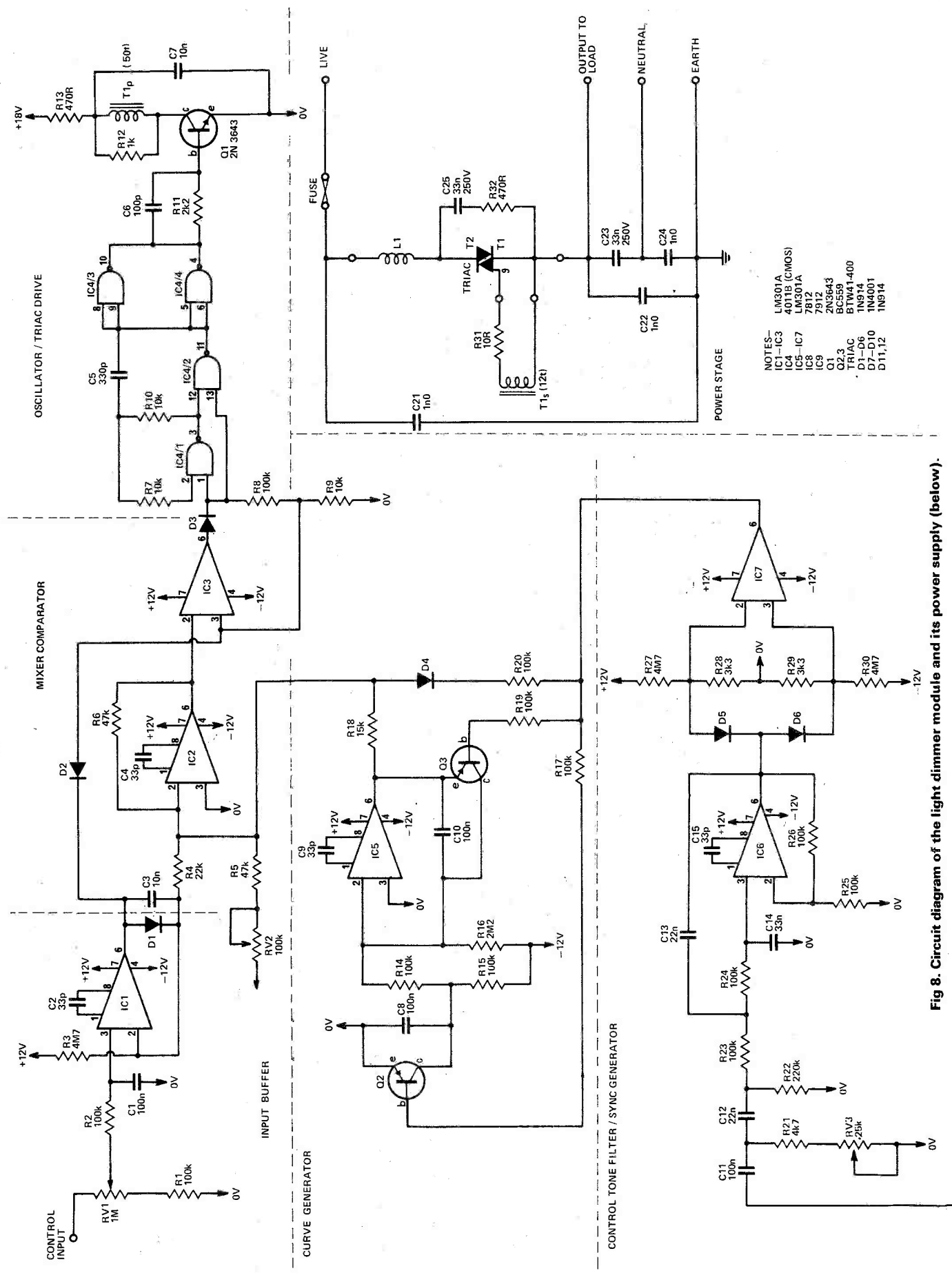


Fig 8. Circuit diagram of the light dimmer module and its power supply (below).

HOW IT WORKS ~DIMMER MODULE

To help explain the operation the circuit can be broken into seven sections.

1. Power supply

This is a simple full wave rectifier which gives about ± 18 V after being filtered by C16 and C17. Using 3 terminal regulators this is reduced to ± 12 volts which is needed for the circuitry.

2. Control tone filter and sync generator

As the name implies this removes the control tones that the supply authority superimposes on the mains voltage. These are normally about 1050 Hz and can cause problems by upsetting synchronization of dimmers. The filter is a low pass type comprising IC6 and associated components. As filters always alter the phase relationship this is corrected using phase shift networks. C11/R21 and C12/R22. Potentiometer RV3 is used to ensure the phase shift is zero (at 50 Hz) with normal component variations. If the output of IC6 is between $+0.6$ volts and -0.6 volts, neither D5 nor D6 will be forward biased sufficiently to change the input voltages to IC7 so its output will be -10 volts. As the output voltage of IC6 is a 'clean' 50 Hz sine wave of about 6 volts amplitude this will only occur at a small region about the zero crossing point. At all other times the output of IC7 will be $+10$ volts. The result is a negative pulse, about $250 \mu\text{s}$ wide at the zero crossing point of the 50 Hz.

3. Curve generator

This produces the output shown in Fig. 6. When the sync pulse occurs, transistors Q2 and Q3 discharge capacitors C8 and C10. Immediately on release of the sync pulse the output of IC5 begins to ramp up slowly due to R16 charging C10. However, while initially the voltage across R14 is zero and therefore does not affect the charging of C10, as C8 begins to charge due to R15 its effect becomes more and more dramatic. A curve is necessary as it gives a better input/output voltage relationship but the curve must be reproducible hence the circuit used.

4. Input buffer

This serves two purposes; firstly, it allows a

megohm input impedance and secondly it detects when the input voltage falls below 0.1 volt and turns the dimmer output completely off. This allows the minimum light control to be turned up to give a better control range, ie with the filaments just glowing, yet have them off if the control voltage is reduced to zero.

If the voltage is above 0.1 volt, the diode D1 will lift the voltage on pins of IC1 to equal that of the input on pin 3. However if the voltage falls below this level, the voltage on pin 2 will remain at about 0.1 volt due to R3 and the output of IC1 will go to about -10 volts.

5. Mixer-comparator

IC2 mixes the input voltage, the output of the curve generator the sync pulse and the minimum adjustment potentiometers. This gives the waveform shown in Fig. 2 with the input voltage and the minimum adjustment only moving the curve up and down without altering the shape. When the output of IC2 falls below zero volts the output of IC3 goes from -10 V to $+10$ volt with D3 and R8/9 providing about 1 volt of positive feedback. The voltage has to rise to above 1V to force the output back to -10 volts. The diode is necessary to ensure that the voltage at the input of the oscillator IC4 remains within the supply voltage of the IC ($+12$ V, 0 V).

6. Oscillator/triac drive

A CMOS oscillator IC4 is used to drive Q1 which supplies the energy for the pulse transformer T1. The oscillator will only operate when the control inputs (pins 1 and 13) are $+10$ V. The frequency is controlled by C5 and is set at about 150 kHz. Resistor R13 provides current limiting for the pulse transformer while R12 prevents the reverse voltage damaging Q1 if the load on the secondary load (the triac) becomes disconnected.

7. Power stage

This is simply a triac with a choke in series to prevent both RFI and 'filament rattle' and a fuse to protect against short circuits. Capacitors are also used as bypasses to help prevent RFI.

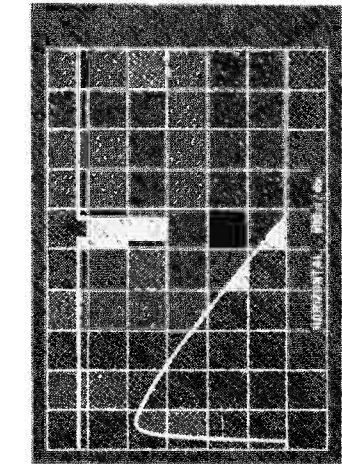
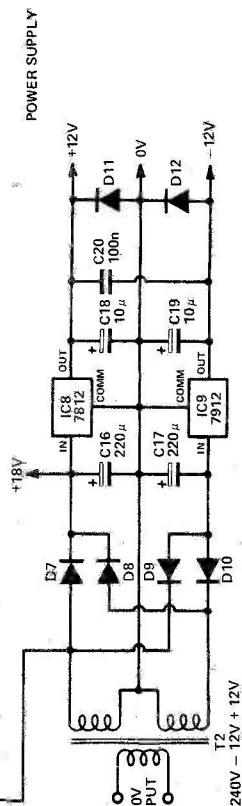


Fig 10. Relationship between the end of half cycle and the sync pulse.

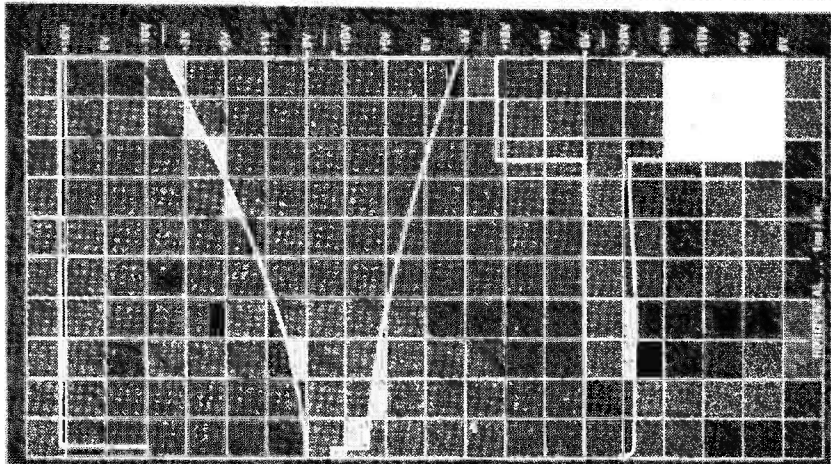


Fig 9. Waveforms shown are: Sync pulse (output IC7), curve generator (output IC5), mixer output (output IC2), oscillator output (IC4), transformer drive (Q1).

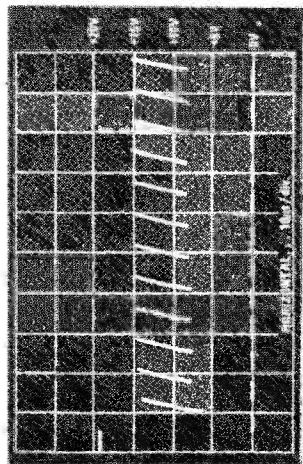


Fig 11. An expanded view of the drive waveform showing Q1 collector voltage.

PARTS LIST

RESISTORS all 1/4W 5%

R1, 2, 8, 14, 15,	100k
17, 19, 20, 23-26,	4M7
R3, 27, 30	22k
R4	47k
R5, 6	10k
R7, 9, 10	2k2
R11	1k
R12	470R 1W
R13	2M2
R16	15k
R18	4k7
R21	220k
R22	3k3
R28, 29	10R
R31	47R 1W
R32	

POTENTIOMETERS

RV1	1M linear
RV2	100k linear
RV3	25k trimmer

CAPACITORS

C1, 8, 10, 11, 20	100n polyester
C2, 4, 9, 15	33p ceramic
C3, 7	10n polyester
C5	330p ceramic
C6	100p ceramic
C12, 13	22n polyester
C14	33n polyester
C16, 17	220u 25V
C18, 19	10u 25V
C21, 22, 24	1n polyester
C23, 25	33n 250V AC

SEMICONDUCTORS

IC1-3, 5, 6, 7	LM 301A
IC4	4011B
IC8	7812
IC9	7912
Q1	2N3643
Q2, 3	BC 559
TRIAC	BTW41/400
D1-D6, 11, 12	1N 914
D7-D10	1N 4001

MISCELLANEOUS

T1 see text, T2 24V, 5VA, heatsink and choke and fuse 10A or 20A to suit, fuse holders.

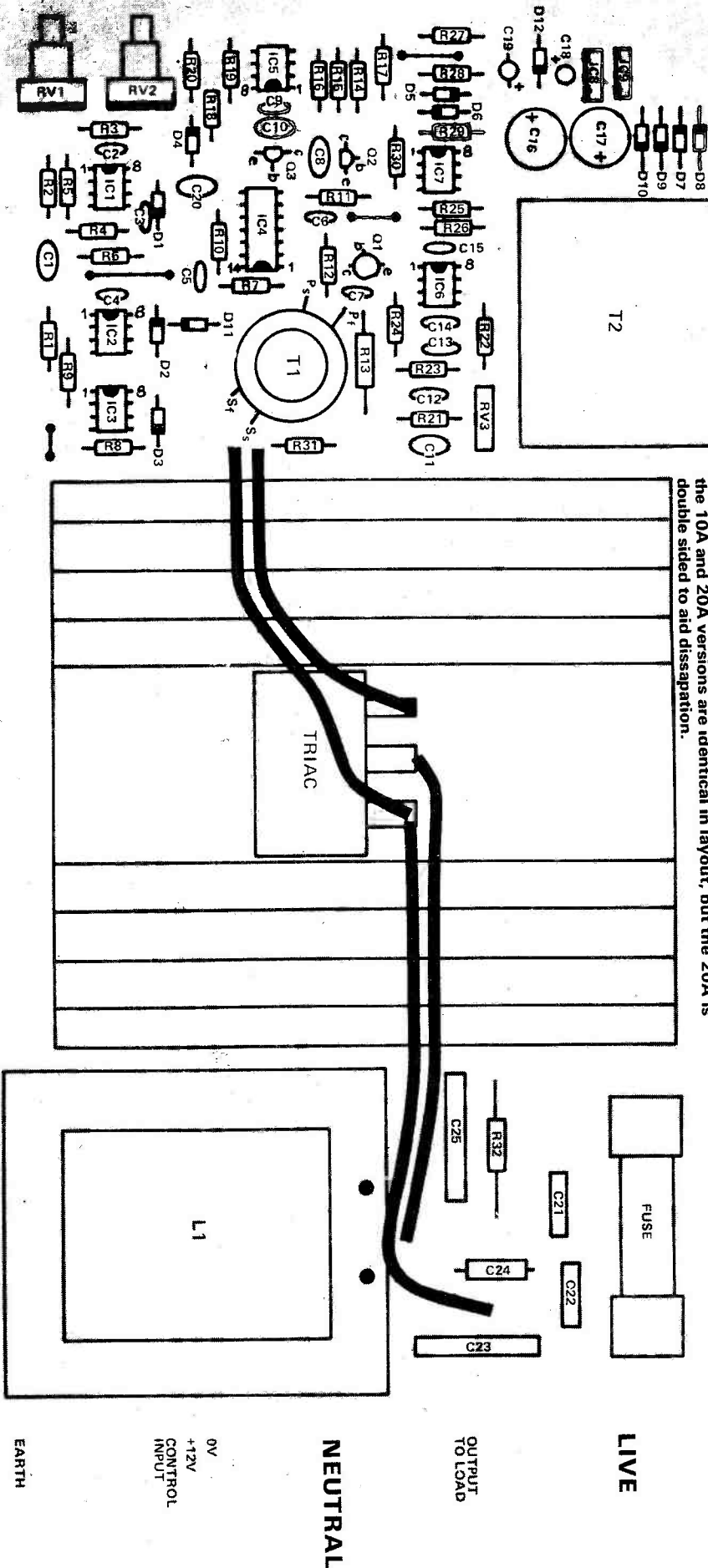


Fig 12. Component Overlay for the dimmer module board. Both the 10A and 20A versions are identical in layout, but the 20A is double sided to aid dissipation.

TABLE ONE

The pulse transformer T1 is the most difficult component in the project to find or produce. Tandy market a 4:1 device and this must be first choice. If this, and all other, commercial units prove elusive — try winding it yourself onto a ferrite ring of about 2in outside diameter, using 50 turns and 12 turns for the windings to obtain the required ratio. Some experimentation may be needed here in order to get the triac to fire properly, and we do not recommend you try this unless you have wound coils previously.

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LS		N		LS		N		Static RAM's		1+		17-63		64+								
7400	.13	.19	7476	.30	.28	74170	1.65	4000	.15	4077	.21	2102A (350ns)	1.05	.95	LM326N	2.60						
7401	.13	.19	7478	.29	.29	74173	1.41	4001	.16	4081	.21	2102A-2 (650ns)	1.29	1.15	LM348K	8.10						
7402	.13	.19	7482	.73	.71	74174	1.01	4002	.16	4082	.21	2111A-1 (500ns)	2.48	2.19	L129/30/31	.85						
7403	.15	.19	7483	.75	.75	74175	1.01	4006	.92	4086	.92	2112A-2 (250ns)	2.14	1.90	1.7's IC's							
7404	.16	.21	7485	1.18	.88	74176	1.01	4007	.18	4086	.92	2112A-2 (500ns)	1.07	.96	.8's	.75						
7405	.16	.21	7486	2.65	.29	74177	1.01	4008	.92	4093	.81	MM5257 (TMS4044)	8.10	7.19	CA3080	.90						
7406	.26	.28	7489	.34	.62	74180	1.01	4009	.54	4099	1.81	2114 (450ns)	8.10	7.19	CA3140E	.37						
7407	.28	.28	7490	.34	.62	74181	2.21	4010	.54	4502	.92	6810	3.50	2.97	CA3140E	.30						
7408	.17	.19	7491	.73	1.05	74182	.81	4011	.18	4508	2.46	Dynamic RAM		8251	5.97	LM324N	.73					
7409	.17	.19	7492	.46	.75	74184	1.81	4012	.18	4510	1.07	4116	12.75	8253	8.10	LM348N	.99					
7410	.15	.19	7493	.34	.65	74185	1.82	4013	.48	4511	.95	CPU's		8255	5.51	LM380N	.87					
7411	.25	.19	7495	.54	.85	74186	2.57	4014	.92	4512	2.70	8080	5.95	8255	5.51	LM381N	1.73					
7412	.18	.19	7496	.67	1.06	74188	1.81	4015	.92	4515	2.70	6800	8.99	8255	5.51	LM382N	1.33					
7413	.27	.40	74107	.27	.35	74190	1.21	4016	.43	4516	1.07	9900	42.50	8255	5.51	LM3900N	.65					
7414	.71	.79	74109	.44	.35	74191	1.21	4017	.81	4517	4.10	E-Prom's UV		8255	5.97	LM3909N	.70					
7415	.19	.19	74112	.35	.35	74192	1.21	4018	.92	4518	.95	1702AQ	5.75	8255	5.51	SN76001N	1.02					
7416	.25	.19	74113	.35	.35	74193	1.21	4019	.56	4519	2.54	2708Q	7.87	8255	5.51	SN76003N	2.32					
7417	.34	.19	74114	.35	.35	74194	1.21	4020	.92	4522	1.89	TriState Buffers		8255	5.51	SN76013N	1.55					
7420	.19	.19	74121	.27	.75	74195	1.01	4021	.92	4526	1.89	+ (POS) 500mA		8255	5.51	SN76023N	1.55					
7421	.19	.19	74122	.60	.78	74196	1.18	4022	.92	4528	.92	5v, 6v, 8v, 12v, 15v, 20v & 24v		8255	5.51	TSAB10AS	.90					
7422	.19	.19	74123	.60	.78	74197	1.18	4023	.18	4534	7.12	81LS97	.75	8255	5.51	TC940	1.75					
7423	.25	.19	74124	.51	.39	74198	1.81	4024	.65	4538	3.74	81LS98	.75	8255	5.51	ZN414	.90					
7425	.25	.19	74125	.51	.39	74199	1.81	4025	.18	4543	1.62	74365	.75	8255	5.51	ZN424E	1.35					
7426	.25	.19	74126	.51	.39	74200	1.81	4026	1.84	4543	6.53	74366	.75	8255	5.51	ZN425E	3.78					
7427	.39	.19	74127	.78	.65	74201	1.21	4027	.51	4566	1.51	74367	.75	8255	5.51	ZN459CT	3.54					
7428	.38	.19	74133	.39	.39	74241	1.21	4028	.70	4583	1.02	74368	.75	8255	5.51	ZN1034E	2.03					
7430	.16	.19	74136	.39	.39	74242	1.21	4029	1.18	4585	1.07	Buffers		8255	5.51	ZN1040E	8.43					
7432	.25	.25	74138	.55	.55	74243	2.25	4030	.56	I.C.		8255	5.51	ZN116E	6.75							
7433	.25	.25	74139	.55	.55	74244	2.25	4032	1.08	SOCKETS		8255	5.51									
7437	.25	.25	74141	.78	.78	74245	2.25	4033	1.08	DIL (Texas)		8255	5.51									
7438	.25	.25	74142	.78	.78	74246	2.25	4034	1.89	8pin	1.0	8198P	1.49	8255	5.51							
7440	.17	.19	74147	1.58	.81	74251	1.21	4035	1.06	14pin	1.21	8196P	1.49	8255	5.51							
7441	.70	.19	74149	1.38	.81	74253	1.21	4040	.92	16pin	1.3	8198P	1.49	8255	5.51							
7443	.50	.55	74150	1.08	.81	74257	1.21	4042	.70	18pin	1.3	8198P	1.49	8255	5.51							
7445	.60	.60	74151	.67	.88	74258	1.21	4043	.81	18pin	1.8	Interface		8255	5.51							
7446	.60	.60	74153	.67	.88	74259	1.21	4046	1.08	20pin	.20	8212	2.21	8255	5.51							
7447	.60	.87	74154	1.31	1.35	74266	1.21	4049	.43	22pin	.24	8216	2.25	8255	5.51							
7448	.16	.87	74155	.67	.78	74273	1.21	4050	.43	24pin	.26	8224	3.59	8255	5.51							
7449	.16	.87	74156	.67	.78	74279	1.21	4051	.81	25pin	.80	8228	5.51	8255	5.51							
7450	.16	.19	74157	.67	.55	74283	1.21	4052	.81	26pin	.80	8228	5.51	8255	5.51							
7451	.16	.19	74158	.67	.55	74290	1.21	4053	.81	28pin	.80	8228	5.51	8255	5.51							
7453	.16	.19	74160	1.21	.85	74295	1.21	4054	1.29	32pin	1.25	OPTO		8255	5.51							
7454	.16	.19	74161	1.21	.85	74298	1.21	4056	1.48	8pin	.23	125	1+	10+	50+	100+	2+	1+	10+	50+	100+	
7455	.16	.19	74162	1.21	.85	74298	1.21	4058	5.18	14pin	.34	TIL209 Red X	.15	.10	.10	.09	.21	TIL200	.16	.125	.125	.11
7460	.16	.19	74163	1.08	.65	74365	1.21	4060	1.24	16pin	.37	TIL212 Yel X	.20	.18	.16	.14	.14	TIL220 Yel X	.23	.21	.195	.17
7470	.27	.19	74164	1.08	.65	74366	1.21	4066	.48	18pin	.43	TIL216 Red X	.20	.18	.16	.14	.14	TIL224 Yel X	.23	.21	.195	.17
7472	.23	.19	74165	.78	.78	74367	1.21	4088	.21	20pin	.55	TIL232 Gre X	.20	.18	.16	.14	.14	TIL228 Red X	.23	.21	.195	.17
7473	.23	.29	74166	1.02	.78	74368	1.21	4089	.21	24pin	.50	X = High Brightness						TIL234 Gre X	.23	.21	.195	.17
7474	.24	.28	74168	1.35	.78	74386	1.21	4097	.47	28pin	.65											
7475	.44	.43	74169	1.85	.78	74670	1.21	4098	.21	40pin	1.05											

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AC126	17p	8C214	10p	BFX85	20p	2N3055	44p	7453	12p	74180	80p	4071	12p	IN5402	15p	7915	80p	7924	80p
AC127	16p	8C237	12p	BFX86	27p	2N3702	8p	7454	12p	74181	130p	4072	12p	IN5404	20p				
AC128	14p	8C238	14p	BFX87	20p	2N3703	8p	7460	14p	74182	50p	4073	16p						
Matched		8C301	30p	BFX88	15p	2N3704	8p	7470	24p	74190	70p	4081	14p						
12B/176	35p	8C303	30p	BFX53	12p	2N3706	8p	7472	24p	74191	70p	4082	14p						
AC141	24p	8C328	13p	BFX50	17p	2N3707	8p	7473	25p	74192	60p	4086	59p						
AC142	18p	8C338	13p	BXS20	10p	2N3710	8p	7474	25p	74193	60p	4089	59p						
AC151	22p	8C547	11p	BXS20	10p	2N3711	8p	7475	25p	74194	55p	4511	70p						
AC152	22p	8C548	11p	BU205	13p	2N3772	172p	7476	25p	74195	50p	4516	64p						
AC153	25p	8C549	11p	BU208	150p	2N3773	275p	7480	40p	74196	50p	4518	65p						
AC176	16p	8C557	11p	OC25	76p	2N3866	54p	7485	60p	74197	50p	4520	65p						
AC187	23p	8CY30	60p	OC28	87p	2N3904	8p	7486	24p	74198	100p	4528	55p						
AC188	20p	8CY34	66p	OC35	76p	2N4061	12p	7490	25p	74199	100p								
AD149	65p	8CY59	24p	OC71	16p	2N4062	12p	7491	40p										
AD161	35p	8CY70	14p	OC72	26p			7492	35p										
AD162	35p	8C715	14p	OC84	42p			7493	30p										
AF114	23p	8O115	30p	TIP29	37p	TTL	7400	10p	4000	12p	741-8	22p							
AF118	30p	8O121	70p	TIP30	35p	7401	10p	7494	51p	4001	12p	747C-14	50p						
AF125	25p	8O123	60p	TIP31	45p	7402	10p	7495	45p	4002	12p	748C-8	30p						
AF126	25p	8O124	77p	TIP32	45p	7403	10p	7496	45p	4006	68p	CA3011	80p						
AF127	25p	8O131	35p	TIP33	45p	7404	10p	7497	120p	4007	14p	CA3018	80p						
AF139	32p	8O132	35p	TIP34	64p	7405	12p	74100	80p	4008	64p	CA3028A	85p						
AF186	54p	8O135	30p	TIP35A	168p	7406	24p	74105	40p	4009	30p	CA3035	140p						
AF239																			

electronics today

international

What to look for in the April issue: On sale March 2nd

Amp Survey

Build-it-yourself hi-fi continues to flourish, and new designs appear almost daily. Power amplifiers are a favourite in the field, and their numbers, by now, are legion.

Unfortunately there is no way for the home constructor to 'listen in' to a module before he builds it, and thus he is left to fall back on the spec. sheets. Fine if you like it, rotten if you don't.

Next month we're surveying the field, giving full details of all the models we can find, and putting the market leaders against top quality commercial equipment to find out how they sound.

MAINS SEEKER

So you are about to drill the living room wall to hang up those shelves you promised the wife 7 years ago. Black & Decker in hand you advance to the plaster. Wait a minute there a mains socket right beneath.

Doubt sets in — to drill or not to drill — that is the question. Which way do the wires run? Will you black out the entire Universe if you try it? How can you find those wires?

Simple really — just read ETI next month when we have a neat little project to show you exactly where the mains wires lie!

OCTAVE SHIFTER

A superb little circuit to add that instant 'jump' to guitar playing. Operated by a footswitch the effect has a unique sound all its own — not to be missed — no strings attached to this one.

3080

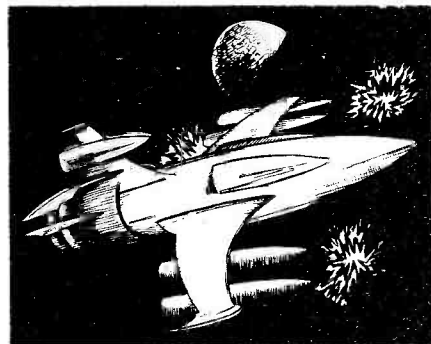
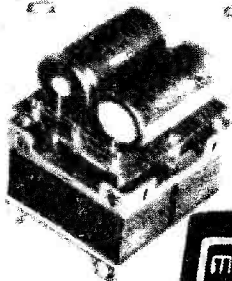
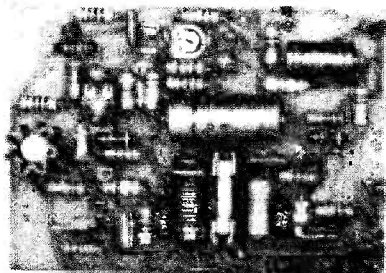
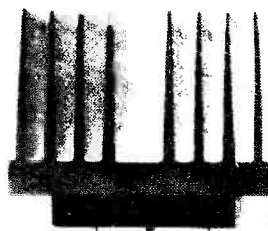
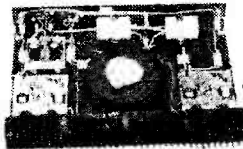
Well ten of them anyway The 3080 is a much under-rated device, and next month's IETs circuit man Tim Orr hopes to put that right with ten ways to use device, all comprehensively explained to help you design the other 3070 circuits yourself.

AMBUSH

Your starship crashes through the void — running between the lines of enemy dreadnoughts to deliver medical supplies to the sieged planet of Tora. In order to preserve energy your ship has no weapons, only its shields and its speed.

Missiles can appear from any direction, and to destroy them you must actuate your shields at the precise moment of impact, thereby conserving power and allowing the engines to keep you moving at Warp Factor 20.

Can you make it through the Ambush and make Capt. Kirk look a cissy?



microfile.....

ALTHOUGH out of the first flush of youth I still consider myself to be young at heart so the young computing funfair seemed just the thing for me. Organised by the **British Computer Society (BCS)** the fair filled the **Bloomsbury Centre Hotel** early in **January** with the younger members of the ever growing group of people with an interest in computers.

Following on from the 'Living with Computers' conference, again organised by the BCS and held in the Institute of Education near the Bloomsbury Centre, the event provided a fitting climax to a very stimulating few days.

The funfair included exhibits ranging from mini-computers, computers being used for choreography in ballet, computer controlled games, DIY computer kits, a micro-computer controlled railway and many stands showing how the computer is in use in our everyday life. Among this last group of exhibits were the Abbey National Building Society (they got the computing habit, they have) and the police, showing that big brother was alive and well at the funfair.

The NASCOM stand was a great attraction for many people, demonstrating as it did the latest add ons to that popular DIY computer kit, the NASCOM 1. The buffer board, mother board and expansion RAM cards allowed the NASCOM's on display to run the 2K BASIC interpreter NASCOM are now producing. The BASIC includes all the facilities common to basics of this size, interger arithmetic, 26 variables (Designated A-Z), single dimension array plus assorted commands, operators and functions. In addition a machine code call greatly extends the power of the interpreter. NASCOM's super tiny BASIC makes use of this machine code call to provide amongst other commands, an edit function which allows the insertion/deletion of individual characters within a line, a renumber command and a facility for string inputs — something sadly lacking in the basic BASICS.

Undoubtedly though the exhibits that caused the greatest interest amongst the younger generation that made up the majority of the visitors to the fair were the rows of amusement machines. Everything from cowboys at the OK coral to star wars in space quadrant 0040.7689. Microprocessors have revolutionised the arcade industry, both in bringing arcade type games into the home and in dramatically increasing the sophistication and supposedly, entertainment value of the machines in the public domain. Certainly the young audience were impressed.

Altergo ran a painting competition in conjunction with the funfair and Saturday saw the prize giving ceremony. The subject for the painting was "My Friendly Computer." The first prize was an Altergon robot, a beast that walks, talks, moves and flashes its eyes. Talking of beasts brings us onto beauty and Joanna Lumley — of the new Avengers — who presented the prize to the winner of the competition — 12 year old Fiona Mackay.

As well as the exhibition stands a concurrent series of lectures was presented in a hall adjacent to the main event. The lectures concentrated on introducing people to the various aspects of computing and the careers potential offered by the computing industry. These were well attended in spite of the attractions of the aforementioned amusement machines.

All in all a successful gathering that introduced the fascinating and diverse world of the computer to people who will form the systems engineers, computer operators, engineers etc. of tomorrow.



Any excuse to get a robot onto the pages of ETI is eagerly taken up. The fact that there are a couple of ladies in frame is incidental. The robot was first prize in the painting competition organised by Altergo. Fiona Mackay won the robot which was presented by Joanna Lumley.

Following on from my item last month concerning low cost keyboard designs Mr Charles Lacey has written to me with details of a project along these lines that is at the prototype stage. Designed as a touch keyboard with fifty keys including space bar, 2 shift keys, a delete key and two spare controls the system is more elegant than my attempt. Looking back at the circuit I proposed it does seem a bit clumsy.

With luck Mr Lacey should have a very nice project in a couple of months time. We'll keep in touch.

By the way if anybody else has had ideas along these lines please let me know.

Finally may I add my own tribute to John Miller-Kirkpatrick who died last December. I'd known John just on two years and it was the System 68 project that brought us together. John handled the design and construction of the system while I dealt with the production from the magazine's end. System 68 had many teething problems but it was the first such project tackled in this country, way ahead of its time, and John remained enthusiastic throughout the problems and put in vast amounts of time to get things sorted out.

The last time I saw John was at the Breadboard exhibition. He took a keen interest in all of the stands and no doubt had a few ideas of his own for things to tackle in the future.

ETI

WHAT'S MISSING?

An ETI T-Shirt of course.

Our little lady is perfectly intact thank you! We took her T-Shirt away just to show you how lost you'd be without one.

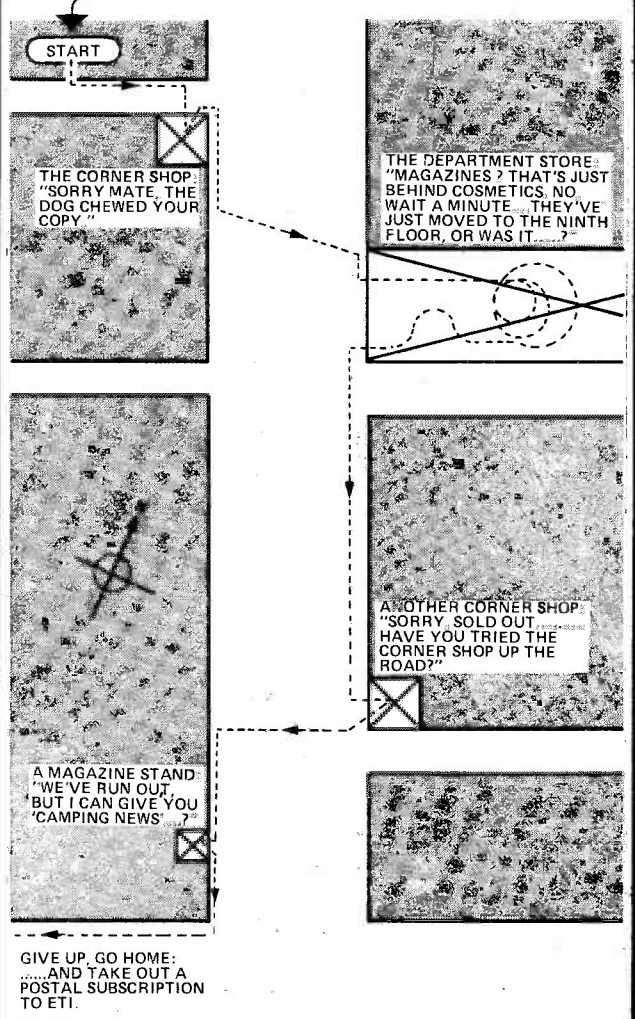
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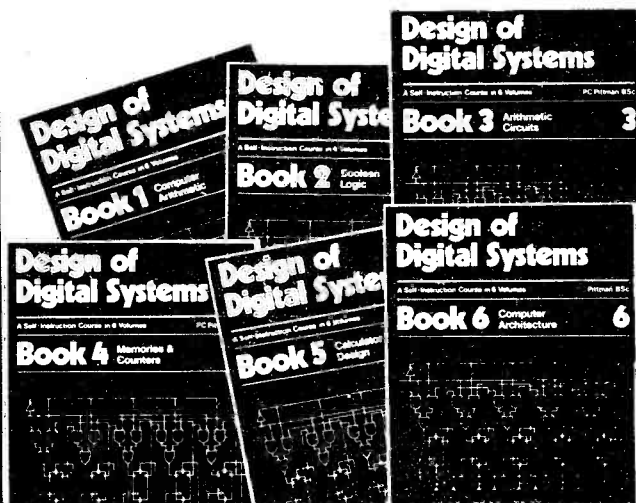
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Understanding Digital Electronics

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Design of digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes — each A4 size — are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.

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- Book 3** Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
- Book 4** Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
- Book 5** Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
- Book 6** Central processing unit (CPU); memory organisation; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.



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In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your vehicle speed and petrol consumption; you could be calling people by entering their name into a telephone which would automatically look up their number and dial it for you.

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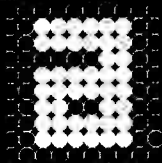


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AUDIO POWER METER

An accurate way to determine what's watt in your hi-fi system, with our true reading power meter

POWER IS PROBABLY the least understood and most misrepresented quantity in the electric measurement system. This is especially so in the area of audio amplifier and speaker specifications when terms like peak, peak to peak, music and RMS are related to power.

Power is simply the rate at which energy is being used. It is expressed in watts and the value may vary from femtowatts (10^{-12} W), as in the input power of a FET, to thousands of megawatts in the power generation field. The term thousand megawatts is generally used in preference to the more correct term, gigawatts.

Power can be calculated simply by multiplying voltage and current:

$$P = EI$$

In a DC circuit where both voltage

and current remain constant no problem arises. However in an AC or a DC circuit where the voltage is not constant with time, this formula only holds for instantaneous power as the power varies with time. Power as we usually use the term is the time average of this. If the load is resistive, i.e. contains no inductance or capacitance, and we can measure the RMS value of the voltage, we can still use this simple formula. However measuring the RMS voltage is not easy as most voltmeters measure the peak or average rectified voltage with a suitable scaling factor built in to give a correct result when measuring a sine wave signal.

Reactive Reaction

If the load is reactive the current and voltage will no longer be in phase,

i.e. the peaks do not occur at the same point in time. The difference can be expressed either by the phase angle in degrees or by the cosine of this angle (known as the power factor). The current waveform can either be ahead of the voltage (leading) or behind it (lagging). Capacitive circuits give rise to a leading power factor while inductive circuits lag.

If working with a sine wave, and if the power factor is known, the formula for power can be expressed as:

$$P = EI \cos \phi$$

where ϕ is the phase angle. In a DC circuit $\cos \phi$ is unity so the formula holds for this case as well. An example is a 40 W fluorescent light which takes 430 mA from the 240 V mains. At first sight, this implies a ►



power consumption of over 100 W, until it is realised that its power factor is about 0.45 lagging. The formula above, using $\cos \phi = 0.45$, thus gives a power consumption of only 46.4 W. (The additional 6 odd watts is dissipated in the ballast.) The product of voltage and current is known as the VA rating and is used when calculating the currents in a circuit. If a capacitor is connected across a sine wave AC circuit the current taken can be calculated by dividing the voltage by the reactance of the capacitor. While this circuit draws current, it has a power factor of very near zero (90° phase lead) and therefore takes no power! By adding the correct amount of capacitance to an inductive circuit (i.e. the fluorescent light) the power factor can be altered, reducing the current drawn (but not the power).

Confused yet?

Ample Reason

Getting back to audio amplifiers and their ratings, the problem lies in the complex nature of the music waveform and how to specify the amplifier's rating. As the waveform is far from a constant sine wave with the peak power being anything up to 20 times the average, numerous methods such as peak power, peak to peak power, music power, etc. evolved. However, for a long time there was no set standard, and one amplifier advertised with a 50 W (music) rating was in fact a 5 W stereo amplifier. The situation got so out of hand that the US Government brought down legislation on how amplifiers were to be tested. This is with a continuous sine wave signal with level set so that the distortion is at a specified level and power calculated from the RMS output voltage: hence the term RMS power. Note however that the term RMS refers to the method of measurement, i.e. the use of RMS voltage, and it is not the RMS value of the power waveform. It is, in fact, the average of the power waveform.

Speakers are just as confusing. They are normally specified not in terms of the power they can dissipate, but the maximum power of amplifier they are suitable for. This is due to the fact that music is never (well, rarely) a continuous sine wave and the average power in the speaker may be only 10% of the RMS rating of the amplifier, even with the amplifier clipping.

To measure the power actually being delivered to the speaker under music conditions, a wattmeter must be used.

Design Features

To multiply current and voltage together we had the choice of analogue or digital techniques. Unfortunately while digital is the 'in' thing, offering versatility and accuracy, it is not fast enough to calculate the instantaneous power on high frequencies. We therefore chose the analogue method.

Looking around the ICs, the only ones with reasonable price and availability were the MC1494, 1495 and 1496. The 1496 (or 796) is the cheapest and most readily available, but has the disadvantage of not being able to multiply DC signals or AC signals with a DC offset. The 1494 and 1495 are about the same price, and of the two, the 1494 was more linear and easier to use.

We chose not to use any input buffer on the voltage input but had to pay the penalty of having a lower input impedance than normal with voltmeters.

Using the Power Meter

To use the meter we must measure both voltage and current. There must be a common point for these measurements. The current

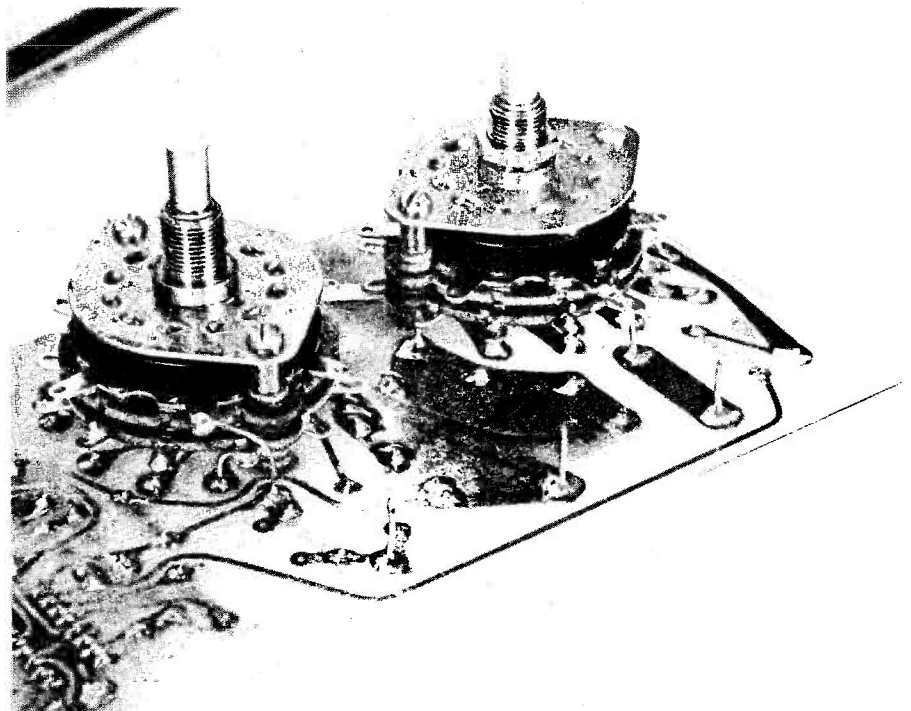
connection can be in either of two ways as shown in the drawings below. One measures the power out of the supply and the second the power into the load. The difference? The current shunt in the wattmeter drops one volt when working at the full range value and this may or may not affect the reading. At 10 A this accounts for 10 W which, if the power being measured is only 100 W, is a 10% error — although if the measured power is 2400 W the error is only 0.4%.

The range of the meter is the product of the individual ranges, i.e. on 30V and 1 A the fsd is 30 W, while 30 V and 3 A gives 100 W FSD. To help give a reading reasonably high on the scale, the voltage range can be overvoltage by a factor of 2. Due to power dissipation problems this should not be attempted on the current ranges. The peak voltage or current can be as high as three times the range value.

Construction

We mounted all the components associated with the meter and the switches on a single pc board and if the same or similar case is to be used this is recommended.

Except for the meter and the switches the components are mounted on the 'normal' side of the pc board. These should be mounted ►



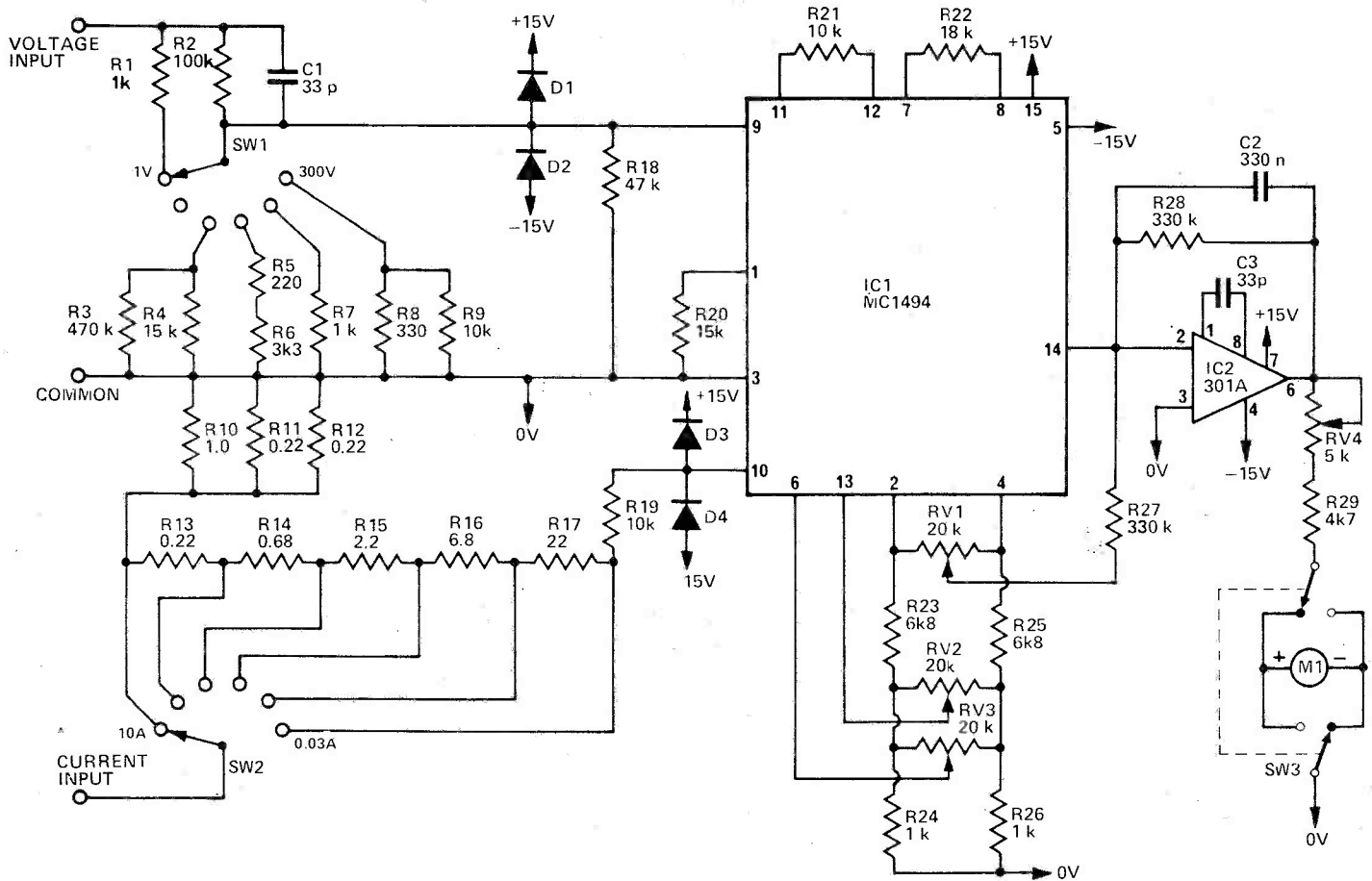


Fig. 1. The circuit diagram of the audio power meter.

HOW IT WORKS

Power is the product of current and voltage. This holds irrespective of the nature of the load, provided you are talking about instantaneous power. By multiplying current and voltage together and then taking the average of these instantaneous values we find the true power. Again this works irrespective of the load.

In this circuit the multiplying is done by IC1 (MC1494), the output of which is a current proportional to the product of the inputs. For more detailed notes on this IC, see the separate section. The current output of this IC is converted to a voltage by IC2 with C2 providing the averaging. The meter is then simply wired across the output of this IC with a meter reversing switch provided. This reversing switch is needed not to measure negative power, but to correct for reversed readings due to differing external connections.

The power supply is a full wave bridge with a centre tap giving about $\pm 20V$ DC which is then regulated to the $\pm 15V$ required by IC1.

Adjustments for zeroing the voltage and current inputs are provided by RV2 and RV3 while RV1 compensates for offsets in the output. These are supplied by a stable $\pm 4V$ reference in IC1. Range switching is done by SW1 and SW2. Protection against overvoltageing the IC is provided by D1-D4.

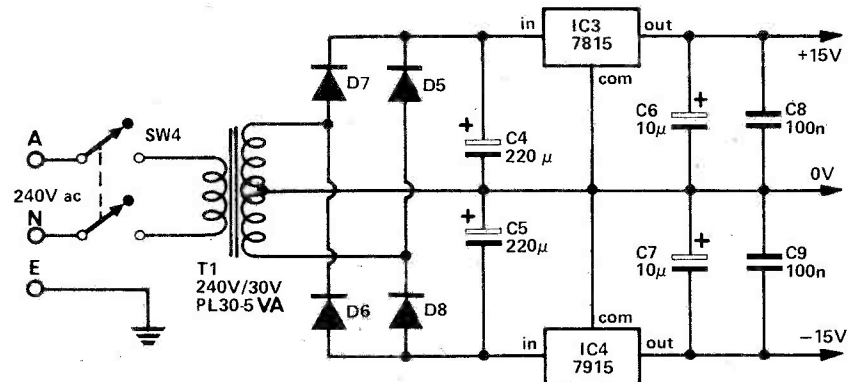
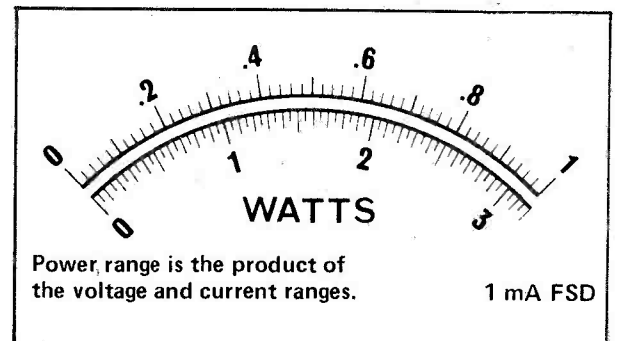
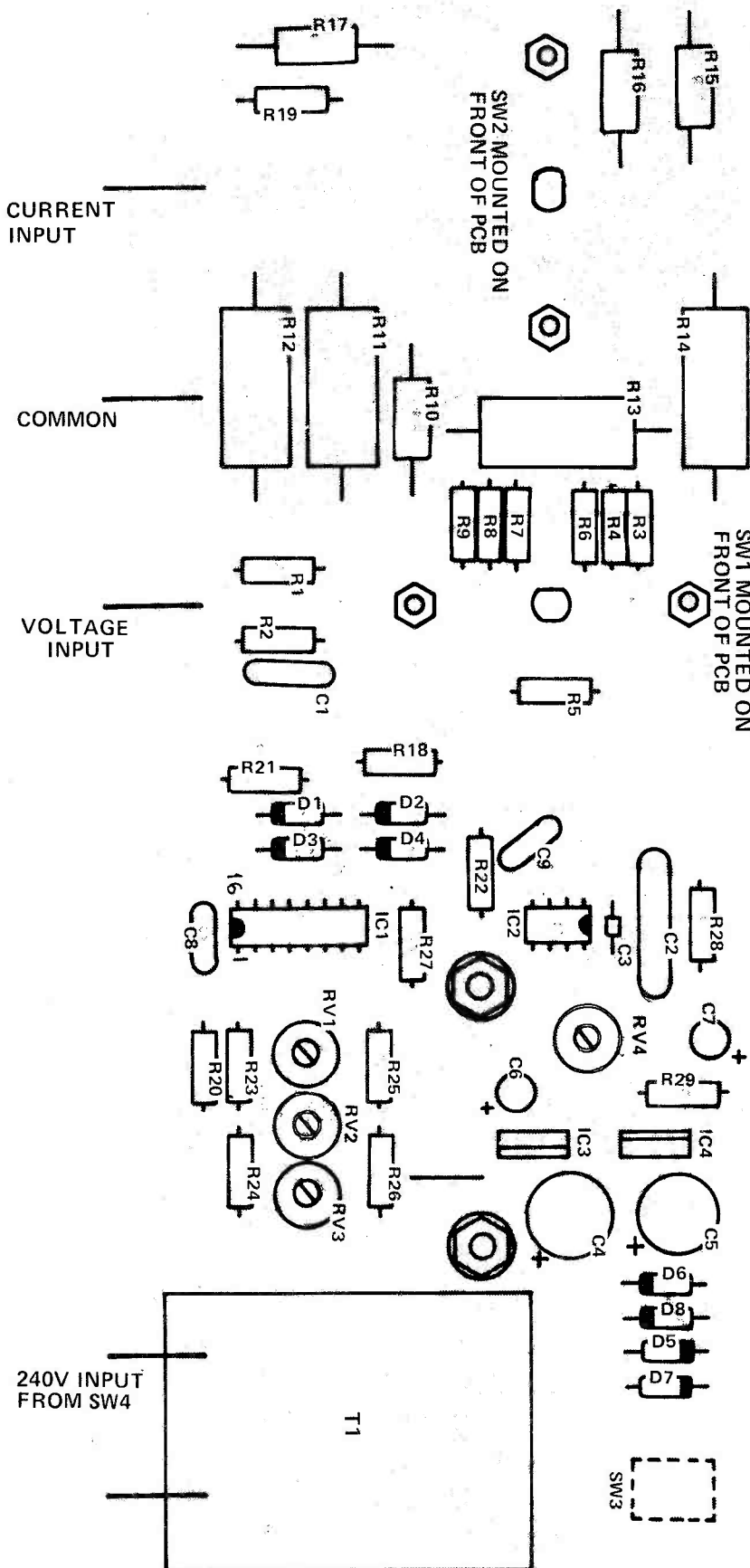


Fig. 2. Power Supply Circuit.

Right: meter scale designed for a 1mA FSD meter. These scales may need to be altered for differing meter units.



PARTS LIST



Resistors all 5% 1/2W unless stated

R1, 7, 24, 26	1k
R2	100k
R3	470k
R4, 20	15k
R5	220R
R6	3k3
R8	330R
R9, 19, 21	10k
R10	1R 1W
R11-13	OR22 5W
R14	OR68 5W
R15	2R2 1W
R16	6R8 1W
R17	22R
R18	47k
R22	18k
R23, 25	6k8
R27, 28	330k
R29	4k7

POTENTIOMETERS

RV1-3	20k trimmer
RV4	5k trimmer

CAPACITORS

C1	33p 500V ceramic
C2	330n polyester
C3	33p ceramic
C4, 5	220u 35V electrolytic
C6, 7	10u 25V electrolytic
C8, 9	100n polyester

SEMICONDUCTORS

IC1	MC1494
IC2	301A
IC3	7815
IC4	7915

D1-D4	1N914
D5-D8	1N4004

MISCELLANEOUS

PCB
 SW1, 2 two pole 6 position 10A rotary
 Radiospares
 SW3, 4 two pole toggle switches
 Transformer 15-0-15, 5VA
 Meter 1mA FSD
 Three binding posts
 Instrument case 255 x 100 x 205mm
 Power cord and clamp
 Two knobs
 Front panel

BUYLINES

Most of the parts for this project are readily available. Two things which may cause trouble are the switch assemblies and the quadrant multiplier itself.

The switch is an RS unit and as such can be obtained from any of their stockists. As for the IC, Tamtronik — who advertise on page 32 of this issue — can supply this and by the time you read this they will be able to sell you all the rest as well!

Fig. 3. Overlay for the Power Meter.

first with the only critical part of the assembly in the area of the range switches. Here the high powered resistors should be spaced at least 5mm from the PCB as they run hot at maximum current. Also the leads of all the resistors in this area should be cut off close to the pc board after soldering. This is to give adequate clearance to the rotary switches. We used two self tapping screws into the plastic of the transformer case to help fix it onto the board. We have made ▶

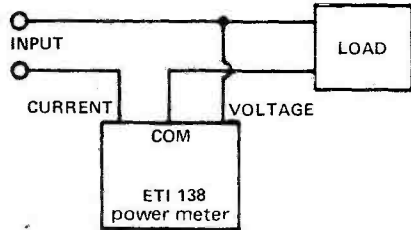


Fig. 4. This connection measures the power into the load.

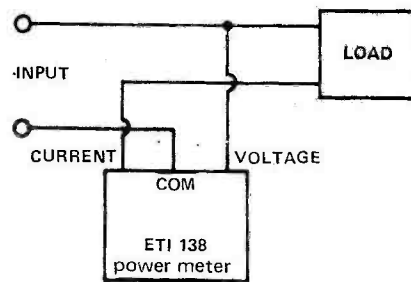


Fig. 5. This connection measures the power out of the supply.

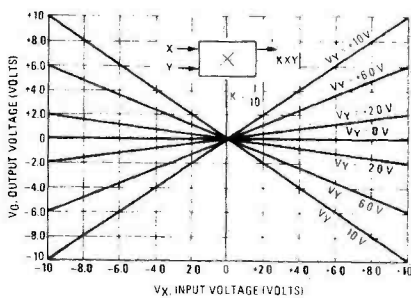


Fig. 6. Transfer characteristics of the IC.

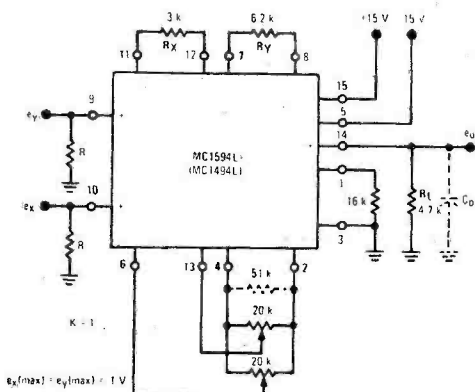


Fig. 7. Typical connections for a wide band multiplier or balanced modulator.

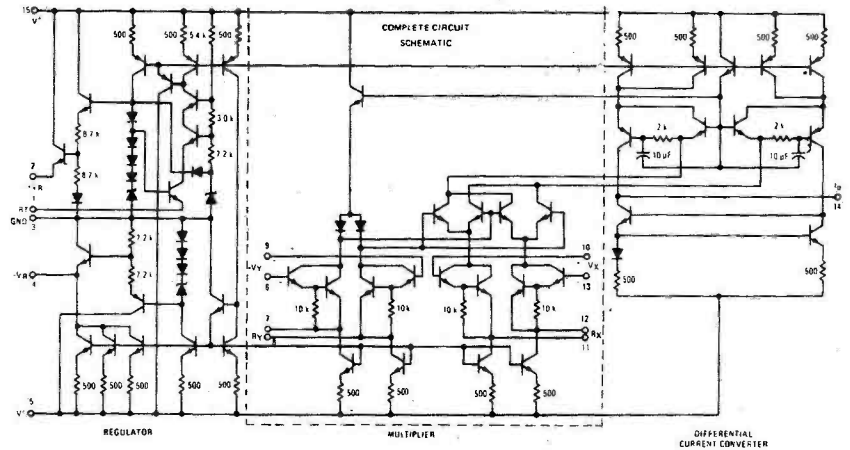


Fig. 8. The internal circuit diagram of the IC.

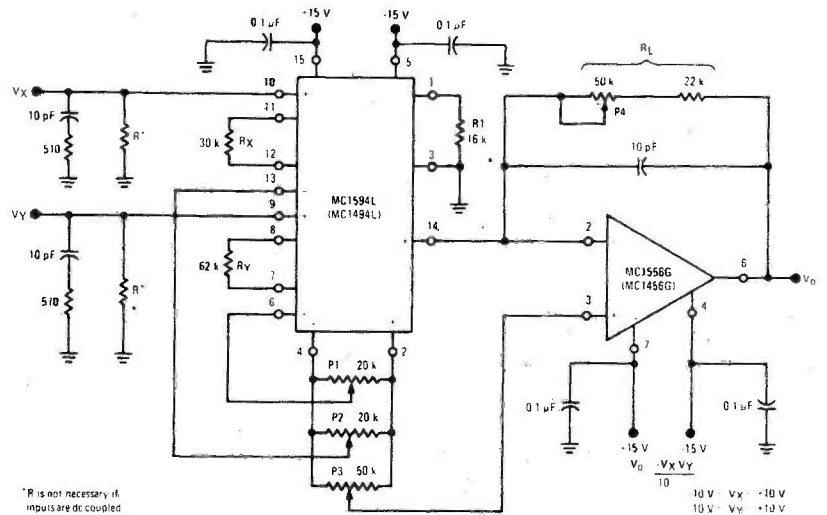


Fig. 9. Typical connection of a low frequency multiplier. For a squaring circuit simply parallel the two inputs. In this case pin 6 can be connected to 0V and P1 deleted.

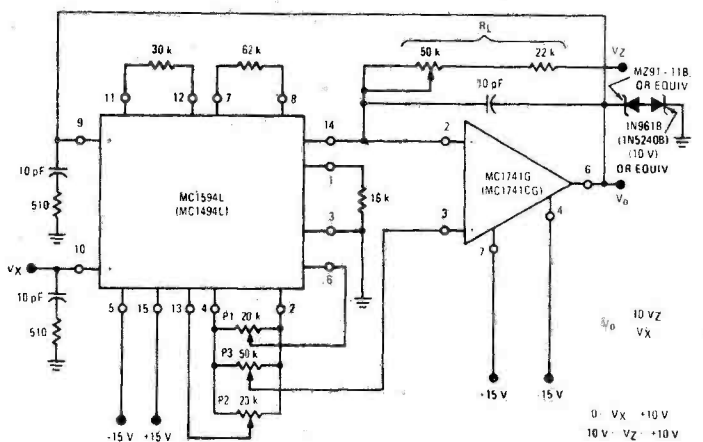
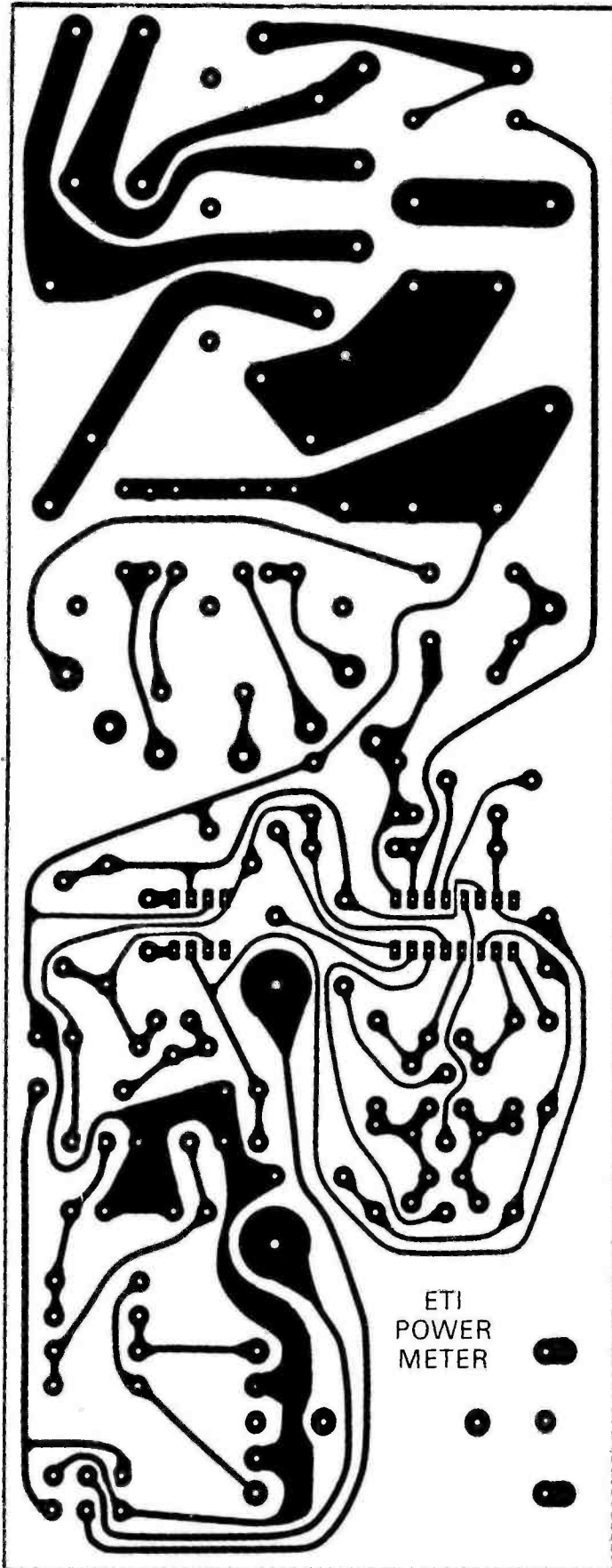


Fig. 10. Typical connection of a divide circuit. For the square root joins pin 9 and 10. Like the squaring circuits pin-6 can be connected to 0V and P1 deleted.

Full size foil pattern for the power meter.



allowance for either the cermet (VTP) or the normal carbon trim potentiometer.

Calibration

Four adjustments are required, which are performed as follows:

Select the 1 V and 0.03 A ranges and switch on. If the meter reads in reverse, toggle SW3. Don't worry about the reading unless it is off scale. If it is, adjust RV1 to bring it back towards zero. Now apply a voltage of about 1V DC to the voltage input and note the meter deflection. Adjust RV2* until there is no deflection when this voltage is applied. Now apply the voltage to the current input (it will take about 30 mA) and adjust RV3 until there is no deflection. Recheck the voltage input and readjust if necessary.

Now with no voltage applied adjust RV1 to give zero output. Apply exactly 1 V to both current and voltage inputs and adjust RV4 to make the meter read FSD.

This is all the calibration that should be necessary.

About the 1494

The 1494 is a variable transconductance multiplier with a bidirectional current source output. What this means is that it looks at the voltage on the two points and gives an output current potential to the product of the two. Typical applications include: multiply, divide, square, square root, phase detection, frequency doubling, balanced modulation/demodulation and electronic gain control. An internal circuit diagram is given for those interested.

Values and Limitations

- 1 For best temperature coefficient R1 (pin 1 to 0V) should be 16k (we used 15k as it is easier to obtain). This sets the value of all the current sources inside the IC ($I_1 = 8/R_1$)
- 2 The value of Rx (pin 11 to pin 12) should be $\geq 3x$ peak input voltage(X) expressed in k ohms.
- 3 The value of Ry (pin 7 to pin 8) should be $\geq 6x$ peak input voltage(Y) expressed in k ohms.
- 4 Choose the scaling factory required ie $V_{out} = K \cdot V_x \cdot V_y$.
- 5 Load resistance (pin 14 to 0V) can be calculated by $R_L = (K \cdot R_x \cdot R_y) / I_1 / 2$
- 6 If R_L is connected between pin 14 and 0V without an inverting amp. the frequency response is limited by the output capacitance of 10pF.
- 7 For best temperature coefficient the load between pins 2 and 4 should be 8.6k.

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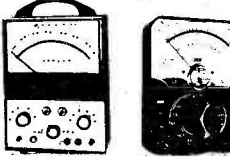
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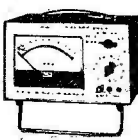


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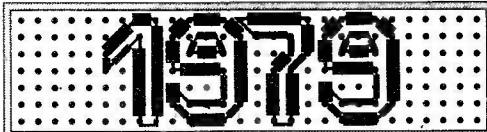
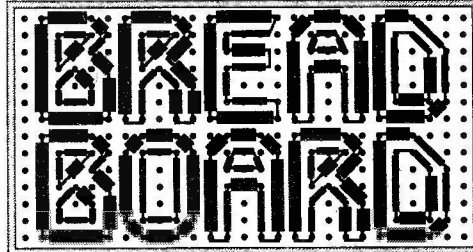
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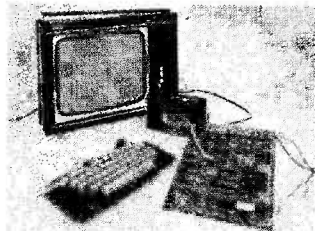
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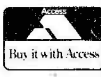
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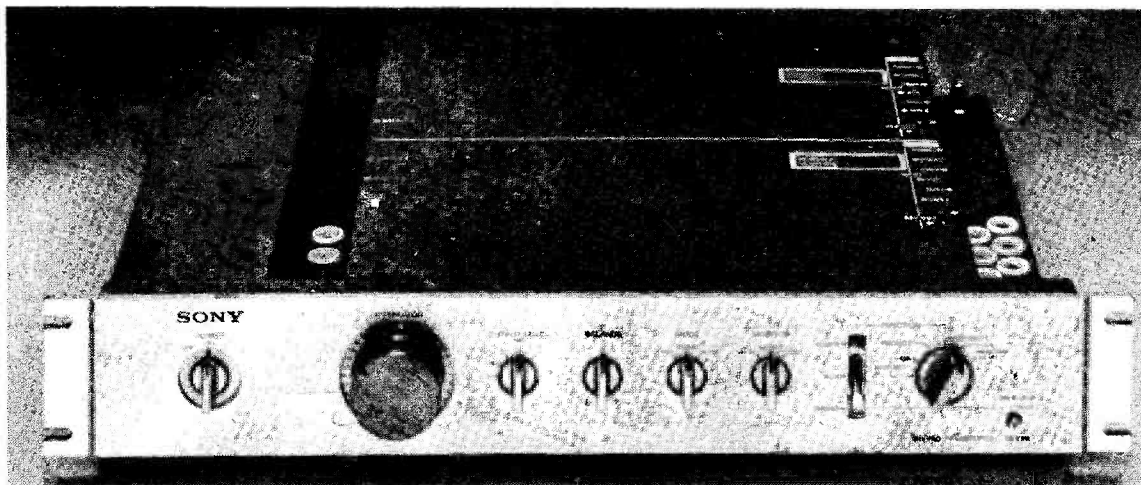
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VISUALLY HI-FI? SONY'S TAE88 PREAMP



BY NOW I expect most of you have already heard of the TA-E88 pre-amp, the Sony flagship design. Costing a mere £699 it has been designed to match the TA-N88 VFET power amp, and uses FETS in the later stages of its circuitry. Overall the finish of the unit is probably up to a £700 standard. All sockets are gold plated, and a gold ended twin phono lead is supplied as standard. The controls are very nice to operate, and the volume and balance controls are very special indeed. Stepped attenuators are employed, but the operation is so smooth as to make you doubt it.

As you can see from the internal shot below, the signal path lies entirely along the PCB. There are no leads from the board carrying signal potentials, all switches and sockets are mounted in place, and extended to the front panel where need be.

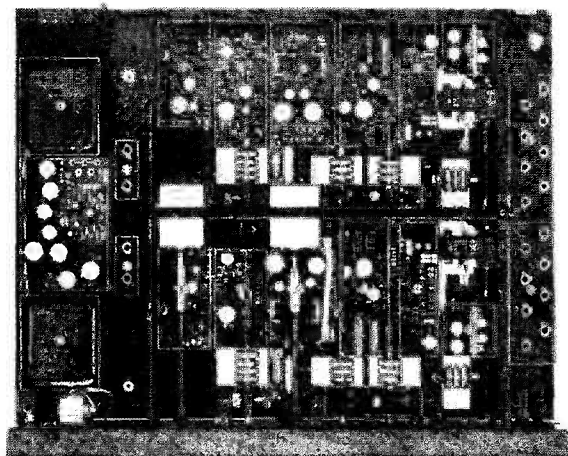
Shifting Load

There is even provision for switching about the resistance and capacitance associated with the magnetic phono inputs. Gold plated switches of course. Adjustment is variable between 10k-100pf and 100k-500pf. A useful provision this.

Completely separate channels — and PSUs — keep the right insensitive to the meanderings of the left and with the moving coil inputs especially this can be no bad thing.

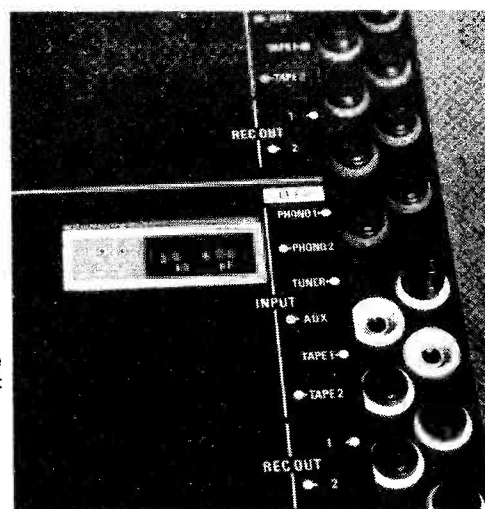
The head amp incorporated is a version of Sony marketed HA55, one of the best mains powered units on the market, and has two possible input impedances.

All this and no tone controls. It should be interesting to go through the circuit section by section, so I suppose the place to begin is the beginning. ▶



Right: an internal shot of the TAE88. The two channel construction can be clearly seen.

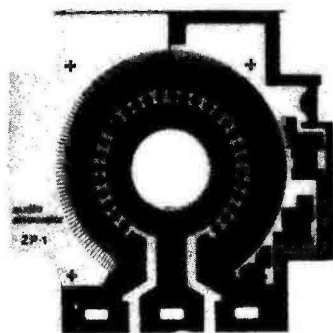
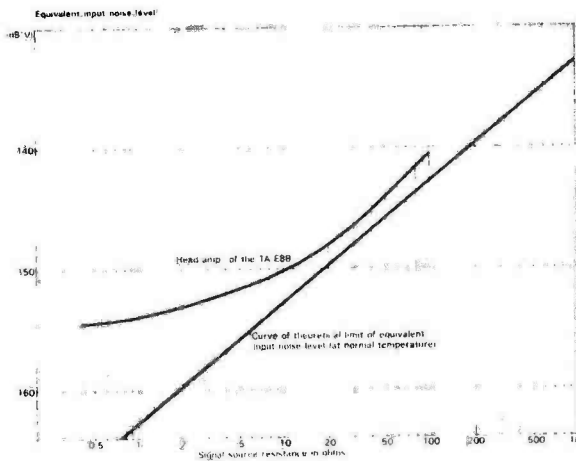
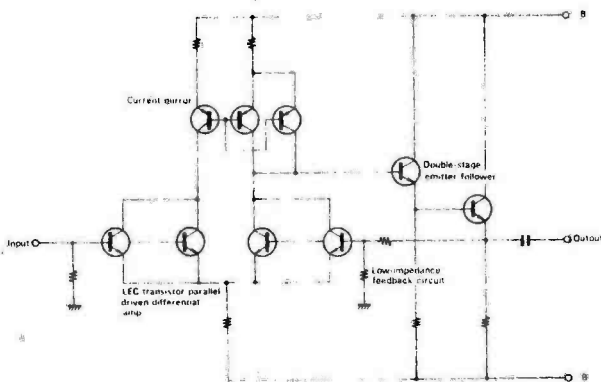
Left: a close up of the cartridge load switching and gold input sockets!



Head Start

As shown below, the moving coil amp consists of a differential pair with current mirror driving an emitter follower output stage.

The differential circuit consists of cascade connected transistors to get the noise and gain figures required, and 44dB of negative feedback is applied to lower distortion as usual. Low impedance feedback paths like this are fine for some applications, but need careful design indeed to avoid becoming more of a hindrance than a help.



Above: moving coil input circuit and performance graph.

Left: the PCB from the balance control. Each 'step' is connected to a precision resistor!

Magnetic Charm

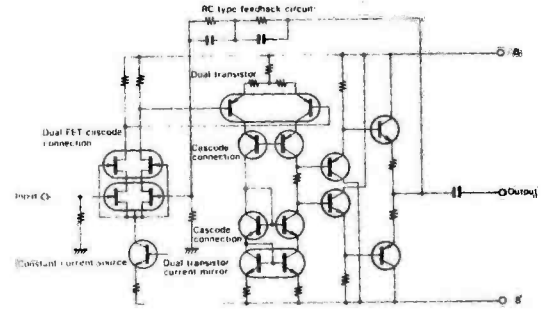
For more normal pickups the TA88 employs dual FET inputs (in cascode mode) and more conventional RC feedback equalisation circuitry. The FETs used were developed specially for the amplifier, when your 'Sony' of course you can get these things done.

The second stage is a differential amplifier also, to further stabilise and give the overall circuit greater immunity from current source drift. Dual transistors are

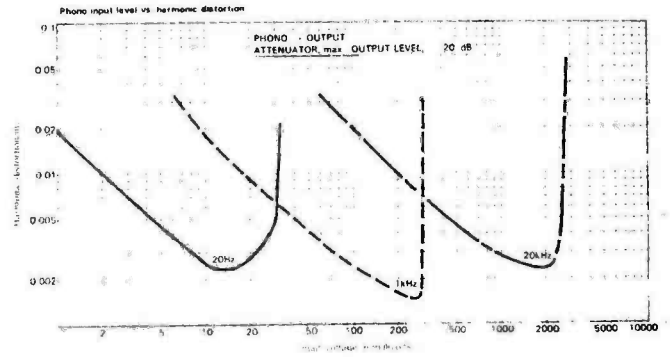
used in both the second differential amplifier and in the constant current stages of the circuit.

The output is once more an emitter follower following an emitter follower, and the components used are the expensive metal film resistors and polypropylene capacitors. Still when you've got £700 to spend — why not eh?

Equalisation is unusually accurate at 0.2%.

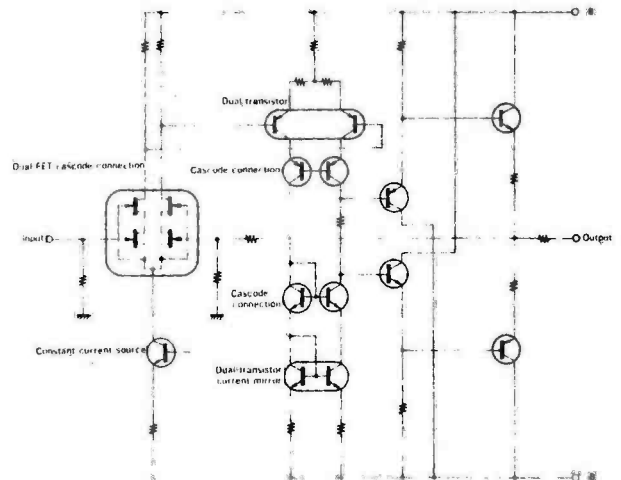


Magnetic cartridge input board.

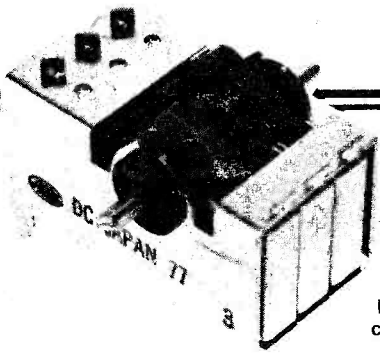


Standing At The Buffers

Buffer stages are liberally employed in the TA88, between source inputs (non phono) and selector, and then either side of the volume control. Sony call the output amp a 'flat' amplifier for no reason I can fathom.



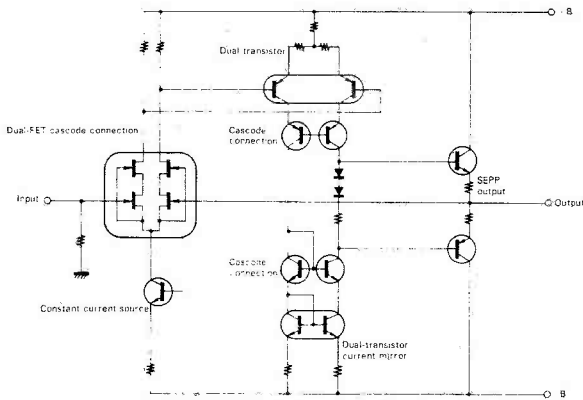
Buffer amplifier circuitry.



One of the PCB mounted cam switches.

You can see the circuit for the buffer circuit opposite. Once again dual FET inputs, and if you thought that there is a very strong similarity between this and the phono amps, I don't think you'll get many arguments from me.

The 'flat' amplifier (below) differs in as much as it is designed to work into the load presented by cable and power amp. To do this without loss of frequency res-



Output buffer circuit.

ponse, a design closely akin to a power amplifier configuration has been adopted.

Output impedance is about 100 ohms, so that fairly long interconnection runs can be tolerated, and up to 15 V can be safely output at around .001% THD.

Lugged Around

After reading through all the imposing technical info supplied with the unit I was almost afraid to wire up the box into my merely mortal system. I suppose I suspected some form of electron snobbery whereby the TAE88 would refuse to 'talk' to any power amp of less than immaculate pedigree.

In practice however it was a case of 'noblesse oblige' and the Sony worked impeccably with the rest of the universe. Several power amplifiers were tried, including the Lecson AP3II and a Crimson set up.

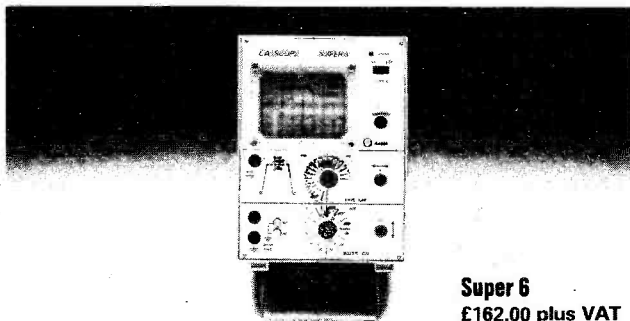
At first the TAE88 sounds very impressive with a particularly good bass end. The treble is a little thin, but nothing to comment adversely on. After a while though I came to suspect that maybe the unit wasn't as good as I thought at first, and perhaps adds a certain metallic quality to the sound.

Using the unit is a treat of the first order, and it inspires confidence better than Mr Callaghan ever did. Reservations must inevitably include that optimistic price level, and the less than perfect (just!) sound quality — which is as close to excellent as any other (but no closer!), but is more expensive approximation.

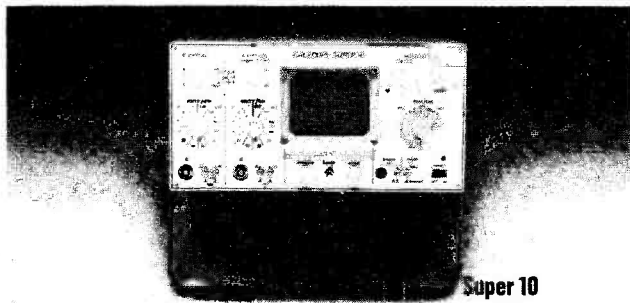
A lovely machine nonetheless and if Sony can pull down the price (exit gold?) one which would have received a wholehearted recommendation.

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HY5 Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: Complete pre-amplifier in single pack — Multi-function equalization — Low noise — Low distortion — High overload — Two simply combined for stereo.

APPLICATIONS: Hi-Fi — Mixers — Disco — Guitar and Organ — Public address.

SPECIFICATIONS:

INPUTS: Magnetic Pick-up 3mV, Ceramic Pick-up 30mV, Tuner 100mV, Microphone 10mV.

Auxiliary: 3-100mV, input impedance 47k Ω at 1kHz

OUTPUTS: Tape 100mV, Main output 500mV R.M.S.

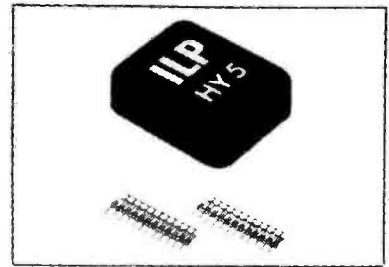
ACTIVE TONE CONTROLS: Treble - 12dB at 10kHz, Bass - at 100Hz

DISTORTION: 0.1% at 1kHz, Signal/Noise Ratio 68dB

OVERLOAD: 38dB on Magnetic Pick-up, **SUPPLY VOLTAGE:** 16.50V

Price £6.27 + 78p VAT. P&P free.

HY5 mounting board 81 48p + 6p VAT P&P free.



HY30 15 Watts into 8 Ω

The HY30 is an exciting New kit from I.L.P. it features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

FEATURES: Complete kit — Low Distortion — Short, Open and Thermal Protection — Easy to Build

APPLICATIONS: Updating audio equipment — Guitar practice amplifier — Test amplifier — Audio oscillator

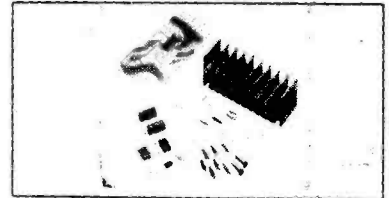
SPECIFICATIONS:

OUTPUT POWER: 15W R.M.S. into 8 Ω , **DISTORTION:** 0.1% at 15W

INPUT SENSITIVITY: 500mV, **FREQUENCY RESPONSE:** 10Hz-16kHz — 3dB

SUPPLY VOLTAGE: +18V.

Price £6.27 + 78p VAT. P&P free.



HY50 25 Watts into 8 Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components

APPLICATIONS: Medium Power Hi-Fi systems — Low power disco — Guitar amplifier

SPECIFICATIONS: **INPUT SENSITIVITY:** 500mV

OUTPUT POWER: 25W RMS in 8 Ω **LOAD IMPEDANCE:** 4-16 Ω , **DISTORTION:** 0.04% at 25W at 1kHz

SIGNAL/NOISE RATIO: 75dB, **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB

SUPPLY VOLTAGE: +25V **SIZE:** 105 50, 25mm

Price £8.18 + £1.02 VAT. P&P free.



HY120 60 Watts into 8 Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection, this amplifier sets a new standard in modular design.

FEATURES: Very low distortion — Integral Heatsink — Load line protection — Thermal protection — Five connections — No external components

APPLICATIONS: Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ.

SPECIFICATIONS:

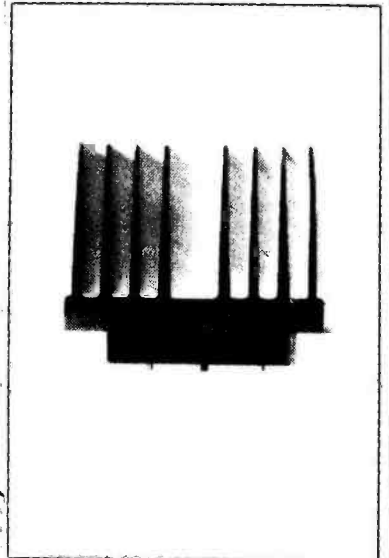
INPUT SENSITIVITY: 500mV

OUTPUT POWER: 60W RMS into 8 Ω , **LOAD IMPEDANCE:** 4-16 Ω , **DISTORTION:** 0.04% at 60W at 1 kHz

SIGNAL/NOISE RATIO: 90dB, **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB, **SUPPLY VOLTAGE:** +35V.

Size: 114 x 50 x 85mm.

Price £19.01 + £1.52 VAT. P&P free.



HY200 120 Watts into 8 Ω

The HY200 now improved to give an output of 120 Watts, has been designed to stand the most rugged conditions, such as disco or group while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown — Very low distortion — Loadline protection — Integral Heatsink — No external components.

APPLICATIONS: Hi-Fi — Disco — Monitor — Power Slave — Industrial — Public address.

SPECIFICATIONS:

INPUT SENSITIVITY: 500mV.

OUTPUT POWER: 120W RMS into 8 Ω , **LOAD IMPEDANCE:** 4-16 Ω , **DISTORTION:** 0.05% at 100W at 1kHz.

SIGNAL/NOISE RATIO: 96dB, **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB, **SUPPLY VOLTAGE:** +45V.

SIZE: 114 x 100 x 85mm.

Price £27.99 + £2.24 VAT. P&P free.

HY400 240 Watts into 4 Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4 Ω ! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: Thermal shutdown — Very low distortion — Load line protection — No external components.

APPLICATIONS: Public address — Disco — Power slave — Industrial

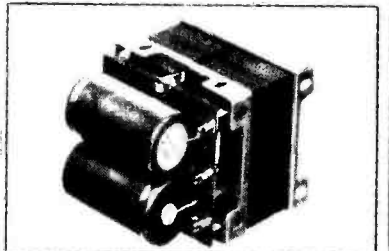
SPECIFICATIONS:

OUTPUT POWER: 240W RMS into 4 Ω , **LOAD IMPEDANCE:** 4-16 Ω , **DISTORTION:** 0.1% at 240W at 1 kHz

SIGNAL/NOISE RATIO: 94dB, **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB, **SUPPLY VOLTAGE:** +45V.

INPUT SENSITIVITY: 500mV, **SIZE:** 114 x 100 x 85mm.

Price £38.61 + £3.09 VAT. P&P free.



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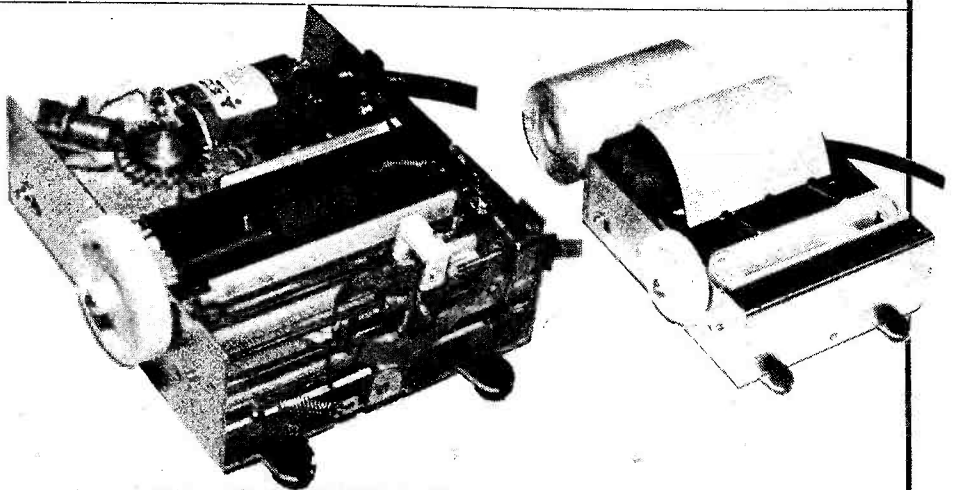
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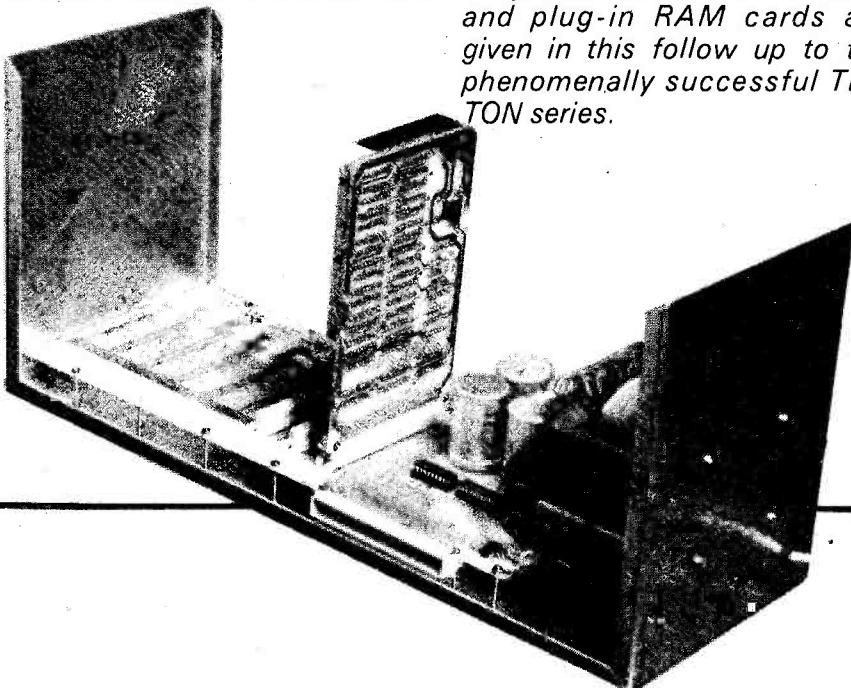
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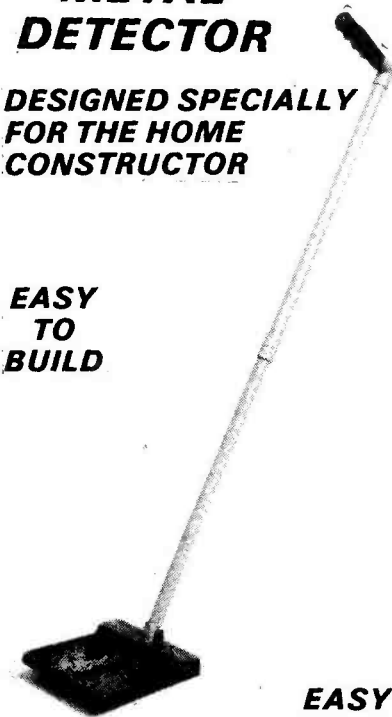
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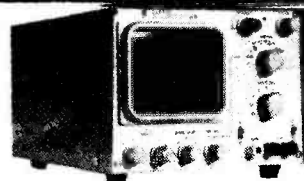
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Input Impedance — 1 Meg/40 pF in shunt. Input Voltage — Max —
600V P/P

HORIZONTAL AXIS (X) Deflection Sensitivity — 0.400mV/
division. Bandwidth (between 3 dB points) — 1Hz-350KHz. Gain
Control — Continuous when time bases in EXT position. Input
Impedance — 1 Meg. Input Voltage — Max — 600V P/P

TIME BASE Sweep Range (calibrated) — 100msec/div to 1µ
sec/div in 5 steps. FINE Control — Variable between steps —
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SYNCHRONISATION Selection — Internal external Synchron-
isation Level — Continues from positive to negative

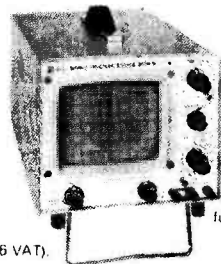
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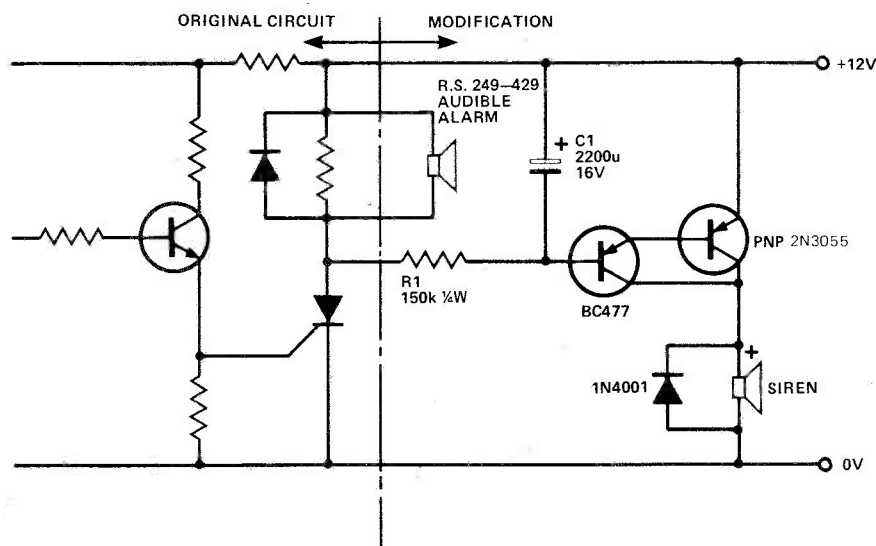
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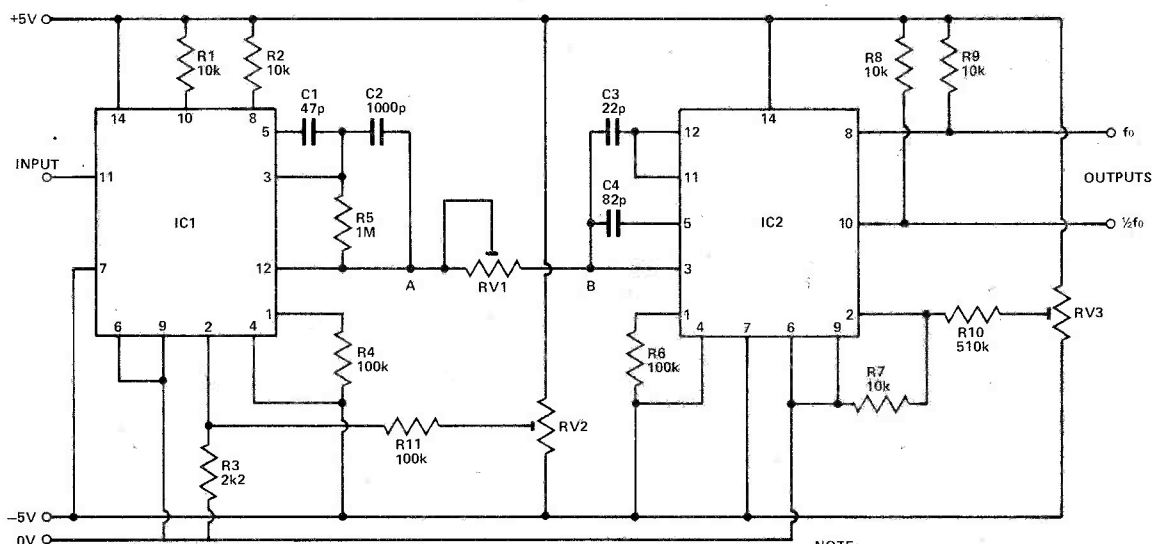
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Less Alarming

J. Master.
The April, 1977 ETI Burglar Alarm works well enough but I thought you may be interested in this modification which enables a low power audible alarm to sound 40 seconds before the main alarm. The main advantage is that the alarm can be set when one is retiring to bed at night and if the alarm is inadvertently triggered at least there is enough time to turn the unit off before the main alarm sounds. This also applies when people come home with the alarm set, no front door by-pass switch is required and accidental setting off of the alarm is avoided. The delay time can be varied by altering R1 and C1.



NOTE:
IC1,2 are RS Voltage to Frequency Chip
No. 307-070
RV1,2,3 are 50k 20 turn trimmers

Keyboard Guitar

A. Parker

The purpose of this project is to convert the waveform from a guitar or other instrument into pure square or pulse waveforms of the same frequency. The circuit is basically a frequency to voltage converter feeding a linear VCO.

The construction is straightforward provided the usual care is taken with the Cmos chips. For RV1, 2 and 3 we suggest 20 turn presets

as these will be needed for fine tuning of the circuit later. Also as an aid in testing we suggest that VR1 should NOT be soldered in until after initial testing has been completed.

The tuning of the circuit is best done using a Meter, PSU, Signal Generator and frequency meter if possible. First set the sig gen to some suitable frequency (ie 100 Hz) and using the meter between point A and earth adjust RV2 to give a voltage according to the formula

$$V = F_{in} \times 10^{-3}$$

(for 100 Hz $V = 100 - V$)

Now using an ACCURATE PSU set point B to +1 V and using VR3 adjust the output to 1 kHz then set to +10 V and adjust to 10 kHz. Now solder RV1 and adjust until

$$F_{in} = F_{out}$$

(NB This is a gross over simplification and patience is vital. Remember the price of the Chips before you throw them out of the window).

Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 25-27 Oxford St., London W1R 1RF.

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- K021** Miniature carbon film 5% resistors, CR25 or similar. 10 of each value from 10R to 1M, E12 series. Total 610 resistors **£6.00**
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- K041** Zener diodes. 400mW 5% BZY88, etc. 10 of each value from 27V to 36V, E24 series. Total 280 for **£15.30**
- K042** As above but 5 of each value **£8.70**

STEREO AMPLIFIER CHASSIS £5.50

Complete and ready built. Controls: Bass, treble, volume/on-off, balance. 8 transistor circuit gives 2 watts per channel output. Just needs transformer and speakers for low cost stereo amp. Suitable metal cabinet (W374) **£2.00**—or buy the amp, case and transformer for **£10.00** and get DIN speaker sockets and knobs free!

AMPLIFIER KIT £1.75

Mono gen. purpose amp with tone and vol./on-off controls. Utilizes sim. circuitry to above amp. Output 2W into 8 ohms. Input matched for crystal cartridge. 4 transistor circuit. Simple to build on PCB provided. Can be either battery or mains operated. (For mains powered version add **£2.20** for suitable transformer) Blue vinyl covered aluminium case to suit (W372) **£1.30**.

BC182B OFFER

Special Offer for quantity users 1k .035 + VAT, 5k .032 + VAT. Price negotiable on 10k + approx. 80k available.

PC ETCHING KIT MK III

Now contains 200 sq. ins. copper clad board, 1lb. Ferric Chloride, DALO etch-resist pen, abrasive cleaner, two miniature drill bits, etching dish and instructions. **£4.25**.

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4096 bit dynamic RAM with 300ns access time; 470ns cycle time; single low capacitance high level clock i/p; Fully TTL compatible; Low power dissipation. Supplied with data **£2.75**.

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Supplied with data if requested. MC3302 quad comp. 120p; 710 diff comp. (F099) 40p; ZN1034E precision timer **£2.25**; LM711 Dual diff comp **85p**; LM1303 dual stereo pre-amp **75p**; MC1469R voltage reg **£1.50**; UPC1025H audio **£3.50**; 575C2 audio **£2.88**; TDA2640 audio **£2.92**; TBA8105 audio **70p**; SN75110 dual line driver **70p**; MC8500 CRCC gen POA.

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We have available from stock the following SCOPEX models: 4010A—DC-10MHz; 10mV sensitivity; Stab. power supplies; Dual beam; 3% accuracy. Excellent value at **£214** inc. VAT and carriage. 4S8—DC-6MHz; 10mV sensitivity. Ideal portable scope. Solid state circuitry. All for **£180** inc. VAT and carriage.

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Carbon film 5% mostly 1/4W, few 1/2W resistors. Brand new but have pre-formed leads, ideal for PC mntg. Wide range of mixed popular values at the unrepeatably price of **£2.50** per 1,000; **£11** per 5,000.

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2 pin switched speaker socket, PC mntg; 5 pin 180° PC mntg, or chassis mntg. (clip fix). All the same price, any mix: 10 for **70p**; 25 for **£1.60**; 100 for **£5.50**.

PUSH BUTTON SWITCH BANKS

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RELAYS

WB47 Low profile PC mntg 10 x 33 x 20mm 6V coil, SPCO 3A contacts **93p**.
WB17 11 pin plug in relay; rated 24V AC, but works well on 6V DC. Contacts 3 pole c/o rated 10A. **85p**.
WB19 12V 1250R DPCO 1A contacts. Size 29 x 22 x 18mm min. plug-in type **72p**.
WB39 50V ac (24V DC) coil. 11 pin plug-in type. 3 pole c/o 10A contacts. Only **85p**.
WB46 Open construction mains relay. 3 sets 10A c/o contacts **£1.20**.
Send SAE for our relay list—84 types listed and illustrated.

LOW COST PLASTIC BOXES

Made in high impact ABS. The lids are retained by 4 screws into brass inserts. Interior of box has PCB guide slots (except V219).

V210 80x62x40mm black **85p**
V213 100x75x40mm black **72p**
V216 120x100x45mm black **85p**
V219 120x100x45mm white **85p**

DIODE SCOPIII

We have been fortunate to obtain a large quantity of untested, mostly unmarked glass silicon diodes. Testing a sample batch revealed about 70% useable devices—signal diodes, high voltage rets and zeners may all be included. These are being offered at the incredibly low price of **£1.25**/1,000—or a bag of 2,500 for **£2.25**. Bag of 10,000 **£8**. Box of 25,000 **£17.50**. Box of 100,000 **£60**.

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Electrovalueables are our own overstock items offered from time to time at greatly reduced prices. Orders for these items should quote "Electrovalueables" and also description and price as advertised. PRICES ARE NET AND V.A.T. MUST BE ADDED @ 8% or 12½% where prices show. Subject to prior sale.

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9mm clear neon **15p**

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T01 crinkle 224F 10 for **30p**

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VEROBOARD

5" x 3.4" x 2" matrix **20p**

TRANSFORMER CORES

0.5W 50 Hz Unisil. Beclere kit E5 **20p**

CAPACITORS

2000µF 50V **20p**

POTENTIOMETERS

Carbon track single gang 2KΩ log standard spindle **8 for £10**

P20 + switch 470K 1M log **3 for £10**

JP20 47K 1in. short spindle **3 for £10**

2M2 1in. long spindle **3 for £10**

100K log. 2M2 log **3 for £10**

1M log. rev log short spindle **3 for £10**

PG58 slider **47K log.**

1M 1in. 10K log. 47K log. **100K log. 220K log. 1M log. any 6 for £10**

WIRE WOUND

Colvern 905C: 100, 150, 1K5, 5K, 15K, 50K any 2 **£1**

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ELECTRONICS TODAY INTERNATIONAL—MARCH 1979

CBM Shoot

I. Holdstock
Shown here is the Shooting Program that I have devised for use on the Commodore PR-100 Programmable Calculator.

The idea is to try to shoot at targets that appear at random ranges. To do this the operator has to guess the correction that is necessary to score a Bullseye. To make things more difficult it is assumed that there is a strong wind blowing from the left, and the correction has to accommodate for this as well. The program works out where the shot would have hit the target and gives a score accordingly out of 5. Points are deducted for complete misses. The number of shots actually fired is stored, together with the total score. To use the program you enter the keystrokes and go to 00. Then 1000 is entered in memory 6. Then take the Sin of any integer less than 100 and run the number obtained. A random range will be displayed. Using the chart below the program listing, the operator has to guess the corrections necessary to score a bullseye and enter them at the correct stages into the program. A score will be displayed after the last correction. To re-use the program, simply press run after the score has been displayed, and a new range will be shown. Before the second correction is entered, 0 will be displayed. If the present range has been forgotten, it is simply obtained by pressing MR 1. (See instructions at the end of the program listing).

STEP NO	KEYSTROKE	CHECK CODE		SKIP	
00	M	51	52		15
01	0	91	53	GO TO	14
02	1	81	54	5	72
03	F	21	55	7	61
04	M+	84	56	±	94
05	7	61	57	F	21
06	MR	52	58	M+	84
07	0	91	59	2	82
08	+	84	60	5	72
09	pi	45	61	—	85
10	=	95	62	MR	52
11	y ^x	34	63	2	82
12	5	72	64	=	95
13	=	95	65	F	21
14	F	21	66	M+	84
15	Frac	51	67	8	62
16	M	51	68	STOP	13
17	0	91	69	GO TO	14
18	X	74	70	0	91
19	MR	52	71	2	82
20	6	73			
21	=	95			
22	M	51			
23	1	81			
24	STOP	13			
25	—	85			
26	MR	52			
27	0	91			
28	inv	31			
29	tan	24			
30	=	95			
31	F	21			
32	int	52			
33	SKIP	15			
34	GO TO	14			
35	3	83			
36	8	62			
37	±	94			
38	M	51			
39	2	82			
40	C/CE	25			
41	STOP	13			
42	—	—			
43	(64			
44	MR	52			
45	1	81			
46	X	74			
47	2	82			
48	tan	24			
49	=	95			
50	F	21			
51	int	52			

TO USE: FIRSTLY F C/CE THEN,
A) GO TO 00
B) 1000 in memory 6
C) Any 2 digit number, then SIN it
D) RUN — the range is displayed
E) Enter elevation guess-RUN
F) 0 will be displayed
G) Enter windage guess — RUN
H) Score will be displayed
I) RUN — a new range is displayed
J) Enter elevation guess — RUN
K) 0 will be displayed
L) Enter windage guess — RUN
M) Score will be displayed
— and so on.

USEFUL HINTS

RANGE	ELEVATION	WINDAGE
000	0	0
100	5	3
300	16	10
500	26	17
700	34	24
1000	45	35

The number of shots fired is in memory 7; the score is in memory 8,
BULLSEYE is 5
INNER is 4
MAGPIE is 3
OUTER is 2
MISS is 0 or —N. Points are deducted for misses.

Versatile CMOS Test bed

J. Anderson

It is a cheap and easily constructed transistor tester utilising inexpensive and readily available CMOS ICs.

It not only carries out the normal GO/NO-GO test but will differentiate between PNP & NPN type as well as identifying their base leads.

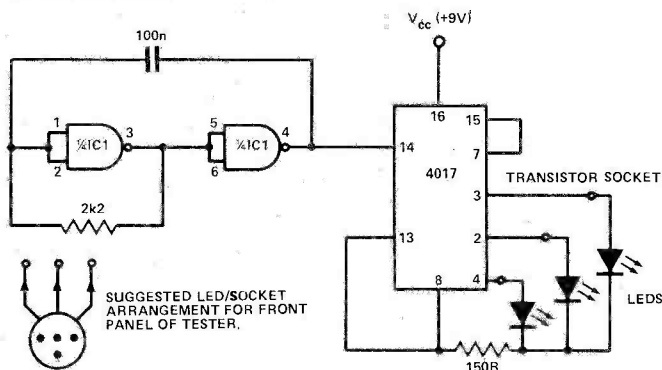
Use of the tester is simple and is as follows:

- 1) GO/NO-GO:—If the transistor is "a dud", either all the LEDs will come on or they will all go out.
- 2) PNP/NPN differentiation:—a PNP only one of the LEDs will come on.
- b) NPN one of the LEDs will go out.
- 3) base lead identification:—the

base lead is identified by the "odd LED out". (ie the one LED that is on with the other two out or the one that is out with the other two on).

The unit will also test diodes by the use of only two of the sockets of

the transistor socket in this case the anode of the diode is identified by the LED associated with its lead going out. The device also tests and identifies the gates of JUGFETs, SCRs & TRIACS.

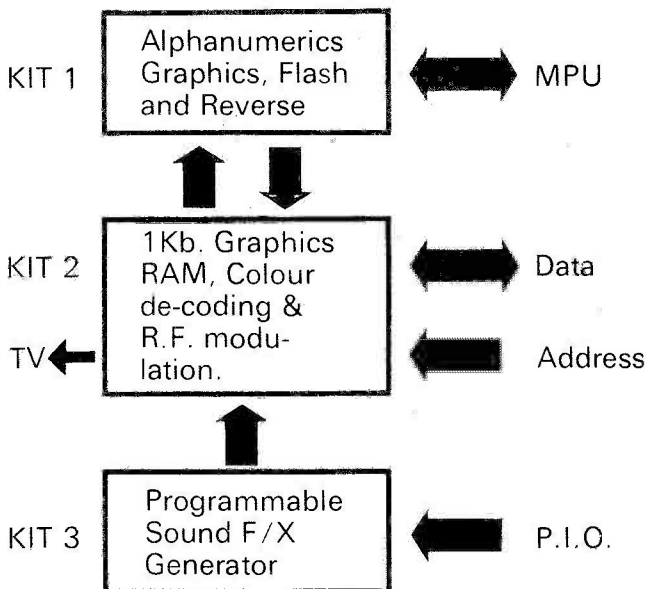


7400	10p	7430	12p	74137	90p	74195	50p	4055	130p	CA 3140	60p	LM 3909 N	65p	TBA 480 Q	200p	
7401	10p	7470	25p	74138	100p	74196	50p	4056	120p	LF 356	80p	MC 1310 P	140p	TBA 520 Q	200p	
7402	10p	7472	20p	74141	50p	74197	50p	4060	100p	LF 357	80p	MC 1312 P	150p	TBA 530 Q	200p	
7403	10p	7473	25p	74142	180p	74198	100p	4066	35p	LM 211 H	250p	MC 1314 P	190p	TBA 540	200p	
7404	12p	7474	25p	74143	270p	74199	100p	4069	12p	LM 300 TR5	170p	MC 1315 P	230p	TBA 550 Q	250p	
7405	12p	7475	25p	74144	270p	74293	90p	4070	12p	LM 301 AN	30p	MK 50398	650p	TBA 560 C	250p	
7406	25p	7476	25p	74145	55p	74L500	18p	4071	12p	LM 304	200p	MM 5314	380p	TBA 641 A12	250p	
7407	25p	7480	40p	74147	100p	745112	80p	4072	12p	LM 307N	65p	MM 5316	480p	TBA 700	180p	
7408	12p	7481	85p	74148	90p	CMOS			4081	12p	LM 308 TO5	100p	NE 529 K	150p	TBA 720 Q	225p
7409	12p	7482	75p	74150	65p	4000	12p	4082	12p	LM 308 DIL	100p	NE 555	25p	TBA 750 Q	200p	
7410	12p	7483	75p	74151	45p	4001	12p	4093	70p	LM 309 K	100p	NE 556	90p	TBA 800	80p	
7411	15p	7484	70p	74153	45p	4002	12p	4510	60p	LM 310 TO5	150p	NE 562 B	400p	TBA 810	100p	
7412	15p	7485	60p	74154	70p	4006	80p	4511	70p	LM 311 TO5	150p	SAD 1024	1500p	TBA 820	100p	
7413	25p	7486	25p	74155	45p	4007	14p	4516	65p	LM 317 K	325p	SL 917 B	650p	TBA 920 Q	280p	
7414	45p	7489	130p	74156	45p	4009	30p	4518	65p	LM 324	70p	SN 76003 N	150p	TCA 270 Q	220p	
7416	25p	7490	25p	74157	45p	4011	12p	4520	65p	LM 339	60p	SN 76013 N	110p	TCA 270 S	220p	
7417	25p	7491	40p	74160	55p	4012	12p	4528	80p	LM 348 N	90p	SN 76013 ND	125p	TCA 760	300p	
7420	12p	7492	35p	74161	55p	4013	30p	4583	70p	LM 380	60p	SN 76023 N	110p	TCA 4500 A	450p	
7421	20p	7493	30p	74162	55p	4015	50p	LINEAR			LM 381 N	90p	SN 76023 ND	125p	TDA 1008	350p
7422	15p	7494	70p	74163	55p	4016	30p	AY3 8500	450p	LM 382	90p	SN 76033 N	150p	TDA 1034	450p	
7423	20p	7495	45p	74164	60p	4017	50p	CA 3039	70p	LM 391	180p	SN 7627 N	160p	TDA 2002	300p	
7425	20p	7496	45p	74165	60p	4018	55p	CA 3046	60p	LM 555	25p	SN 76228 N	180p	TDA 2020	300p	
7426	22p	7497	120p	74166	75p	4019	40p	CA 3060	225p	LM 709 C	40p	SN 76660 N	75p	TL 084	120p	
7427	22p	74100	80p	74167	160p	4020	50p	CA 3065	200p	LM 710 TO5	60p	TAA 300	100p	XR 320	250p	
7428	25p	74104	40p	74170	100p	4022	50p	CA 3076	250p	LM 710 DIL	65p	TAA 350	190p	XR 2206	450p	
7430	12p	74105	40p	74173	80p	4023	12p	CA 3080	75p	LM 723 TO5	40p	TAA 550	35p	XR 2207	450p	
7432	20p	74107	25p	74174	60p	4024	40p	CA 3084	250p	LM 723 DIL	40p	TAA 570	220p	XR 2208	600p	
7433	28p	74108	100p	74175	60p	4025	12p	CA 3085	85p	LM 733	120p	TAA 661B	140p	XR 2216	650p	
7437	20p	74166	75p	74176	50p	4026	80p	CA 3086	60p	LM 741	20p	TAA 700	350p	XR 2567	250p	
7438	20p	74109	25p	74177	50p	4027	30p	CA 3088	190p	LM 748	40p	TAA 790	350p	XR 4136	150p	
7440	12p	74118	75p	74178	75p	4028	45p	CA 3089	160p	LM 1303 N	100p	TAD 100	150p	XR 4202	150p	
7441	45p	74120	80p	74179	120p	4029	50p	CA 3090 AQ	360p	LM 1458	100p	TAD 110	130p	XR 4212	150p	
7442	40p	74121	25p	74180	90p	4030	30p	CA 3123 E	130p	LM 3080	75p	TBA 120 S	60p	XR 4739	150p	
7443	60p	74122	35p	74181	130p	4032	80p	CA 3130	100p	LM 3900	55p	TBA 120 T	85p	ZN 414	100p	
7444	60p	74123	40p	74182	50p	4033	100p	IN 4148 Diodes by ITT/Texas, 100 for £1.50			First grade LEDs					
7445	65p	74125	35p	74184	120p	4040	60p	Static Ram 2102 1024x1 bit 450 nano sec, £1.00 each			.125 or 0.2" red					
7446	50p	74126	35p	74185	100p	4043	60p	2112 256x4 bit 450 nano sec, £2.50			10p each, 100 for					
7447	50p	74128	60p	74188	320p	4046	90p	Murata Ultrasonic Transducers 40kHz, £2.00 each; £3.50 pair			£7.50, 1,000 for					
7448	50p	74130	120p	74190	70p	4047	80p	All prices include post and VAT			£60.					
7450	12p	74131	90p	74191	70p	4048	50p	T. POWELL								
7451	12p	74132	45p	74192	60p	4049	25p	306 ST. PAULS ROAD, HIGHBURY CORNER, LONDON, N.1. TEL. 01-226 1489								
7453	12p	74135	90p	74193	60p	4050	25p	Barclay / Access credit cards accepted								
7454	12p	74136	80p	74194	55p	4054	100p									



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Microcomputer Accessories



Kit 1 provides 64 graphics pre-programmed on a 2708 EPROM. Other features include inverse video (black characters on white background) and flash (adjustable flash rate). Available now. Price £32.50.

Kit 2 when used in conjunction with kit 1 provides 1Kb of programmable colour graphics. Also included is a colour/audio R.F. modulator enabling direct connection to a colour TV aerial socket (NTSC or PAL). Available April. Price £52.20.

Kit 3 is a programmable sound effects generator which can be used by itself or with kit 2 to provide audio from a TV loudspeaker. The generator can provide "bell" sounds for keyboard, etc. Available April. Price £18.96.

*Conversion boards will shortly become available for other systems

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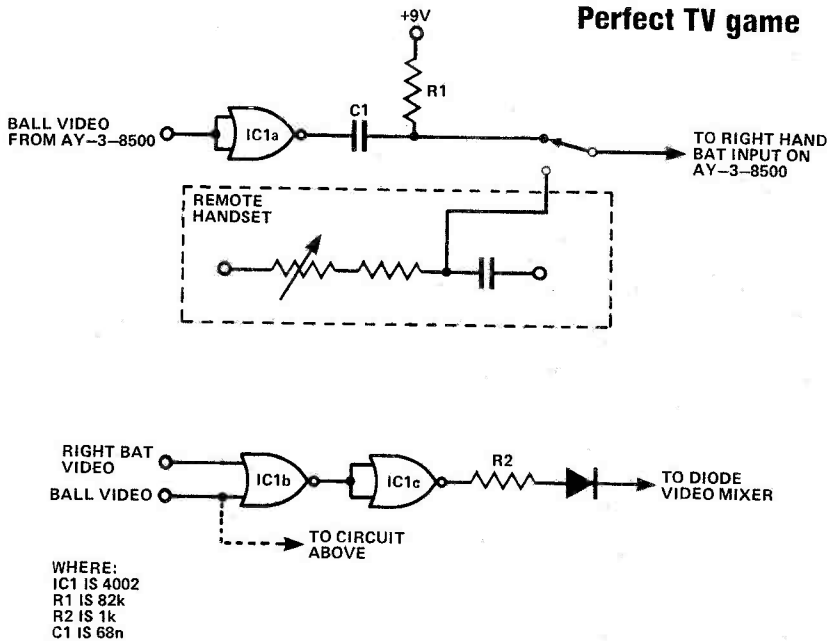
All kits supplied include fibre-glass PCB, all components and full documentation. Ready made kits available at £2 extra. Please add 8% VAT and 50p postage/packing.

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01-402 9244

Perfect TV game

B. Harvey



Although the circuit appears simple, (it only uses one gate from one IC!) the way it works is quite complex, suffice to say that it relies upon the way the AY-3-8500 games chip determines bat position from the setting of the hand controls.

The only modifications to the TV game are: (i) One lead connected to the ball video output of the games chip.

(ii) A switch wired in, selecting either a manual or an automatic player on the right hand bat.

(iii) This may not be necessary in home built games that use CMOS video mixers, but may have to be used in commercial units that sometimes use diode mixing circuits. The modification is shown and uses gates from the same IC. This will give a brighter bat and ball which is useful when playing squash.

The circuit shown allows a player to play tennis or squash against a perfect opponent, which is useful if one wishes to practise and cannot find another player.

The circuit 'plays' tennis or squash simply following the ball up and down the screen, thus it is always in the right place in order to hit the ball.

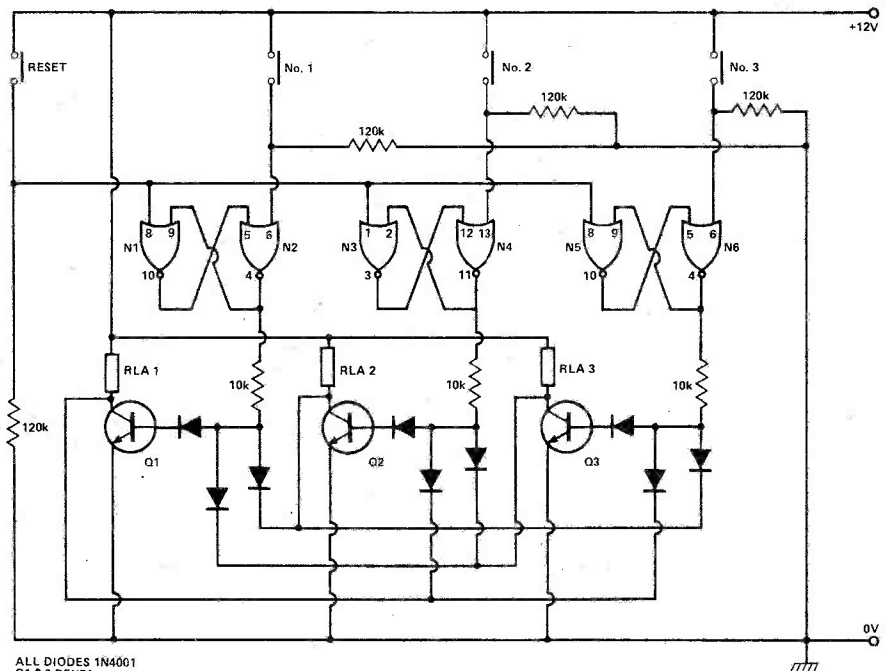
Sequence Switch

B. Willis.

The circuit right was designed to enable three relays to be individually switched by their appropriate buttons but such that only one relay can be energised at any one time. When any one relay has been energised the corresponding collector falls to near zero volts, which is connected to the base of the remaining two transistors; now if another relay is attempted to be energised the base of it's transistor will remain bottomed and keep the relay off. The rest button must be pressed before another relay can be energised. DI ensures that each transistor is kept off until the voltage applied to the base exceeds 0.6 V.

The flip-flops and push buttons can of course be replaced with standard switches if momentary action is not required.

The circuit was used to control three radio transmitters where it was important that two should not be



ALL DIODES 1N4001
 Q1,2,3 BFY51
 N1 - N4 CD4001
 N5, N6 1/2CD4001
 RELAYS 120R OR ABOVE

switched on at the same time. The circuit lends itself to further applications; for example, switching various

inputs into an amplifier where it can replace the self-cancelling selector buttons.

ambit international [®]

The PW Sandbanks Metal Locator: a kit based on this recently published design for this uniquely effective type of metal locator is available for only £35.00 + 8% VAT. The kit closely resembles the appearance as published, except that a close fitting injection molded housing replaces the vacuum molded electronics box - to improve the environmental suitability of the construction. Carriage for complete kits £1.

The New Catalogue - "Tecknowledgey Part 2"

Part 2 of the catalogue: by the time this advert reaches the press, part 2 should be on sale. Sorry it's late, but it contains so many new and interesting things that we felt we had to hold up production to include them. Part three by the autumn - and already there are many new items to go in! Part one 45p, part 2 50p. (inc PP etc).

Radio ICs

TDA1062	HF/VHF tunerhead	1.95
TDA1083	One chip AM/FM rx	1.95
TDA1090	One chip HiFi am/fm	3.35
TDA1220	One chip am/fm rx	1.75
HA1197W	HiFi AM tuner IC	1.40
CA3123E	AM tuner IC	1.40
TBA651	AM tuner IC	1.81
CA3089E	Famous FM IF system	1.94
CA3189E	As 3089+ deviation mute	
	AF preamp, adj, agc	2.75
	Improved S/N 3089	2.20
HA1137W	limiting amp+detector	0.75
TBA120S	high gain	1.00
MC1350P	agc'd IF preamp	1.20
MC1330P	synch AM/video detector	1.35
KB4406	Cascade IF preamp	0.65
ua753	limiting FM preamp	1.95

Communications circuits

SD6000	DMOS RF/mixer pair	3.75
KB4412	Bal mixers, 1F+agc	2.55
KB4413	AM/SSB det, squelch, agc	2.75
KB4417	mic processor	2.55
MC3357	best thing in NBFM yet	3.12
MC1496P	popular double bal mixer	1.25

Multiplex decoders + noise blanker

MC1310P	popular PLL decoder	2.20
ua758	buffered 1310	2.20
CA3090AO	RCA PLL decoder	3.25
HA1196	improved PLL decoder with stereo preamps	3.95
HA11223	19kHz pilot cancel, low distortion, high S/N	4.35
KB4437	as HA11223 with remote VCO kill facility	4.55
KB4438	stereo MUTING preamp for post decoder mute	2.22
KB4438	impulse noise blanker	2.53

Discrete devices: more than ever:

BF960	800MHz/2.8dB nf mosfet	1.60*
BF961	200MHz/2.0dB nf	0.80*
40822	FM RF amp	0.43*
40823	FM mixer	0.51*
40673	Famous MOSFET	0.55*
2SJ49/2sK133	120V/100W MOSPOWER output devices	10.50*

LEDs:

the best value today			
	3mm	5mm	2.5x5mm
Red	0.14	0.14	0.17
Green	0.18	0.16	0.20
Yellow	0.18	0.15	0.20
Orange	0.22	0.29	0.24

100 off mix, 25% discount. All are AEG first grade types - absolutely no junk. 5mm clips for panel mounting 0.03 each

Misc. ICs for radio/audio applications

U237B	5 LED bargraph driver	0.80*
SAS6610	4 station touch tune IC	1.48*
SAS6710	adds 4 stations to 6610	1.48
MSM5523/4	LW/MW, SW and FM digital frequency readout plus clock, timers, stopwatch	£14*

MSM5526	LW/MW/FM OFM with direct drive for LCD	£11*
TCA730	DC volume control	3.50
TCA740	DC tone control	3.50
TDA1028	DC input switch	3.50
TDA1029	DC mode switch	3.50

Radio and Tuner modules

We cannot really list all the details we would like to here - but with advent of the new mark 3 tuner system, the Dorchester and matching AF units, Ambit offers you the widest choice ever, plus hardware and styling that matches the very high standards we have set in this new range.

At last, DIY HiFi which looks as if it isn't.

That's not to say it doesn't look like HiFi - just that it doesn't look like the usual sort of thing you have come to associate with DIY HiFi. The Mk3 outstrips and outperforms all British made HiFi tuners, and most imported ones too. Certainly at the price, there isn't one near it. But more than that, it looks superb. A small pic here would be an insult, so send an SAE for details on the kit that looks as if isn't. It's something else.....

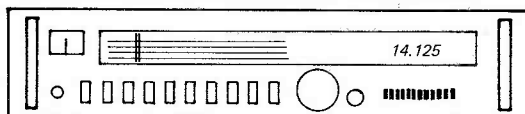
- ★ Exceptionally high performance - exceptionally straightforward assembly
- ★ Baseboard and plug-in construction. Future circuit developments will readily plug in, to keep the MkIII at the forefront of technical achievement
- ★ Various options and module line-ups possible to enable an installation approach to the system

and now previewing the matching 60W/channel VMOS amplifier:

- ★ Matching both the style and design concepts of the MkIII HiFi FM tuner
- ★ Hitachi VMOS power fets - characterized especially for HiFi applications
- ★ Power output readily multiplied by the addition of further MOSFETs
- ★ VU meters on the preamp - not simply dancing according to vol level
- ★ Backed with the usual Ambit expertise and technical capacity in audio

The PW Dorchester-LW, MW, SW, & FM stereo tuner

THE DIGITAL DORCHESTER ALL BAND TUNER



With styling and dimensions to fit in with the rest of AMBIT's new range of tuner & audio equipment.

When the new range of OKI digital frequency display ICs was announced, the original prototype of the Dorchester had been made - but since so many of you wanted to use the OKI frequency counterdisplay system with the Dorchester, we quickly designed a unit to incorporate the necessary facilities. The Digital Dorchester is designed in 19 inch form, and forms a perfect match for the other units in the range. If you don't want to go to the expense of the full Ambit DFM1 module, with AM/FM/Time/Timers, then the MA1023 clock module can be used instead.

The Dorchester has been described in PW Dec., Jan. and Feb. issues - but for those of you who may have missed it - it is an All Band broadcast tuner, covering LW/MW/SW and FM stereo in 6 switched ranges. Construction is very straightforward, with all the switching being PCB mounted - and the revolutionary TDA1090 IC used for AM/FM.

The electronics for the radio section of the Dorchester remain unchanged at £33.00, with 12.5% VAT. The hardware package, of case, meter, PSU now costs £33.00 + 8% with the MA1023 available for an extra £5 only.

For the fully digital version, with Ambit DFM1, the price is £56.50 + 8% VAT.

2 Gresham Road, Brentwood, Essex.

AUDIO MODULES

1 Stereo Cassette Deck N999

Complete with electronics uses: Music centres, disco consols, tape editing, etc. Freq resp 63 Hz-10KHz. WOW: 0.15% FLUTTER. 0.18% channel; separation 55dB. Electronic speed control. ALC Mic and line inputs. JAPANESE manufacture - requires 12 VDC. **£23.95.**



2 Preamp Amp - PSU Wimborne 11W per channel.

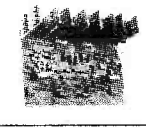
Four Rotary controls. Vol., Bass, Treble, Bal. 2 x PSUs for RF Board - cassette deck, LM 387 preamp IC driver. TIP 31 - TIP 32 Output Pairs. Special price includes transformer, **£16.95.** (October, 1978, PW).



3 AMP 041 8 watt RMS per channel amp - preamp supplied with pots. Fully complementary requires 28 VDC. Price complete **£6.99.**



4 AMP 020 Stereo power amp 30 W RMS per channel. Class ABI TIP 34A - TIP 33A. 16 Transistor circuit. Fre. resp. 15Hz - 18 KHz - 1dB. **£7.99.**



5 Matching Hi-Fi Preamplifier, four rotary controls. Vol., Bal., Treble, Bass. Treble - 14dB Bass-14dB facility for loudness control. **£6.99.**



RF MODULES

6 Surplus RF Board 020

Complete MW/LW/FM/MPX Tuner uses 3-stage FET front end 2 ceramic filters 3089E-1310 Decoder. AM section built around 3132E, 2-stage tuning comes with 4-way switch - ferrite rod aerial. **£9.99.**



7 RF 030

Improved version of above extra gain stage imposed S/N ratio and 1.5 μV sensitivity for 26dB S/N way selector switch AFC stereo/mono switching - two additional inputs. **£19.95.**

8 RF 040 MW/LW/FM/MPX varicap tuned RF board as per 78 Nov./Dec. PW Dual gate MOSFET front end, 2 x 1F gain stages 3189 Deviation mute, interstation mute, MPX filters. STab PSU 1 μV sensitivity and 75dB S/N ratio. AM Section also varicap tuned HA1197, excellent performance. Special price **£28.95.**

9 VT01 108-150MHz MOSFET front end 26dB gain. 10.7MHz 1F output. Covers 2 metres. Amateurs. Aircraft, etc. **£7.99.**



10 IF15 Matching IF Strip double conversion 10.7MHz/470 KHz AM/NB/FM. Excellent performance. **£12.95.**

We have all parts in stock for the Wimborne Music Centre - parts for amps/tuner amps and music centres up to 25 watts per channel. We stock all hardware and trim to give units a professional finish. Front panels, meters, knobs, sockets, etc.

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4001	17p	4060	115p	4527	157p
4002	17p	4063	109p	4528	102p
4006	109p	4066	55p	4529	141p
4007	18p	4067	400p	4530	90p
4008	80p	4068	25p	4531	141p
4009	58p	4069	20p	4532	125p
4010	58p	4070	20p	4534	614p
4011	17p	4071	20p	4536	380p
4012	17p	4072	20p	4538	150p
4013	55p	4073	20p	4539	110p
4016	52p	4075	20p	4541	141p
4017	80p	4076	90p	4543	174p
4018	80p	4077	20p	4549	399p
4019	60p	4078	20p	4553	440p
4020	93p	4081	20p	4554	153p
4021	82p	4082	20p	4556	77p
4022	90p	4085	82p	4557	386p
4023	17p	4086	82p	4558	117p
4024	75p	4089	150p	4560	388p
4025	17p	4093	50p	4560	218p
4026	180p	4094	190p	4561	65p
4027	55p	4096	105p	4562	530p
4028	72p	4097	372p	4566	159p
4029	100p	4098	110p	4568	281p
4030	58p	4099	122p	4569	303p
4031	250p	4160	90p	4572	25p
4032	100p	4161	90p	4580	600p
4033	145p	4162	90p	4581	319p
4034	200p	4163	90p	4582	164p
4035	120p	4174	104p	4583	84p
4036	250p	4175	95p	4584	63p
4037	100p	4194	95p	4585	100p
4038	105p	4501	23p		
4039	250p	4502	91p		
4040	83p	4503	69p		
4041	90p	4506	51p		
4042	85p	4507	55p		
4043	85p	4508	24p		
4044	80p	4510	99p		
4045	150p	4511	149p		
4046	130p	4512	98p		
4047	99p	4513	206p		
4048	60p	4514	260p		
4049	55p	4515	300p		
4050	55p	4516	125p		
4051	65p	4517	382p		
4052	65p	4518	100p		
4053	65p	4519	57p		
4054	120p	4520	109p		
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N'	LSN'	N'	LSN'	N'	LSN'	N'	LSN'	N'	LSN'			
7400	13	20	7455	35	24	74126	57	44	74185	134	74377	124
7401	13	20	7460	17		74128	74		74188	275	74378	93
7402	14	20	7463	28		74132	73	78	74190	115	74379	130
7403	14	20	7470	28		74133	29	74	74191		74386	37
7404	14	24	7472	28		74136	40	74	74192	105	74390	140
7405	18	26	7473	32		74138	60	74	74193	105	74395	139
7406	38		7474	27	38	74139	60	74	74194	105	74396	133
7407	38		7475	38	40	74141	56		74195	95	74398	180
7408	17	24	7476	37		74142	265		74196	99	74399	150
7409	17	24	7478			74143	312		74197	85	74400	92
7410	15	24	7480	48		74144	312		74198	150	74447	90
7411	20	24	7481	86		74145	65		74199	160	74490	140
7412	17	24	7482	69		74147	175		74248		74668	110
7413	30	52	7483A			74148	109		74249		74740	249
7414	51	130	7484	97		74150	99		74251	90		
7415	24	7485	104	99		74151	64	84	74253	105	MISCELLANY	
7416	30	7486		40		74153	64	54	74257	108	NE555	30p
7417	30	7489	205			74154	96		74258	153	NE556	78p
7420	16	24	7490	33	90	74155	54	110	74259	420	NE568	150p
7421	29	24	7491	76	110	74156	80	110	74260	153	ICM7217	850p
7422	24	24	7492	38	78	74157	67	55	74261	353	ICL7106CP	1495p
7423	27		7493	32	99	74158		60	74266	40	LCD DVM IC	
7425	27		7494	78		74159	210		74273	124	955P	
7426	35	27	7495A	65	99	74160	82	130	74275	312	LCD DVM KIT	
7427	27	29	7496	58	120	74161	92	78	74279	52	LCD DVM KIT	
7428	35	32	7497	185		74162	92	130	74283	120	2480P	
7430	17	24	74100	119		74163	92	78	74290	90	3 1/2 digit LCD	
7432	25	24	74104	63		74164	104		74293	95	display 1150p	
7433	40	32	74105	62		74165	105		74295	120	ICL7107 LED	
7437	40	24	74107	32	38	74166			74298	100	DVM kit 2065p	
7438	33	24	74109	63	38	74167		20	74324	167	ICM7216 - 8 digit	
7440	17	24	74110	54		74168			74325	242	10MHz DFM	
7441	74		74111	68		74169		200	74326	247	timer	£19.82
7442	70	99	74112	88		74170	230	200	74327	237	(for LED C. Cath)	
7443	115		74113		38	74172	625		74352	100	SCALAR ICs	
7444	112		74114		38	74173	170		74353	100	8629 150MHz	
7445	94		74116	198		74174	87	120	74362	715	divide by 100	
7446	94		74118	83		74175	87	110	74365	49	720p	
7447	82		74119	119		74176	75		74366	49	95H90DC	480p
7448	56	99	74120	115		74177	78		74367	43	11C90DC	1400p
7449	17	99	74121	25		74180	85		74368	49	8618 - new-divide	
7450			74122	46		74181	165	350	74373	77	by 100 or 10	
7451	17	24	74123	48		74182	160		74374	77	for 120/60MHz	
7453	17		74124	24		74183		210	74375	60	450p	
7454	17	24	74125	38	44	74184	135					

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LM301AH	67p
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LM308H	121p
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OPTO 7 seg displays

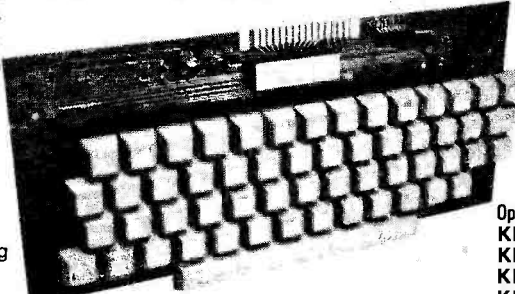
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5082-7653	red CC
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FND507	red CC 150p
FND507	red CA 150p

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KB756 mounted on PCB
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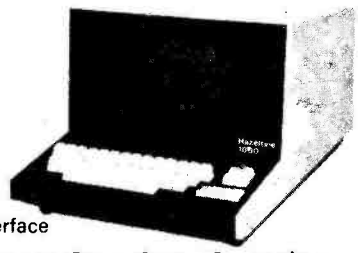
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7400	.10	74154	1.00	74827	.38	2K303	.20
7401	.12	74156	.60	74851	.28	2K3054	.57
7402	.12	74157	.54	74864	.20	2K3056	.57
7403	.12	74158	1.04	74874	.38	2K3072	.12
7404	.10	74159	1.18	748112	.66	2K3074	.12
7406	.27	74163	.80	748124	3.25	2K3079	.29
7408	.12	74164	.87				
7409	.15	74165	.93				
7410	.12	74175	.67				
7411	.21	74176	.84				
7412	.21	74177	.86				
7413	.24	74190	1.04				
7414	.64	74192	.98				
7416	.26	74193	.98				
7417	.33	74194	.86				
7420	.12	74196	.86				
7426	.24	74197	.86				
7427	.24	74198	1.41				
7430	.12	74199	.86				
7432	.23	74180	.16				
7433	.50	74181	.16				
7437	.23	74182	.18				
7438	.23	74184	.19				
7440	.16	74185	.21				
7441	.50	74186	.21				
7442	.38	74187	.21				
7443	.85	74188	.21				
7445	.67	74189	.21				
7446	.67	74190	1.10				
7447	.59	74191	.18				
7448	.48	74192	.21				
7450	.16	74193	.24				
7451	.16	74194	.26				
7453	.16	74195	.29				
7454	.16	74196	.25				
7456	.16	74197	.54				
7470	.36	74198	.29				
7472	.32	74199	.32				
7473	.21	74200	.33				
7474	.26	74201	.36				
7475	.29	74202	.38				
7476	.31	74203	.40				
7480	.68	74204	.42				
7485	.84	74205	.44				
7486	.25	74206	.46				
7489	1.95	74207	.48				
7490	.38	74208	.50				
7491	.62	74209	.52				
7492	.42	74210	.54				
7493	.29	74211	.56				
7495	.51	74212	.58				
7496	.67	74213	.60				
74104	.48	74214	.62				
74105	.48	74215	.64				
74107	.27	74216	.66				
74109	.46	74217	.68				
74121	.29	74218	.70				
74122	.47	74219	.72				
74123	.38	74220	.74				
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7443	.60	LM735	.38
7444	.60	LM736	.38
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7450	.14	LM741	.38
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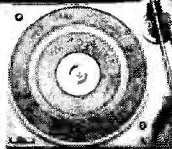
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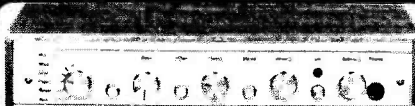
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£23.00 + £2.50 (NOTE Cabinet not available separately.) **£29.00** complete with cabinet. p&p £2.50

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£29.95 P&P £2.50

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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.

SPECIAL OFFER The above 50 watt amp plus 4 Goodmans Type 8P. 8" speakers. Package price **£45.00** + £4.00 P&P.



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Size approx. 14" x 4" x 10 1/2"

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it in. VU meter monitors output level. p & p **£4.00**

Output 100 watts RMS 200 watts peak. 100 watt **£65**



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pause control, solenoid assisted auto-stop, 3 digit tape counter, belt driven balanced fly wheel by DC motor

with electronic speed control, twin VU meters. Specification Power

Output, more than 0.5v. mic. -65dB 10KHz, DIN -47dB 100KHz

Track 2 channel stereo record play-back. Tape speed 4.8cm/sec Freq

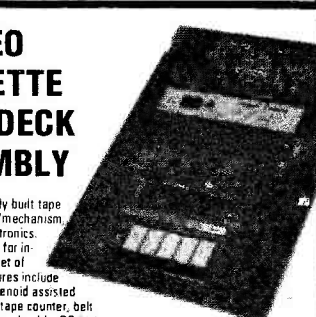
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Erasing system AC erase Bias free. 57KHz. Compatible for both normal and chrome dioxide tapes. Size of mechanism only 4 1/4" x 6 1/4" x 11 1/4" approx.

included a moulded top-plate as illustrated **£25.00** P&P £2.50

13 1/2" x 9 1/2" approx. with circuit diagram. **£25.00** P&P £2.50

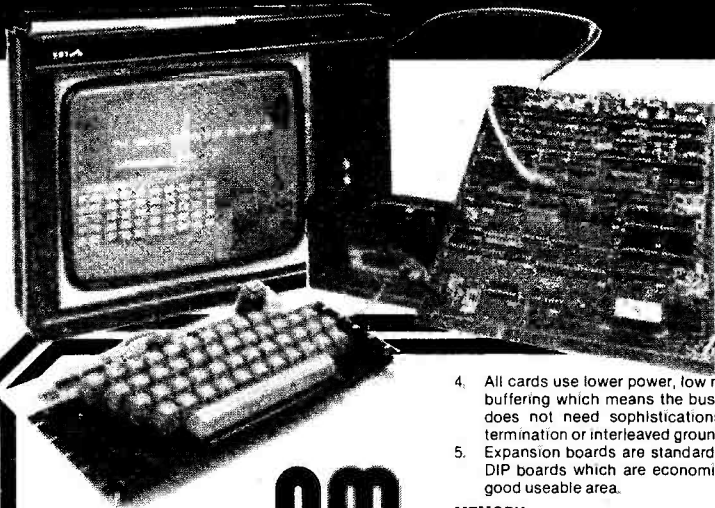
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The Nascom I was exceptional value for money at the old price, now it is unbeatable.

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The specification includes powerful Z80 processor, parallel I/O controller with two 8 bit ports UART driving cassette interface or most serial peripherals, video output to plug in the ariel socket of your T.V., 2K bytes of RAM (1K user and 1K video), proven 1K byte monitor program in EPROM and a spare EPROM socket.

The kit is complete, all that is required is a power supply a domestic T.V. and a domestic cassette recorder.

POWER SUPPLIES

There are two power supplies available, a 3 amp supply which will power the basic kit and some expansion and an 8 amp supply with toroidal transformer which will power a very large system. Both supplies can be mounted in the vero frame.

3 amp P.S.U. kit.....£26.46
8 amp P.S.U. kit.....£64.80

EXPANSION

Nascom I is expanded by connection to a buffer board which creates a 77 way bus structure "NASBUS" into which expansion boards plug directly. The bus structure is carried along a motherboard which allows future boards to be added and to keep your computer neat the Nascom I, power supply, buffer board, mother board and expansion boards can all be mounted in a vero frame.

Buffer Board.....£27.00
Mother board.....£10.26
Mini Motherboard.....£3.13
Vero frame.....£31.86

NASBUS

The 77 way Nasbus has the following advantages:—

1. Uses standard Veroboard as a motherboard and Standard 0.1" single sided edge connectors for expansion cards. These components are readily and cheaply available.
2. The bus structure leaves 8 spare data lines and 4 spare address lines for future use of 16 bit processors.
3. The power lines are regulated, on board regulators are therefore not needed which obviates the necessity for fan assisted cooling.

All prices include VAT and Carriage.

4. All cards use lower power, low noise shottky buffering which means the bus is quiet and does not need sophistications like active termination or interleaved ground planes.
5. Expansion boards are standard 8" x 8" vero DIP boards which are economic and give a good useable area.

MEMORY

The memory expansion board can carry 16 dynamic RAM chips, these can be either 4K bit or 16K bit chips and the board is offered with 8,16 or 32K bytes of RAM. The 16K board can be expanded to 32K by plugging in 8 more 4116 chips.

The memory expansion board also has room for 4 2708 UVEPROMS each of 1K bytes and a lot of pre-programmed systems software is available to fit these sockets.

8K RAM board kit.....£91.80
16K RAM board kit.....£151.20
32K RAM board kit.....£216.00
Set 8 x 4116.....£75.60
Additional 2708.....11.34

INPUT/OUTPUT

For people wanting to use more peripherals than the standard kit allows for, Nascom are producing an I/O board which can carry a counter timer chip and a number of PIO's and UARTS. This will be available in March.

I/O board.....£37.80
CTC.....£8.64
UART.....£5.94
PIO.....£8.64

BASIC

To allow high level language programming Nascom have produced a 2K Tiny basic and a 3K Super Tiny Basic in 2 or 3 2708 EPROMS respectively. Also available is an 8K Microsoft precision floating point basic in 8 2708's which will be available in April on a single 64K bit ROM to fit the EPROM board.

Tiny Basic.....£27.00
Super Tiny Basic.....£37.80
8K Basic (8 x 2708).....£108.00
8K Basic (ROM).....£43.20

EPROM BOARD

Available in March this board will carry 8 x 2708 UVEPROMS and the 64K bit ROM containing basic. The board can also be used for burning in 2708 UVEPROMS.

EPROM BOARD.....£43.20

GRAPHIC BOARD

Allows high resolution graphics on your Nascom I. Contains 4K of RAM.

Graphics board.....£102.60

MONITOR

Nascom have written a new monitor, T4 the most powerful yet available for this machine it contains many desirable features not found on any other monitor. T4 comes in 2 x 2708 to plug into the main Nascom I board.

Nasbug T4.....£27.00

FIRMWARE

A powerful editor assembler zeap 15 available to run under Nasbug in 3 x 2708 or on tape. ICL Datakill have produced a letter Editor available in 2 x 2708.

Zeap (tape).....£32.40
Zeap (Eprom).....£48.60
Letter Editor.....£75.60

THE FUTURE

In the near future a mini-floppy disk system will be available with either single or double drive. These will probably offer in excess of 1/2 a megabyte and 1 megabyte respectively at prices that will allow even the hobbyist to have a large data base. To take full advantage of the business and scientific uses opened up by disks Nascom intend to release several high level languages. Looking further forwards Nascom is a developing product, and the fact that many thousands are now in use will ensure that the latest in computer technology will be available at a competitive price.

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SPECIFICATIONS

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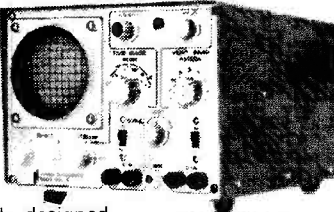
Deflection Sensitivity — 100mV/division
Bandwidth (between 3dB points) — DC — 5MHz
Input Attenuator — (calibrated) — 9 stop: 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50V/div

Input Impedance — 1 Meg/40pF in shunt
Input Voltage — Max — 600V P-P

HORIZONTAL AXIS (X)

Deflection Sensitivity — 0-400mV/division
Bandwidth (between 3dB points) — 1 Hz — 350KHz
Gain Control — Continuous, when time base in EXT position
Input Impedance 1Meg
Input Voltage — Max — 600V P-P

TIME BASE
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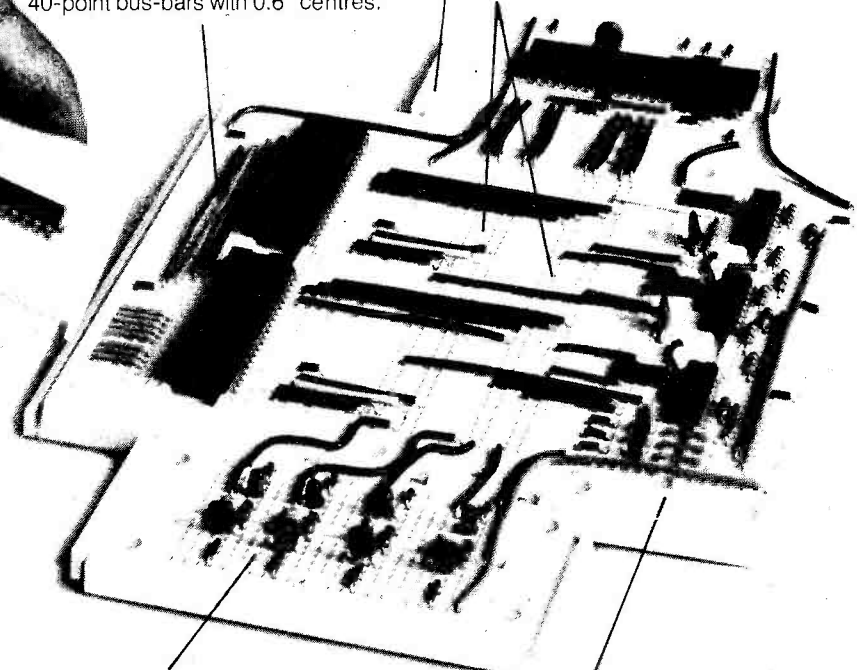
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EXPERIMENTOR 650 £4.70

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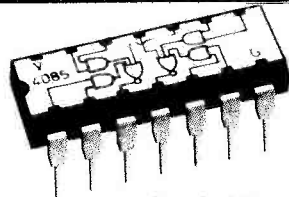
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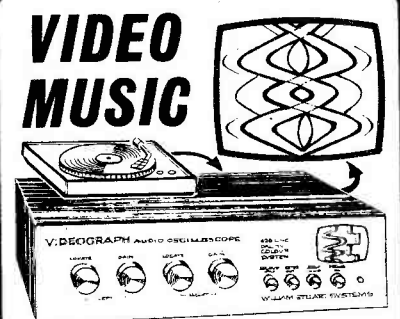
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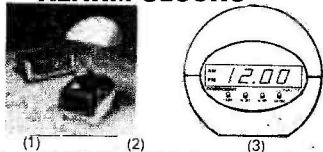
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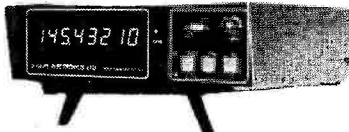
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