electronics today INTERNATIONAL

NOVEMBER 1979

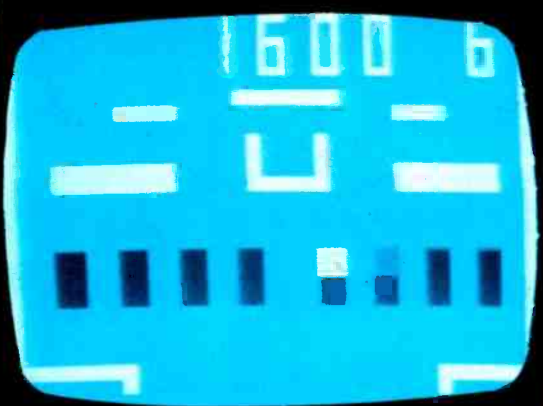
50p

8 PAGE SPECIAL

TECH TIPS

2 Wire Model Train Controller

Pinball TV Game



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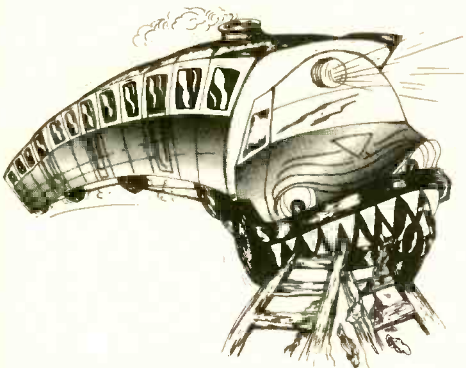
NOVEMBER 1979 VOL 8 NO 11

Eight page special of your circuits P.96



The Beast — and we're not joking P.42

ur telly into a games
.24

FEATURES

PROJECTS

INFORMATION

RNATIONAL
DITIONS

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Acting Editor

) Anton Kriegsman
Editor-in-Chief

CANADA Graham Wideman
Editor

GERMANY Udo Wittig
Editor

ABC

EDITORIAL AND ADVERTISEMENT OFFICE
145 Charing Cross Road, London WC2H 8DEE. Telephone 01 437 1002/3/4/5

Ron Harris, B.Sc	Editor
Ian Graham B.Sc.	Editorial Assistant
Diego M. Rincon	Art Director
Dee Camilleri	Production
Paul Edwards, Tony Strakas	Technical Illustrators
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Ray Marston	Project Editor
Keith Brindley, John Fitzgerald	Project Engineer
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GMT ELECTRONICS

(A DIVISION OF GOTHIC ELECTRONIC COMPONENTS LTD)

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Birmingham B19 3JR

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CAPACITORS

Electrolytic Axial Leads — Order Code: Cap 015 + µF + V d.c.
−10% to +50% Tol

µF	V d.c. 16	25	40	63
1.0				8
1.5				8
2.2				8
3.3				8
4.7				8
6.8			8	9
10		7		9
15	7		8	10
22		7		12
33	7		8	
47		7	10	12
68	8			
100		8	12	
150	8	9		29
220	12		24	34
330			28	37
470		21	30	44
680	19	28	36	50
1000	23	28	55	
1500	32	36		
2200	39			

Tantalum Bead — Order Code: Cap PR + µF + Volts
20% Tol.

µF	V d.c. 3.15	6.3	10	16	25	35
0.1						9
0.15						9
0.22						9
0.33						9
0.47						9
0.68						9
1						9
1.5						10
2.2				9		11
3.3				9	11	14
4.7				10	14	15
6.8		9		11	15	6
10		10	11	14	16	20
15		11	14	15	20	
22	11	14		16		
33		15	16	20		
47		16	20			
68	16	20				
100	20					

Electrolytic Can Type — Order Code: Cap HR + µF + Volts
High Ripple, IEC Grade 1, Low E.S.R.
Supplied complete with Vertical Fixing Clip

µF	V	Ripple 1A @ 85°C	1.4A @ 50°C	Price
2200 µF	16V			166
4700 µF	16V	2.6A	3.6A	184
10000 µF	16V	5.8A	8.1A	222
22000 µF	16V	9.8A	13.7A	346
2200 µF	25V	1.3A	1.8A	175
4700 µF	25V	4.6A	6.4A	201
10000 µF	25V	8.0A	11.2A	264
22000 µF	25V	12.8A	17.9A	438
1000 µF	40V	0.9A	1.2A	168
2200 µF	40V	2.4A	3.3A	188
4700 µF	40V	5.6A	7.8A	231
10000 µF	40V	9.2A	12.8A	367
1000 µF	70V	1.8A	2.5A	190
2200 µF	70V	4.0A	5.6A	235
4700 µF	70V	7.5A	10.5A	376
1000 µF	100V	4.0A	5.6A	222
2200 µF	100V	7.8A	10.9A	346

Electrolytic Radial Leads — Order Code: Cap 034 + µF + Volts
−10% to +50% Tol.

µF	V d.c. 6.3	10	16	25	35	40	50	63
47								6
.68								6
1.0								6
1.5								6
2.2								6
3.3								6
4.7						6		7
6.8				6			7	8
10			6			7		8
15			6	7			8	10
22		6	7			8	10	
33			7	8		10		
47		7	8		10			
68			8	10				
100		8	10					
150		10						
220	10							

Miniature Low Value — Order Code
Polystyrene, Axial, ±1% Tol., ≥ 63V D.C. Wkg — Cap 424
Ceramic Plate, Radial, Low K, 1.8pF–8.2pF ±.25pF Tol; 10-330pF ±2% Tol, 100V D.C. Wkg — Cap 632
Ceramic Plate, Radial, Med K, ±10% Tol, 100V D.C. Wkg — Cap 630
Ceramic Plate, Radial, High K, −20% to +80% Tol, 63V D.C. Wkg — Cap 629
+ Value

pF	424	632	630	629
1				
1.2				
1.5				
1.8		5		
2.2		5		
2.7		5		
3.3		5		
3.9		5		
4.7		5		
5.6		5		
6.8		5		
8.2		5		
10		5		
12		5		
15		5		
18		5		
22		5		
27		5		
33		5		
39		5		
47		5		
56		6		
68		6		
82		6		

pF	424	632	630	629
100	16	6		
120	16	8		
150	16	8		
180	16	6		
220	16	6		
270	18	8		
330	18	8		
390	18		5	
470	18		5	
560	16		5	
680	16		5	
820	16		5	
1000	16		5	5
1200	16		5	
1500	18		6	
1800	18		6	
2200	18		6	6
2700	18		6	
3300	18		6	
3900	18		6	
4700	23		7	6
5600	23			
6800	23			
8200	23			

nF	424	632	630	629
10	25			6
12	26			
15	26			
18	27			
22	28			8
27	38			
33	41			
39	43			

Polyester Radial Leads — Order Code
Dipped Type, ±20% Tol, ≥ 250V D.C. Wkg. C280/352 Style — Cap 352
Moulded Type, ±10% Tol, ≥100V D.C. Wkg. 10.2mm Pitch Centres — Cap 360
Moulded Type, ±10% Tol; ≥100V D.C. Wkg. 7.6mm Pitch Centres — Cap PHE280
+ Value

µF	352	360	PHE280
.001		5	6
.0015		5	6
.0022	5	6	7
.0033	5	6	7
.0047	5	6	7
.0068	5	6	7
.01	5	6	7
.015	5	7	8
.022	5	7	8
.033	5	7	8
.047	5	7	8
.068	6	8	9
.1	6	8	9
.15	7	9	
.22	8	10	
.33	10		
.47	12		
.68	15		
1.0	19		
1.5	27		
2.2	32		

Trimmers — 250V D.C. Wkg, Film Dielectric, Miniature

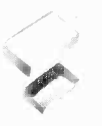
	Price	Order Code
1.4 – 4.1pF	19	Cap 808 A
2 – 8pF	19	Cap 808 B
2 – 20pF	21	Cap 808 C
5.5 – 59.5pF	29	Cap 808 D

500V D.C. Wkg C004 EA Tubular Type

	Price	Order Code
.8 – 3.8pF	46	Cap 802 3
.8 – 6.8pF	48	Cap 802 6
1 – 13pF	61	Cap 802 12
1.7 – 19.7	62	Cap 802 18

CASES

Small Desk Console — Boss Industrial Mouldings
Slope Front Console, Recessed Top
ABS Base, C W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey

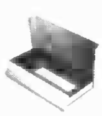


		Order Code
W161, D96, H39 (57)	186	Case BIM1005 OR
W215, D130, H47 (73)	268	Case BIM1006 OR

Plastic Boxes — Boss Industrial Mouldings
Moulded Box and Close Fitting Flanged Lid
ABS Box, C W Brass Bushes, and Lid In Orange

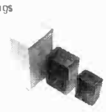
		Order Code
L112 W62 D31	87	Case BIM2003 OR
L150 W80 D50	115	Case BIM2005 OR
L190 W110 D60	195	Case BIM2006 OR

Instrument Case — Boss Industrial Mouldings
Covers Manufactured from 14SWG Aluminium
Chassis Manufactured from 18SWG Mild Steel
Covers Finished Orange
Chassis Finished Matt Black



		Order Code
W250 D167.5 H 68.5 (Chassis 153mm Deep)	1480	Case BIM3000 OR

Plastic Boxes with Metal Lids — Boss Industrial Mouldings
Recessed Top Box
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey



		Order Code
L85 W56 D29	97	Case BIM4003 OR
L111 W71 D42	130	Case BIM4004 OR
L161 W96 D53	182	Case BIM4005 OR

Diecast Boxes — Boss Industrial Mouldings
Diecast Box and Flanged Lid
Aluminium Box and Lid in Natural Finish

		Order Code
L113 W63 D31	104	Case BIM5003 NA
L152 W82 D50	181	Case BIM5005 NA
L192 W113 D61	280	Case BIM5006 NA

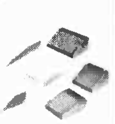
VERO ELECTRONICS PRODUCTS

2.5" x 5" .1" pitch Veroboard	59	VERO 21069J
3.75" x 5" .1" pitch Veroboard	66	VERO 21072D
2.5" x 1" .1" pitch Veroboard (5)	70/Pack	VERO 21076C
3.75" x 5" .1" pitch Plain Board	56	VERO 21078E
5.82" x 2.9" 1" pitch V-Q DIP Board	111	VERO 21084E
Spot Face Cutter	89	VERO 21013A
Pin Insertion Tool for .040 type pin	122	VERO 21015F
DS Pins .040 (100)	38/Pack	VERO 21087G
SS Pins .040 (100)	38/Pack	VERO 21017B
6mm Board Standoff (100)	181/Pack	VERO 21321K
15mm Board Standoff (100)	215/Pack	VERO 21322G
19mm Board Standoff (100)	226/Pack	VERO 21323D
Verowire Kit (1-pen, 2-wire, 25-comb)	375/Kit	VERO 21341D
Verowire Combs (100)	407/Pack	VERO 21339F
Verowire Wire (4)	228/Pack	VERO 21340G
Flip Top Box, Small, Black	192	VERO 21317D
Flip Top Box, Large, Black	250	VERO 21319J

Small Desk Consoles — Boss Industrial Mouldings
Slope Front Console, Recessed Top
ABS Base, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel Finished Grey
Ventilation Slots In Base

		Order Code
W105 D143 H32 (56)	206	Case BIM6005 OR
W170 D143 H32 (56)	271	Case BIM6006 OR
W170 D214 H32 (82)	375	Case BIM6007 OR

All Metal Desk Consoles — Boss Industrial Mouldings
Slope Front Console, Recessed Top
Two Piece All Aluminium Construction
Ventilation Slots In Rear and Base
Choice of 15° or 30° Sloping Front
Off White Top Panel, Blue Base



		Order Code
W102 D140 H28 (51) 15° slope	1018	Case BIM7151A
W165 D211 H33 (76) 15° slope	1350	Case BIM7154A
W254 D287 H33 (76) 15° slope	1572	Case BIM7156A
W356 D287 H33 (76) 15° slope	1823	Case BIM7158A
W102 D140 H28 (76) 30° slope	1018	Case BIM7301A
W165 D183 H28 (102) 30° slope	1202	Case BIM7303A
W254 D259 H28 (102) 30° slope	1572	Case BIM7306A
W356 D259 H28 (102) 30° slope	1823	Case BIM7308A

Eurocard Size Desk Console — Boss Industrial Mouldings
Slope Front Console
ABS Case, C/W Brass Bushes, In Orange
1mm Aluminium Top Panel, Finished Grey

		Order Code
W169 D127 H45 (70)	375	Case BIM8006 OR

HARDWARE

D.I.L. Sockets

		Order Code
8 Pin Low Profile Socket Tin	11	DIL SKT 8
14 Pin Low Profile Socket Tin	13	DIL SKT 14
16 Pin Low Profile Socket Tin	14	DIL SKT 16
24 Pin Low Profile Socket Gold	66	DIL SKT 24
28 Pin Low Profile Socket Gold	78	DIL SKT 28
40 Pin Low Profile Socket Gold	127	DIL SKT 40

Heatsinks

Individual Type for 1 x T05 50°C/W	10	Sink 5F
Individual Type for 1 x T066 10.5°C/W	26	Sink TV2
Individual Type for 1 x T03 7.2°C/W	24	Sink TV3
Individual Type for 1 x T0126 17°C/W	23	Sink TV4
Individual Type for 1 x T0220 17°C/W	23	Sink TV5

P.C.B. Components

Dalo Pen, Blue Ink, Slow Drying	92	Pen 33PC

Fuseholders
Suit 20mm x 5mm fuses.

P.C.B. Mounting, Open Type	8	Fuse/H20B
Chassis Mounting, Open Type	17	Fuse/H20C
Panel Mounting, Screwdriver Slot	77	Fuse/H20PT
Panel Mounting, Finger Release	56	Fuse/H20P

Fuses
20mm x 5mm Glass.

Quick Blow, Range 100mA–5A	8	Fuse 20
Slow Blow, Range 250mA–5A	22	A/S Fuse 20

+ Rating

Lampholders, Panel Mounting
Similar In Style to Fuse/H 20P
Low Voltage Type Suits LES and M/F Bulbs.

Low Voltage, Red, Amber or Green	75	Lamp LV
Internal Neon 200/240V Red or Amber	95	Lamp N

+ Colour

Bulbs, Low Voltage, L.E.S.

6V, 0.36W; 6.5V, 1W; 14V, 0.75W	22	Bulb LES

+ Voltage

RESISTORS

Carbon Film, Fixed — Order Code

0.25W, E24 Values IRO 10M, 5% Tol.	1.5 ea.	90p/100 (Mult 10/Value)	£7.90/1000 (Mult 100/Value)	Res RD¼
0.5W, E12 Values IRO-4M7, 10% Tol.	2 ea.	1,25p/100 (Mult 10/Value)	£10.10/1000 (Mult 100/Value)	Res RD½

+ Value

Metal Film, Fixed

0.5W, E24 Values, SRI-IM, 2% Tol.	6 ea.	3.80/100 (Mult 10/Value)	£32.40/1000 (Mult 100/Value)	Res MR30
2.5W, E12 Values 10R-27K, 5% Tol.	13 ea.	7.90/100 (Mult 10/Value)		Res PR52

+ Value

Metal Glaze, Fixed

0.5W, E24 Values, IM-33M, 5% Tol.	10 ea.	5.40/100 (Mult 10/Value)	Res VR37

+ Value

Skeleton Presets, Miniature — Order Code

0.1W, E3 Values, 100R-IM, Lin. Vertical Mounting	7	Min Preset V
0.1W, E3 Values, 100R-IM, Lin. Horizontal Mounting	7	Min Preset H

+ Value

Skeleton Presets, Standard

0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting	10	Std Preset V
0.3W, E3 Values, 100R-4M7, Lin. Horizontal Mounting	10	Std Preset H

+ Value

Potentiometer, Rotary

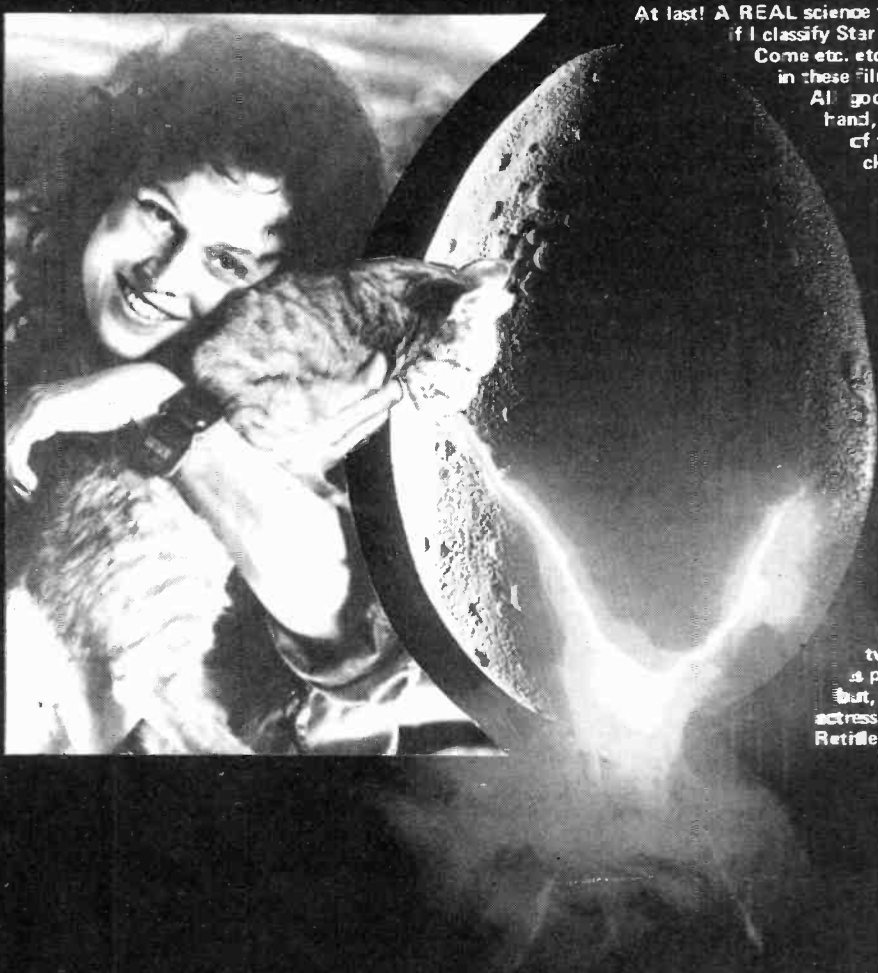
0.5W, E3 Values, 1K-2M2 Lin.	34	Pot Lin
0.25W, E3 Values, 4K7-2M2 Log.	34	Pot Log

+ Value

DIGEST

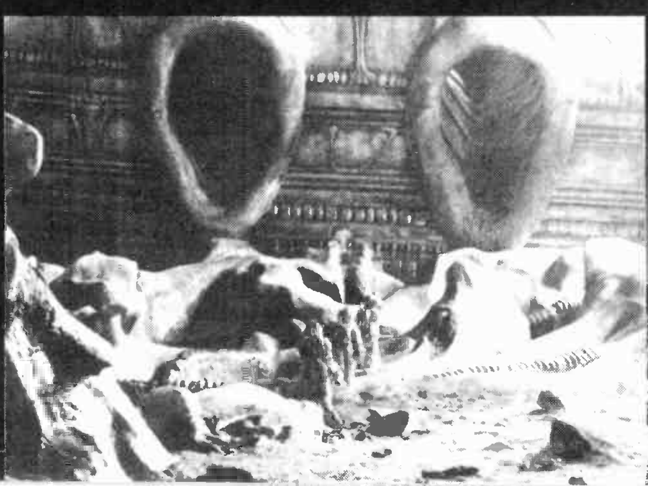
A L I E N

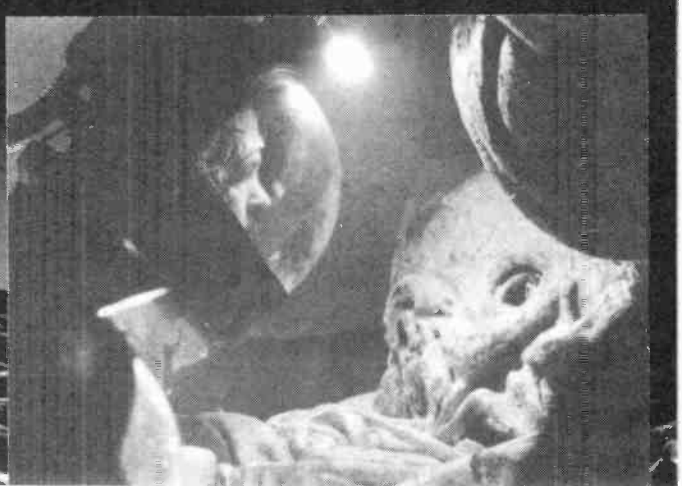
Cert X Running Time — 1hr 56min.



At last! A REAL science fiction film. Sci-fi fans will know what I mean if I classify Star Wars, Battlestar Galactica, Shape of Things to Come etc. etc. as enjoyable space opera. The special effects in these films are practically the story-line in themselves! All good fun but not serious SF. Alien on the other hand, whilest boasting special effects as good as any of the aforementioned works, is primarily a cracking good sci-fi story which uses the effects in the same way a good play uses stage props. An aid to the story, but not as the main attraction. It is giving nothing away to tell you that the story concerns an interstellar towing vehicle (?), returning home with an unbelievable amount of minerals, which is diverted to investigate a non-human distress call. Things naturally go wrong and the alien creature gets loose on the ship. As a horror/thriller Alien is unrivalled and as a sci-fi film it is first rate. I would advise any addicts of the genre to read the book first, however, it won't spoil the shocks at all and there are gaps in the film (which will only bother sci-fi fanatics) from leaving too much on the cutting room floor I think. It could be an hour longer without ever being in danger of being boring and the extra detail would be welcome. There is one more excellent reason for seeing Alien — Sigourney Weaver. Being chased around a starship by a thing with two sets of dentures and a taste for human flesh is perhaps not the best way to make your film debut, but she manages beautifully. The lady is a fine actress — and extremely attractive.
Retitle — "Beauty And the Beast"?

In space no one can hear you scream.





CHROMATHEQUE 5000

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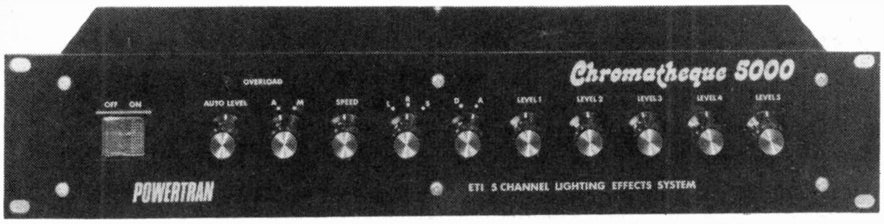


Panel size 19.0" x 3.5". Depth 7.3"

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

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

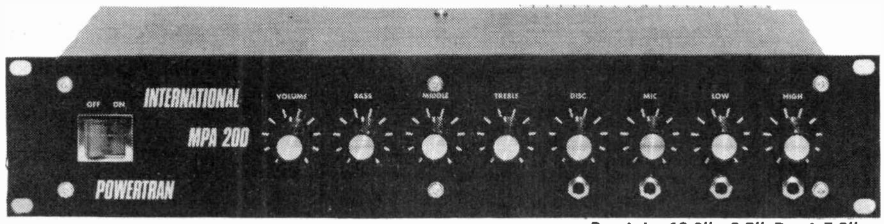
MPA 200 100 WATT (rms into 8Ω) MIXER/AMPLIFIER

COMPLETE KIT

ONLY

£49.90 + VAT!

MATCHES THE CHROMATHEQUE 5000 PERFECTLY!



Panel size 19.0" x 3.5". Depth 7.3"

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features adaptable input mixer which accepts a wider range of sources such as microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 2000 is simplicity itself with minimal wiring needed making construction very straightforward.
The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.

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

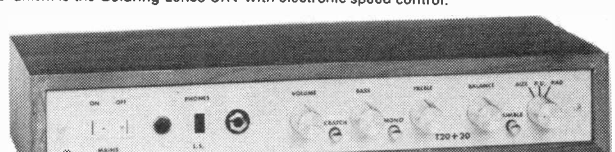
This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in H-Fi News and Record Review and features include rumble filter, 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.



T20+20 20W STEREO AMPLIFIER £33.10+VAT

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

MATCHING TUNERS — SEE OUR FREE CATALOGUE!

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 (last 4 kits on this page), or professional quality rack mounting cabinet (first 2 kits on this page), cables, nuts, bolts, etc., and full instructions — in fact everything!

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

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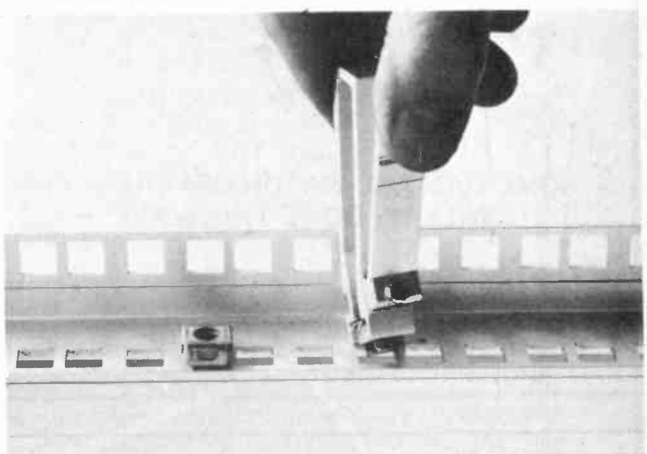
C-MORE EASILY

How's your car battery standing up to all the motoring projects you built from the September issue of ETI? Thinking of buying a battery charge gauge, but the fitting and wiring puts you off?

The C-More vehicle charge monitor is compact (fits on top the dash), easily installed (sits on adhesive pads) and can be read and understood at a glance (light bar display). There are only two wire connections to be made to the car.

The unit compares the battery circuit voltage to reference voltages and presents the result as coloured bars. If the yellow part of the display is as bright as, or brighter than, the red, you have a healthy battery. All this *and* a 12 month guarantee!

The C-More charge monitor is made by Harvelec, 1 Formby Avenue, Thatto Heath, St. Helens, Merseyside WA10 3NW.



CAGED NUTS?

Vero's unique insertion tool comes to the rescue of your caged nuts (or you can have them seen to on the National Health).

Vero claim that the tool can save up to 50% in the time taken to assemble 19in racks, cabinets and enclosures. It is designed to be used with caged nuts to fit a standard 9.5mm square aperture.

The caged nut insertion (and extraction) tool is £2.67 from Vero Electronics Ltd, Industrial Estate, Chandler's Ford, Eastleigh, Hampshire SO5 3ZR.

SEIKO Calculator Watch

Never be without an abacus again — wear it on your wrist! We were swamped with orders for the Seiko memory bank calendar watch we offered in September. So, by popular request, here we are again with yet another exclusive, unbeatable bargain offer. No, your eyes don't deceive you. It's a super Seiko combined watch and calculator for only £96.20. So, as you're strap-hanging your way home, you can work out that you've just saved 46% on your new Seiko calculator watch. Your local timepiece emporium, selling it at full price, will cut your balance down to the tune of (are you sitting down) £178.20. You'll have noticed by now that the keys on the calculator bit are somewhat diddier than the normal run-of-the-mill puddy pushers. Seiko have thought of that. At no extra cost whatsoever you get a free, gratis pointy bit of metal (they call it a stylus) to bash the buttons. In addition to the usual four functions, the calculator has percentage, square root, memory + and memory — facilities. All for only £96.20.

ETI Reader Offer £96·20

Save £82

SOME DAY ALL WATCH OFFERS WILL BE DONE THIS WAY!

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I enclose cheque/P.O. for £96.20 payable to ETI for ONE Seiko Calculator Watch.

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. . . .

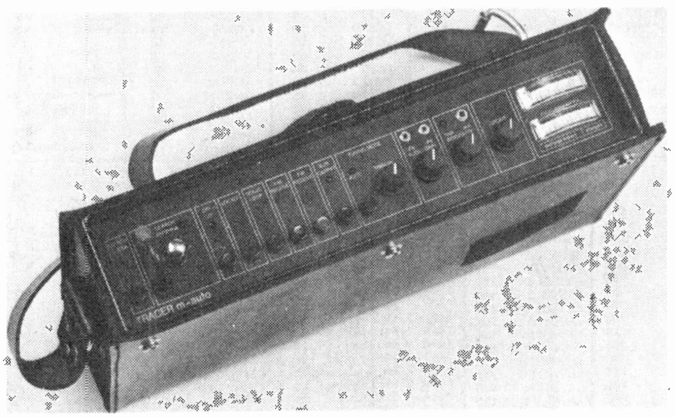
SICK MOTOR?

The AA says that 7 out of 10 of us are still not having our cars tuned. Slapped wrists all round. If we all chugged off to the car hospital and came out ship shape and piston fashion (sorry, I couldn't resist that) we'd save around 800 million gallons of petrol every year.

If you'd like to repent, you might not even have to take the car to the garage soon. Autrac Computerised Tuning Ltd is a mobile service using vans with an on-board computer to check the state of tune and condition of a car's engine and electrics. Each 'Total Health Check' covers 80 different tests and provides the motorist with a computer print out of the results. A VDU also shows the driver how the tests are progressing.'

Cost to you and I? The average price of a full check and tune-up, complete with replacement parts (plugs, points, etc) should be around £20 incl VAT. That's about £12.50 for an Escort and £17.50 for a Rover 3500 plus parts and VAT.

For further information contact Zockoll Group Ltd, Zockoll House, 143 Maple Road, Surbiton, Surrey KT6 4BJ.



GOT BUGS?

No, not creepy crawlies. I'm talking about electronic eavesdroppers. Want to get rid of them? Now you don't have to enlist the special skills of the professional counter-espionnage men with their radio experts.

The Tracer M-Auto is a new unit designed to be used by your company's own personnel. It is a scanning radio receiver which activates any bugs in the woodwork and warns of their presence. It will even detect the latest sophisticated sub-carrier devices. Moreover, bugs 'hiding' near strong public broadcasts can be rooted out by the Tracer, which can also be left on stand-by during meetings. An accessory is available to search for hard-wired devices. No technical skill is required to operate the unit.

All you budding 007's can find out more about the Tracer M-Auto bug basher from Bonaventure International (Security) Ltd, Bonaventure House, 18/21 Jermyn Street, London SW1Y 6HN.

TELLY-TOT

The first offspring from the Hitachi-GEC marriage is to be a 20 teletext receiver for the UK market. The set has full remote control.

Also available is its first 22 model, with earphone socket and tape socket for recording sound. You can also play back video tape on any of the set's channel selectors.

TECHNICAL QUERIES

We regret that as of this issue ETI cannot accept any more telephone technical enquiries. This is entirely due to the amount of pressure being placed upon the technical staff in attempting to run this service. We have kept going for the last year-just-in the face of mounting adversity but cannot do so any longer.

In future therefore all questions concerning articles (especially projects) MUST be sent to us by post enclosing an SAE if you want a reply (some people don't!) Address your envelopes to our Editorial offices, and mark the envelope TECHNICAL ENQUIRY.

We apologise for any inconvience this may cause and will do our best to make the postal service as rapid a turnround as we can.

CALLING ALL K9s, R2D2s, ROBBIES, C3POs, MICROMICE etc, etc.....

ETI is very keen in getting a robot dialogue going.

Anyone out there on the other side of the printers ink interested in robotics, especially anyone actually building robots - of WHATEVER complexity - should contact us here at ETI.

If possible how about some photographs of your machines? They may well be in line for an appearence in ETI. So come on, lets be hearing from you - ALL of you - take pen in hand (or get the robot to do it) and write to

The Editor,
ETI Magazine,
145 Charing Cross Road,
London WC2.
Mark your envelope "ROBOTS"

So we can deal with it with our usual machine - like efficiency.

SOLAIR CELLS

Within the next few months the construction of a 283 kW solar cell plant will begin at Phoenix Sky Harbour International Airport in Arizona, USA (Unusual Solar Applications?)

Thirty large arrays of 7,200 photovoltaic concentrators are being supplied by Motorola. Each of the modules, 30in in diameter and 11in deep, is designed to concentrate energy equivalent to 70 times that of the Sun onto a three inch silicon solar cell. Motorola is also supplying a master control system to regulate the output power, steer the arrays and acquire data.

Power from the new solar plant will supply the needs of roughly half of the new airport terminal building.

If you're thinking of knocking up something similar for your back garden you'll need to be able to pick up the bill of about £3.25 million.

STEVENSON CAT

We've now received a copy of Stevenson's new catalogue — an attractive little volume, covering everything from A/D converters to zener diodes.

The comprehensive index covers components, cases, tools and cables. There's even a seven page section packed with books.

The semiconductor section includes data on transistor packages and pin-outs, IC pinouts and even a few suggested circuits.

You can get this new 80 page catalogue FREE from Stevenson, 76 College Road, Bromley, Kent BR1 3BR.

TORCH FINDER

There is an error in the circuit diagram of the Torch Finder (Top Projects No.7). The connection between the battery negative, ie IC1 pin 4, and LED1 should be deleted. The LED should be connected between IC1 pin 8 and pin 6. My thanks to Mr Massey of Boston, Lincolnshire for pointing out this error.

HEADPHONE AMP

We've had a few calls about the headphone amplifier project in the May edition of ETI. If you're having problems, try this — insert a 330k resistor between C6 and the phono pin of SW1a. Put another 330k resistor between C13 and the phono pin of SW1b. Isolate the output sockets from the metal case, because they are referenced to 11 volts. Hence, the chassis symbol on the right and left outputs is wrong. On the component overlay, take the mains earth to the transformer case, not the PCB track.

MOTOR SPEED CONTROLLER (July)

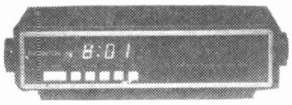
A resistor was omitted from the circuit diagram. Let's call it R15 (why not?). R15, then goes from IC4 pin 2 to the OV line, ie in parallel with C5. Its value? — 2M2.

RADAR ROOSTER

If you go down to the woods today you're in for a big surprise, 'cos somewhere in Middlesex a man in a white coat is putting the final touches to Dr Who's new sidekick — Mighty Chick. Seen here with its beak open in the baddy-zapping mode, the phenomenal phoul's phinger-licking good drumsticks will be phunctional just as soon as our man in the white coat has completed the vital task of tensioning the powerful poultry's nuts.

Now do you want the true story? It's the new AGA Speckter radar reflector, designed for use principally on light buoys. The 360° cluster of six interlocking aluminium units offers an echo area of about 170 m2 from the 600 mm diameter unit. A lantern weighing up to 110 kg can be put on top. You can get more information on the SR66 from AGA Navigational Aids Ltd, Beacon Works, Brentford, Middlesex TW8 0AB.

DIGITAL CLOCK RADIO



Mains. AM/FM/LW radio. Green digital display. Snooze alarm. Auto switch off. Clock dimmer External FM Aerial.

£19.95

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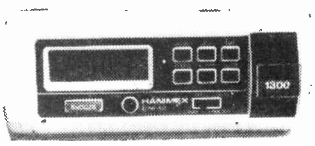
M40

Portable LCD Clock Radio

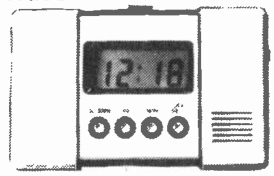


* Back-light.
* Batteries supplied free.
* Quartz crystal controlled.

£17.95

M41

DIGITAL CLOCK LCD Travel

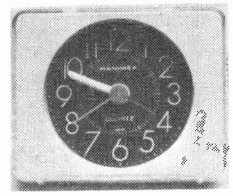


Hours, mins. 24 hour time and Alarm. Snooze timer. Large 12.5mm display. Night light. Size. 120mm x 74mm x 19mm.
Weight. 120 grams.

£17.65

M42

QUARTZ ANALOGUE CLOCK TRAVEL

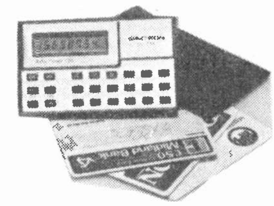


Mini Quartz Alarm clock. Complete with travel pouch. Features loud alarm and operates from 1½ volt battery.

£9.95

M43

LCD Calculator

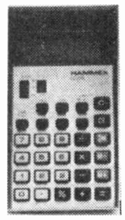


Credit Card size
Memory % ect plus auto power off

£7.95

M44

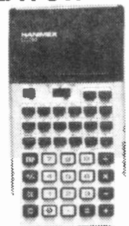
Digital Clock/Alarm/Calculator/Stopwatch



Calculator with % and memory. Continuous clock with hours, mins., secs., day, month, day of week, Alarm, Stopwatch, split-time. 1 year battery. Leatherette wallet.

£17.95 **M45**

LCD CALCULATOR SCIENTIFIC



8-digit mantissa, 2-digit exponent electronic calculator on one single chip.

Functions-SIN, COS, TAN, SIN-1, COS-1, Tan-1, SINH, COSH, TANH, e^x, 10^x, Ln, Log, Y^x, 1/x.
Statistical functions

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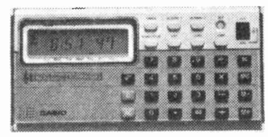
LCD CALCULATOR CASIO MELODY 80

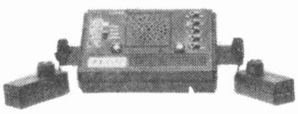


Full calculator spec 3 independent musical alarms time, stop-watch, count-down timer

£23.95

M47

TV GAMES



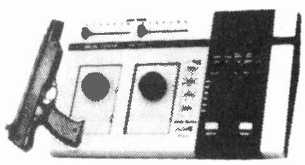
Black & White or Colour
4 game, 2 ball speed, 2 ball angles, 2 battery sizes. Tennis, Hockey, Football, Handball, Practice

£11.95 Colour
£8.95 B/W

plus 54p Post & Packing

M48

TV GAME WITH GUN



Colour. 6 games. Moving target, Football, Target, Tennis, Squash, Practice. Battery or main.

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plus £1 25 Post & Packing.

M49

AIR FRESHENER Electronic

Timer can be set to emit nice smells when required or running permanently to remove really bad smells. Battery operated.

Price £4.95

M50

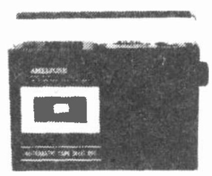
DIGITAL CLOCK

LED Display,
Features Hours/mins.
Display Alarm with snooze.
Mains operated excellent value for money. Compact size only 6 in x 2½in x 3 in.

£6.95

M51

RADIO/CASSETTE 3-Band/LW-MW-FM



Auto stop DC6V. AC Power 220V Built-in condenser microphone High power output

M52

RADIO/CASSETTE 1-Band/MW

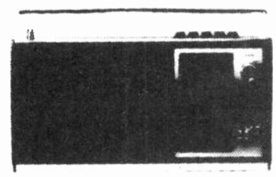
Condensor microphone. Battery or AC. Pushbutton key operation. Auto level control Retractable handle. Eject equipment

£17.95

plus £2.00 Post & Packing

M53

MAINS/BATTERY Portable Radio



4 Bands, LW/MW/SW/FM. Teak finish case.

£19.95

plus 85p Post & Packing

M54

AIRCRAFT RADIO

AM/FM.
Receives Police/Aircraft frequencies
Battery operation. Retractable aerial.

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M55

RADIO CONTROLLED CAR

Formula One Racer
4 function, forward, reverse, steering left to right
No wires, remote control

£19.95 **M56**

MODEL CAR RADIO

Scale model car incorporating single band radio. Excellent quality sound with clever design of controls incorporated in the car components.

£5.95 **M57**

ELECTRIC CAR AERIAL

Sonix automatic motor antenna. 5 sections. One meter in length. Excellent value at

£10.95 **M58**

CAR RADIO/CASSETTE

2 band car radio/stereo cassette player. Long and Medium waveband coverage. Rotary controls for on-off/volume, tone, balance and tuning. Push-button control for cassette eject and fast forward wind Output 2×3 Watts (music) 12 volts.

£34.95 **M59**

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RADIO IN CONTROL

Thinking of building a radio control system? How many channels do you need for your model? What sort of model is it best to start with? Where do you get your licence from? Geoff Chapman leads you through the R/C jungle.

YOU HAVE PROBABLY at some time watched a radio controlled model, the pilot gracefully landing his aircraft after a perfect flight at exactly the right spot or the helmsman taking his boat on a chosen course, or the driver taking his car around a difficult track. Ability of this nature does not come overnight but with time, devotion and practice.

Firstly, let's look at the equipment. In proportional control the movement of the remote output device (a servo) follows in strict proportion to the movement of the transmitter control, usually a joystick. This type of control is a must for all but the crudest system. The radio link part of the system must be 100% reliable, the choice of AM or FM is one of personal preference rather than actual performance. It is, however, convenient to be able to change the radio frequency of the system, usually by plug-in crystals, so that several models may be operated in one location each having its own radio frequency denoted by the colour of the pennant on the transmitter arerial.

A superior quality radio system (the Strato Transmitter and Receiver), incorporating the above features, has been described in the May and June issues of ETI, giving full details for the home constructor. Now let's discuss the Servo and what follows to control the model.

Prime Mover

Servos typically consist of a high quality electric motor, prime mover, a train of gears, to step up the available thrust and drive the feedback device, usually a pot, and an amplifier, usually a special purpose IC plus a few discreets to convert the input signal to a useful power sufficient to drive the motor. The physical output of the servo may be either semi rotary 80-90 degrees travel total, multi turn rotary as for a winch or linear motion of approximately 12 mm total travel, Servos are available both in kit and ready-made forms. Their power requirements are normally supplied from the receiver battery except in the case of heavy duty servos where a separate battery may be required.

The mechanical connection to the servo may be by one of the devices featured here and the thrust transmitted to the control point by push rod or if straight line operation is not possible, by Bowden cable or nylon snake. Whichever system is used, careful planning of the installation is essential so that adjustments can be easily made and geometric errors are avoided. The linkage must be free but not sloppy and, most important, neither lock in any operating position nor reach a solid stop at either end of travel otherwise if the servo is left in this position, stalled, for any length of time it would drain the battery sufficient to cause intermittent failure of the remote system. Remember the receiver is connected to the same battery.

Rotary or Linear

Most semi rotary servos have an output device which is symmetrical on at least one axis with a series of holes at various radii to give a choice of travel dimension and thrust and whilst one not only gets linear motion there is a certain amount of unwanted sideways movement also, which when operating distances between servo and control point are short say, 100 mm or less can be very noticeable and cause jamming against adjacent surfaces. Linear output servos avoid this problem but neither their travel nor therefore their thrust can be adjusted. The Fleet servo recommended with the Strato system comes as standard with both semi rotary and linear output types of device so that either may be fitted.

R/C Pig Tails

Sometimes it becomes necessary to manufacture a piece of linkage, say an extension to a servo arm to increase the travel beyond that which the servo normally gives. When doing so ensure that a non-conducting material is used (fibre glass PCB with the copper removed is ideal). In any situation metal to metal moving connections must be avoided at all cost once modern model receivers' sensitivity is such that this can cause interference of sufficient level to be decoded and cause the servos to twitch. If metal to metal connection cannot be avoided then a flexible pig tail conductor should be bonded to the two metal parts in question.

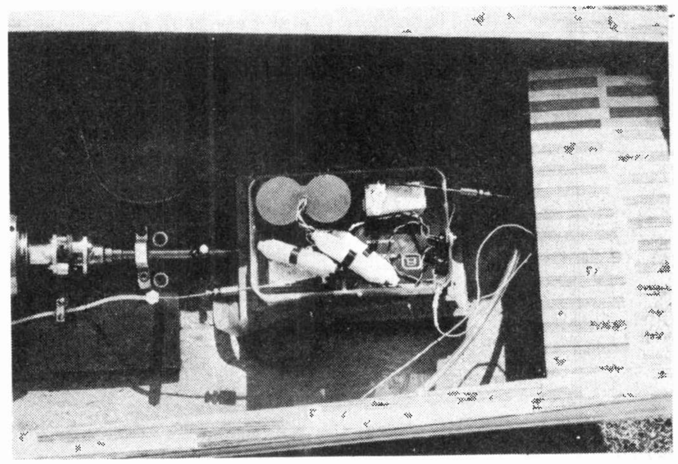
In planning an installation the semi-complete model and radio equipment should be available so that a trial run may be carried out before any part is fixed in permanently. At this time the servo travel required should be determined as well as ascertaining that the direction of travel matches the control stick direction and axis — left, right, up, down, fast, slow, etc. Reversal of servo direction of travel may most simply be carried out by transferring the pushrod from one side of the output device to the other, or it may be electrically carried out by reversing the motor and end connections of the pot.

Front Heavy Crashes

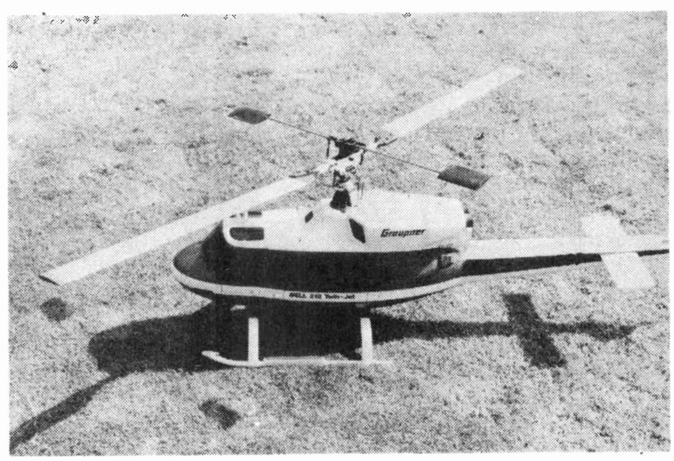
In general, installation cannot follow any standard pattern since it is dictated by the form of the model. In models which are known to travel at speeds in excess of 5 mph it is worthwhile trying to arrange the layout so that the equipment is placed in order of descending mass from front to rear so that, in the event of an abrupt stop in the direction of travel, the lighter and generally weaker pieces collide with the heavier pieces in front of them.

An installation the writer has found effective for use in model power boats, where the general layout of all models is similar, namely engine amidships and rudder astern, is a set of equipment permanently installed in a rigid plastic lunch box with an air/water tight lid. The receiver batteries and two servos are installed in the box and short screw adaptors fitted to the servo outputs protruding from diagonally opposite corners. Each boat is then fitted with pushrods of appropriate length to engine throttle and rudder terminating with matching male threads and lock nuts. Thus the box can be transferred from model to model in a few minutes even at the pond side. The box sits on a pad of ½'' foam rubber (never use plastic) and held down with moderate force by 2 crossed over elastic bands. It should be noted ▶

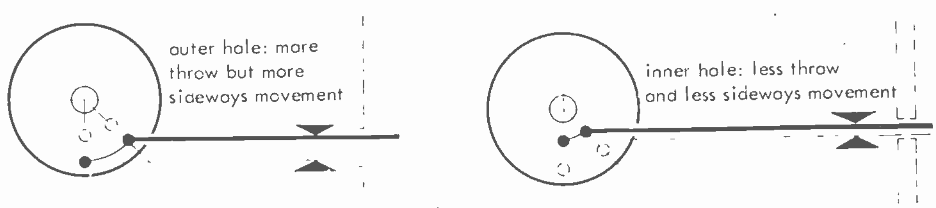
The impressive 60 inch Chris Craft cruiser.



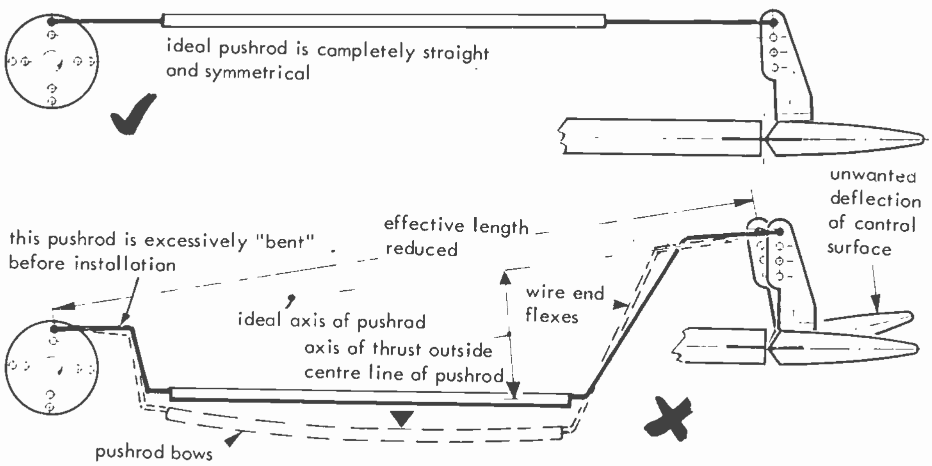
The Chris Craft cruiser is fitted with a 15cc 4-stroke petrol engine. The radio control unit is housed in a plastic lunch box.



A radio control model helicopter — not for beginners!

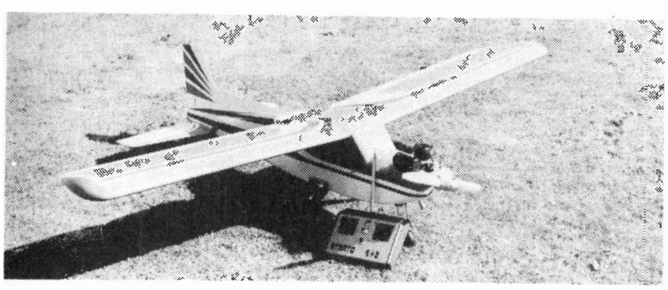


When using a rotary servo with a push-rod, allow for sideways movement when mounting the servo in a tight spot.



The ideal pushrod (top) is straight. Moral: beware of bendy pushrods.

The Marble Head 50 inch yacht has a radio winch and rudder (above). The ideal trainer R/C model aircraft (below) — the 'Super Sixty.'



that the on/off switch is always fitted to a vertical face of the box to prevent water lying on the surface of the switch and the aerial is taken from a hole on the vertical face also.

The aerial location must be given some thought at the time of equipment installation. In general one wants to position it away from the machinery as far as possible. On aircraft, the aerial may most conveniently take the form of a stranded wire which emanates from the fuselage somewhere near the wing centre and attaches to the fin, keeping taught by a looped elastic band held in place by a glass headed pin. On boats, a stern sighted whip aerial of 20 gauge piano wire with a simple screw on fixing at the deck and non-eyecatching loop formed at the other makes a practical arrangement.

Protection Racket

At the planning of installation stage consideration must be given to protecting the equipment from both vibration and impact loading in the event of a crash. Servos come with this feature built-in in the form of rubber grommets inserted in their fixing lugs, which, providing all screws are fitted and not tightened excessively, is adequate protection. The receiver, possibly the most delicate piece of the equipment, should be packed completely in at least ½'' thick sponge rubber (not plastic) or alternatively, inside a foam rubber tube now available from model shops. It is also worthwhile making sure that the batteries, the heaviest part of the equipment, are either similarly packed or securely anchored so that in the event of impact they cannot fly around and cause damage to more vulnerable pieces of the equipment or the model itself.

So much for generalities. We now consider the various types of models broadly and point out features of which the newcomer may not be readily aware. Table 1 shows various types of model. It descends in order of skill required to operate together with their environmental nasties. By 'skill to operate' we mean simply the ability to control safely and bring home in one piece!

Buddy Box

This is a useful feature of the Strato system in that two transmitters can be coupled together so that the command may be transferred from one transmitter to the

TABLE 1

Model Type	No. Servos	Comment
Helicopter	Four	Much mechanical skill required to install the R/C equipment. Subject to much vibration from engine. Not easy to learn to fly, buddy box required for beginners. If they crash they don't break they explode! Definitely not for the newcomer.
Scaled down full size model aircraft	Four to six depending on complexity	Very worthwhile to build if this is one's interest but not as a first model. Choice of subject endless, but all important. Generally weight is a problem particularly at tail end. R/C equipment may be subject to some vibration due to having to pack near engine.
Power model aircraft designed for R/C	Min three	The model to start with — high wing monoplane. Wing span 48"-60". Engine size 5-8cc. Gloplug with speed control. The simpler the model the better. Roomy fuselage for simpler equipment installation. Essential to be able to control engine speed from tick-over to max rpm. Elevator and either or both rudder and aileron control depending on model. Follow the kitmaker's or designer's instructions precisely.
Gliders—both towline and slope soaring	Two to four	Probably the easiest of all flying models. Wing span 60"-120". Main controls rudder and elvator; ailerons secondary. Some towline gliders have towline release servo. No vibration problems here — just have to defy gravity for as long as possible! Build accurately and carefully to designer's or kitmaker's instructions.
R/C racing cars I/C engine	Two	Some mechanical ability required to install and maintain R/C equipment. Equipment subject to severe vibration and operational stress. Must be installed inside sealed boxes to prevent the ingress of dust and dirt thrown up from the track. Probably the most punishing environment into which R/C equipment is put. A lot of fun if you are competitive by nature, having learnt to drive not so much fun operating solo.
R/C cars electric	One or two	As with above but since they can be operated indoors ie a school hall, do not pick up so much dirt. Vibration much less. Wide choice of scale subjects you may only have dreamt of owning one day.
Power boats	Two	If you are really keen on building a true scale model of a subject this is the place to start. Alternatively, a simpler semi-scale power boat gets you at the helm quicker. See recommended R/C equipment in any boat because get wet it surely will. Weight not too important.
Yachts	Two	Again an ideal beginners' subject, but one of the servos should be some form of winch to control the sail position and winches cost two to three times that of servos. Good size for portability and sailing in varying weather conditions is known as the Marblehead Class, 50" long. Fits on the car's back seat too!
Tanks, robots, spaceships & thingies	One to six	Tanks and other AFVs have their installation normally determined by the kit manufacturer, so just follow the yellow brick road. Robots and so on are for those who want to be creative together with the ability so to do.

other. This is helpful when one is learning to operate a difficult model since the tutor can give the pupil control at his instigation and take back control should the pupil be having difficulty. Husbands and wives can have fun this way too!

Slope Soaring

This is where a model glider is launched from a hillside onto the face of which a steady wind of 5-15 mph is blowing, causing an up-current of air in which the glider flies (watch seagulls soar on the cliff top).

Do's and Don'ts

Finally a few obvious do's and dont's for the newcomer to R/C modelling. Do obtain a GPO licence for your R/C equipment. It costs £2.80 for five years and is obtainable from The Home Office, Radio Regulatory Department, Waterloo Bridge House, London, SE1 8UA. In this way our numbers will swell and when the authorities are reconsidering radio frequency allocation, which they are at this time, then the more licence holders there are the more consideration we shall receive. It is also illegal to operate without a licence.

Do fly a pennant of the appropriate colour of the crystal frequency in your transmitter, eg brown — 26.995 MHz, etc.

Don't attempt to operate any model unless you know the equipment is functioning perfectly — remember all models are potentially dangerous. Initially with new equipment one should carry out a full range check at what is likely to be the greatest distance + 10 % one is going to operate. Thereafter a collapsed transmitter aerial check before each session is advised.

Do enquire of your local Sports Council representative as to his knowledge of the place in your vicinity where you can operate the type of model you wish. Again, the more enquiries, the greater the likelihood of better facilities.

Do seek help from other modellers but don't disturb one while he is performing with his own model, or better still join a club.

Don't carry your transmitter in the boot of the car unless supported on sponge since the vibration on say a motorway journey can play havoc with screw fixings and electronic adjusters.

Do ensure your model creates as little pollution as possible, namely noise, smell and particularly oil on pond water. Remember that what turns you on might be the next fellow's reason for initiating a petition for getting your activity stopped on the grounds of pollution.

For further information.
STRATO R/C system manual, price £2.75 is available from Remcon Electronics, 1 Church Road, Bexleyheath, Kent.
Radio Control Guide, price £3.95 is available from Radio Control Publishing Co Ltd, High Street, Sunningdale, Berks.

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DC Current	Range 2mA, 20mA, 200mA, 2amp. Accuracy 1% ± 1 digit, Resolution 1 Microamp Overload protection — 2 amp fuse and diodes
AC Current	Range 2mA, 20mA, 200mA, 2 amp Accuracy 1.5% ± 2 digits, Resolution 1 Microamp Overload protection — 2 amp fuse and diodes
Resistance	Range 20, 200, 2K, 200K, 2 Meg. 20 Meg. Accuracy 1% ± 1 digit, Resolution .01 ohms
Environmental	Temp coefficient 0° to 30° C ± .025% °C Operating Temp 0° to 50° C Storage — 20° to 60° C
General	Mains adaptor: 6 - 9 Volts @ 200mA (not supplied) 4C size batteries (not supplied) Size 8¼ x 5¾ x 2¼ Weight 2½ lbs.

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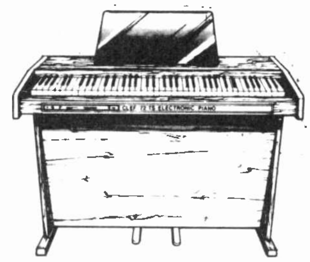

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BARCLAYCARD

Next Month

Hobby Electronics

HAPPY BIRTHDAY TO US . . . .

Yes, it's HEs first birthday next month, as a special treat to all our readers we will be featuring an eight page pull-out section containing masses of useful data. How to de-code those colour coded components, how to connect up all those little legs on ICs and transistors, everything in fact (well, nearly everything) you'll ever need to know.

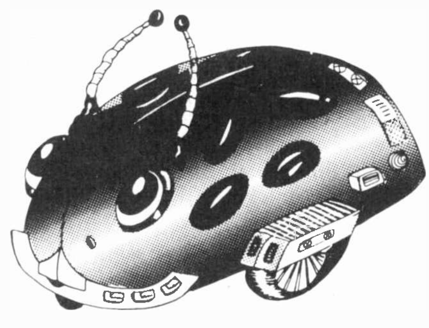
TV BROADCASTING

Even if you can only get two channels (industrial action notwithstanding) you can still find out all about how those exciting episodes of Crossroads and the Magic Roundabout (no they're not using the same actors) reach the flickering picture box in the corner of your living room. What dramas never reach the watchful eye of the camera, how high is Nicholas Parsons in real life, these are some of the questions that probably won't be answered next month.

WRIGHT FIRST TIME

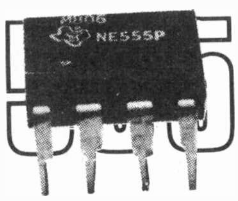
Congratulations to Mr D. J. Wright of Bodmin, Cornwall, and Mr P. R. Cheeseman of Birstall, Leicester, for winning the first and second prizes in our August Scope competition — more details next month. In the meantime we'll be contacting all the winners and runners-up by post.

HEBOT



From the darkest corners of the HE workshop comes a new terror to strike fear into the hearts of brave men (and women, if they dare). HEBOT is here, from an original design by the Gonoids of Andromeda it will over the next few months develop into a creature to rid you of the mother-in-law for ever. The first part next month will describe how to assemble the locomotive and propulsory support mechanism (Chassis and drive gear to mere earthlings) and basic sensory perceptors. The basic module will perform evasive manoeuvres and month by month we will attempt to increase its 'intelligence' until it is able to exist on its own. If our plans are fulfilled they will wipe out the human race HEBOTs will control the universe . . . Exterminate, we will exterminate . . .

INTO LINEAR ICs



This month just over half-way through the series, Ian Sinclair takes leave of the 741 to start anew with the famous 555 timer, as usual all of the circuits are practical, tried and tested. For those of you following the series with the Eurobreadboards we will include all of the codings for the board.

KIT REVIEW

Something out of the usual in the way of kits next month, we shall be looking at a rather novel car burglar alarm. This new kit should be of interest to anyone wanting to protect their vehicle, without having to take out a second mortgage to buy the kit.

BREAKER ONE FOUR

Following our disclosure this month you can be sure that next month's Breaker One Four will have some more very interesting revelations. Remember Breaker One-Four is Britain's first and best, regular Citizens Band feature.

MINI-MODULES

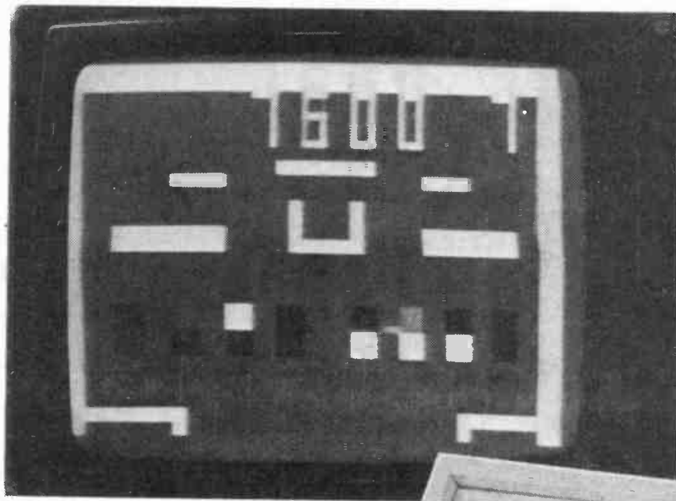
We've been promising some Vero-Board based projects. Well, here they are, ten of them, all using a commercially sized piece of strip board. All of the Modules can be used either as building blocks for larger, more ambitious projects or used on their own as projects in their own right.

The November issue will be on sale October 12th

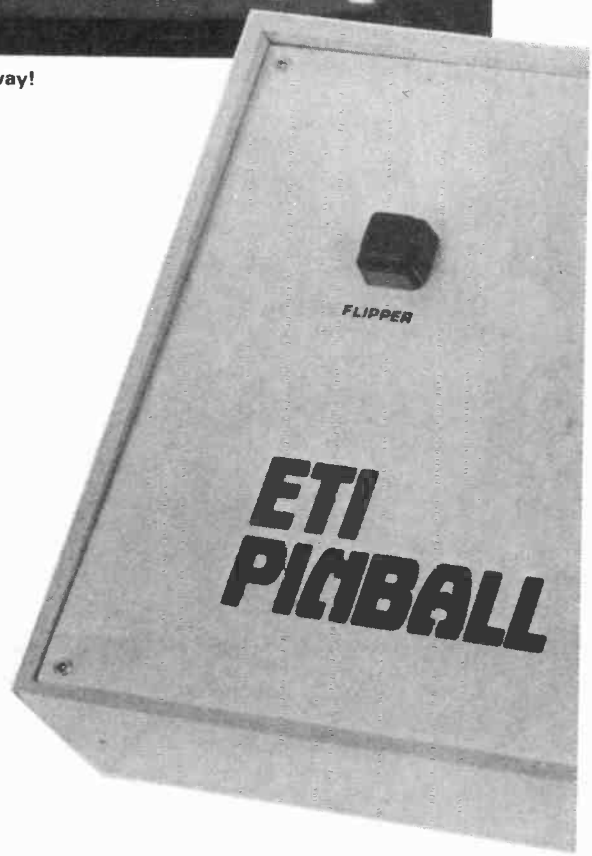
The items mentioned here are those planned but circumstances may affect the actual contents

PINBALL TV GAME

A dedicated chip TV game may seem strange in these days of the programmable? It won't when you consider the unique games and the fact that this EXCLUSIVE ETI PROJECT will only ever be built by 500 people.



Pinball one underway!



THIS TV GAME is a 'dedicated chip' version of a game which has been available on cartridge models for some time — breakout. In addition to this, however, there are four pinball games and two solo 'basketball' type of game which are rare — if not unique. The breakout is highly addictive we warn you — it has amazing potential for stopping all life beyond the paddle control. And as only 500 of the chips are available, the Jones's will have some trouble keeping up! The pinball games are available in both flipper and paddle options — and also a small bat option for inflicting greater frustration upon oneself.

Breakout!

Undoubtedly our favourite game was the breakout. It comes in four options, of which the simplest is the most fun. Each hit knocks a brick out of the wall, until a gap right through is produced, and then the ball can demolish the wall from the back, but note that the bat goes down to half size as soon as the ball hits the rear wall and the ball speeds up on contact with the back three rows of bricks.

In addition the angle at which the ball deflects from the bat alters radically on the eighth 'hit' — just to keep things interesting. You have seven balls to remove two sets of walls, appearing consecutively, from the screen.

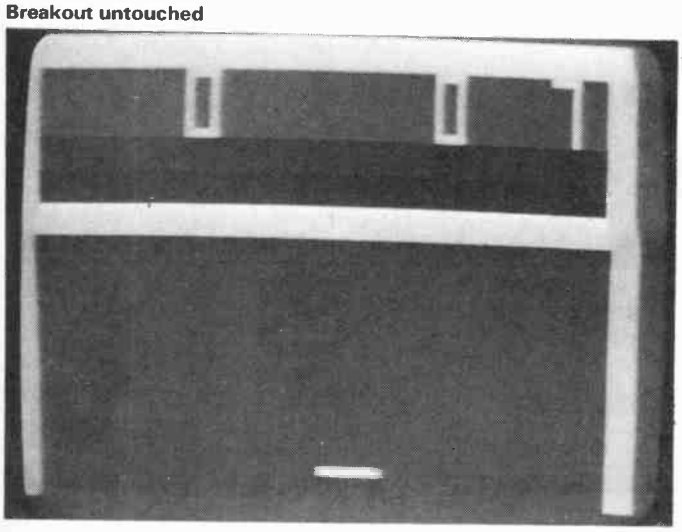
Two other versions provide small bat and only five balls with which to work.

Other Attractions

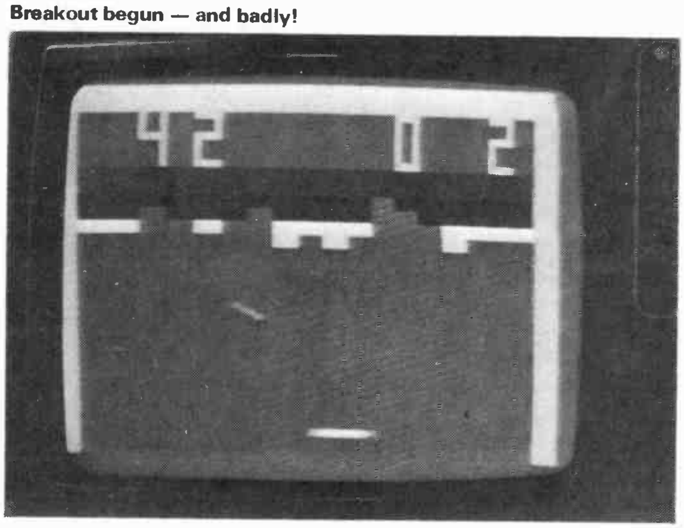
Rather than iterate every last little detail, we've used screen display photos to show the games and options available around those games. Pinball with a paddle is entertaining — to put it mildly!

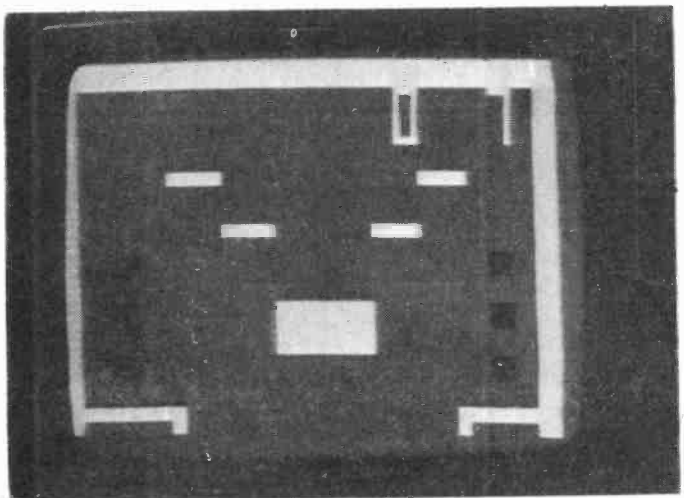
Solo basketball requires that you keep the ball bouncing on the bat,

Breakout untouched

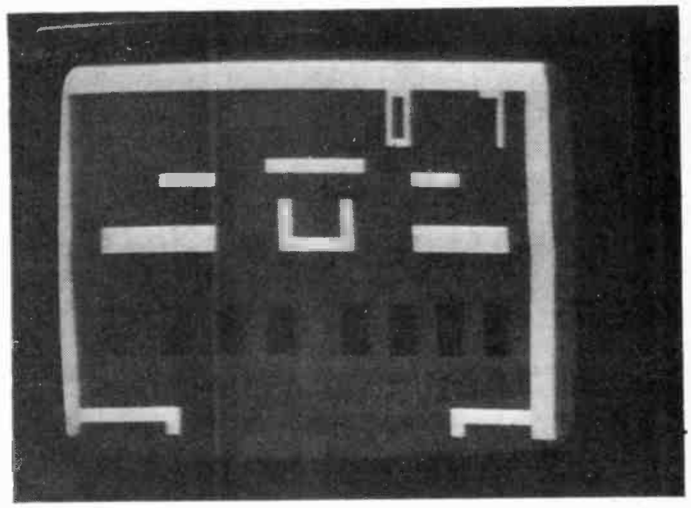


Breakout begun — and badly!





Pinball Two — four options



Pinball One — four options

and then press the enter flipper button to "fire the ball upward to the targets. The longer the ball has been bounced on the bat, the more energy it possesses on firing.

No PSU is shown here, beyond a suggested circuit, because these 9V battery eliminators are available commercially at prices that probably make them cheaper to buy than build. If you must go it alone then this is not critical. All that is required is 9V at about 1.0mA or thereabouts.

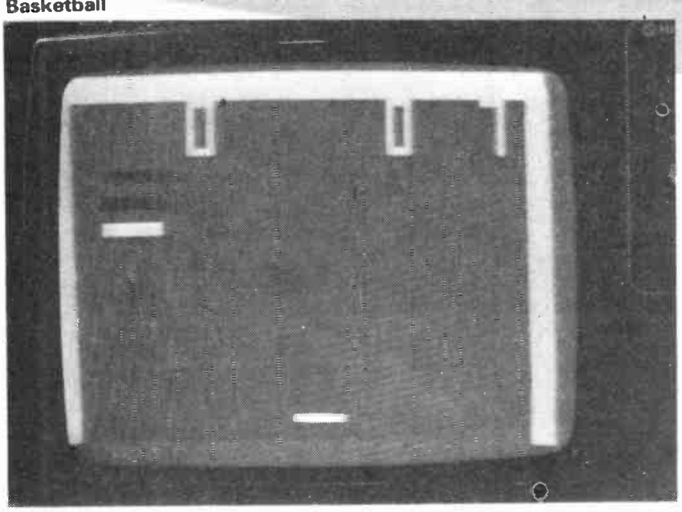
Construction

There is no setting up to be done, apart from tuning your TV to channel 36. All the components mount onto the PCB, including the modulators, so building up the game should pose no problems at all. Use sockets for the ICs as the 'capital cost' is low compared to that for a new set of chips!

Mount up all the 'passives' first, then the modulators and Xtal. Test your 5V line before plugging in the ICs if possible. If all is well fit a UHF lead and plug into the aerial socket of the TV set. The signal should appear somewhere around channel 36, at which point the white noise will vanish and the first pinball game appear on the screen. The brightness and contrast may need adjusting to get the best display — use the breakout game for this. All three tones of brick should be clearly distinguished from one another.

Pressing game select should step the display through the range of games available, with Reset getting things under way. ▶

Basketball



HOW IT WORKS

As with all LSI based games, there is little outside the games chip package of which to speak. All the video sound and sync signals are generated within IC1. The 2112 RAM is provided to hold the 'game selected' signal and score. This is refreshed by IC1 whenever an increment is added by play. At the end of each game (in breakout and basketball) the final score is loaded for display on the screen during the next game. The pinball game scores would require too much screen space, and too many bits, to store.

Q1 and associated circuitry regulate the 9V input from the external PSU to a stable 5V to drive the units' own circuitry. The clock frequency is set by XTAL1, C9, C11, and R14 forming a standard Xtal oscillator. IC3 is a 4019 Quad and/or multiplexer to interface SW1-SW6 with the select lines of IC1.

Paddle control RV1 is 'padded' by the 27k resistor to prevent a 'zero resistance' condition between the 5V line and IC1.

BUYLINES

NIC Models supply all the components for this project.

A complete kit is available for £28.95 all inclusive. Individual components may be purchased as follows:

PCB and Game Chip:	£19.90 all inc.
Modulators:	£5.80 pair
Xtal	£3.00 all inc.

The PCB is copyright NIC models and may not be obtained elsewhere. See ad elsewhere in this issue for ordering details. Likewise the chips (all 500 of them!) are initially single sourced.

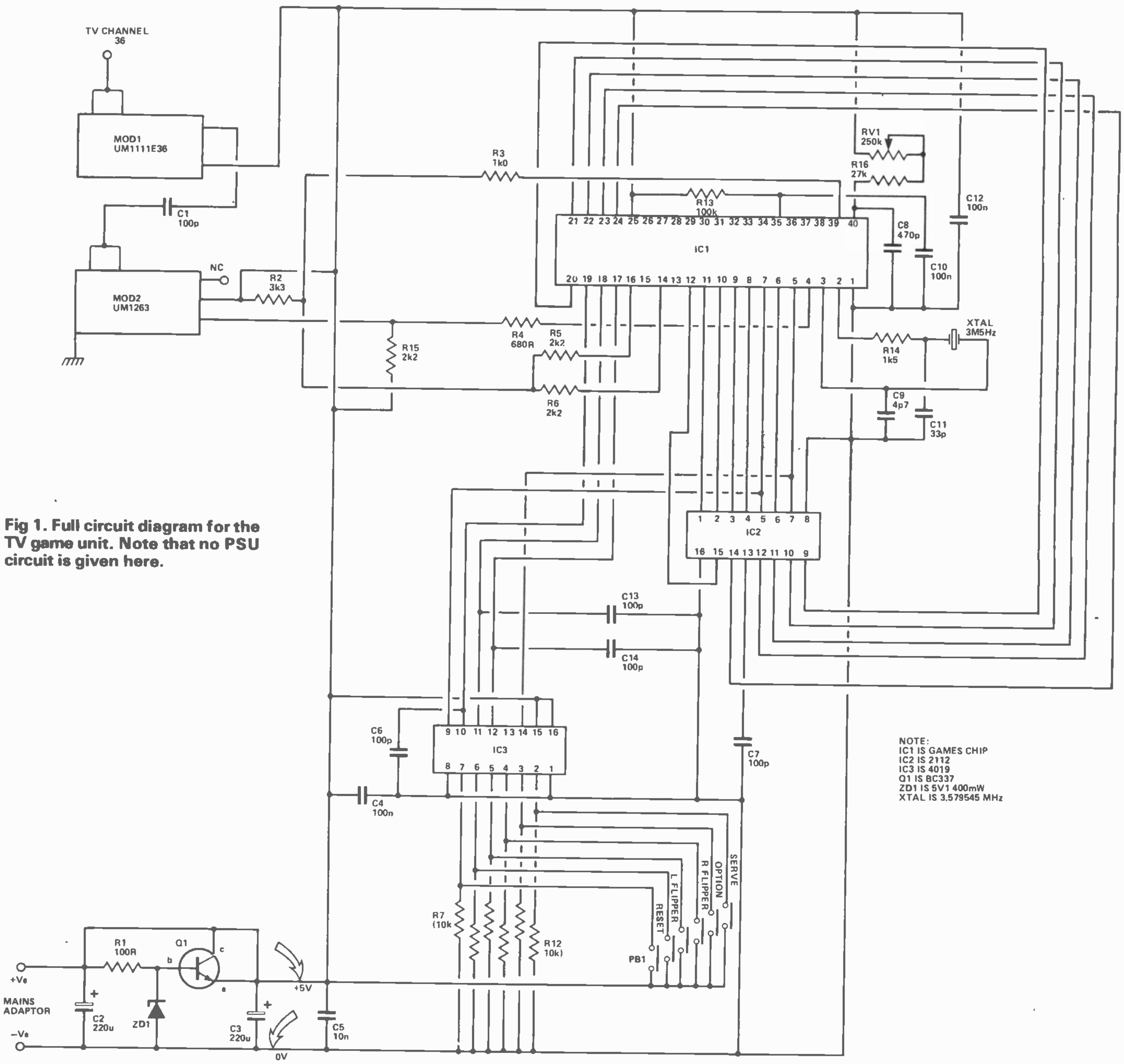
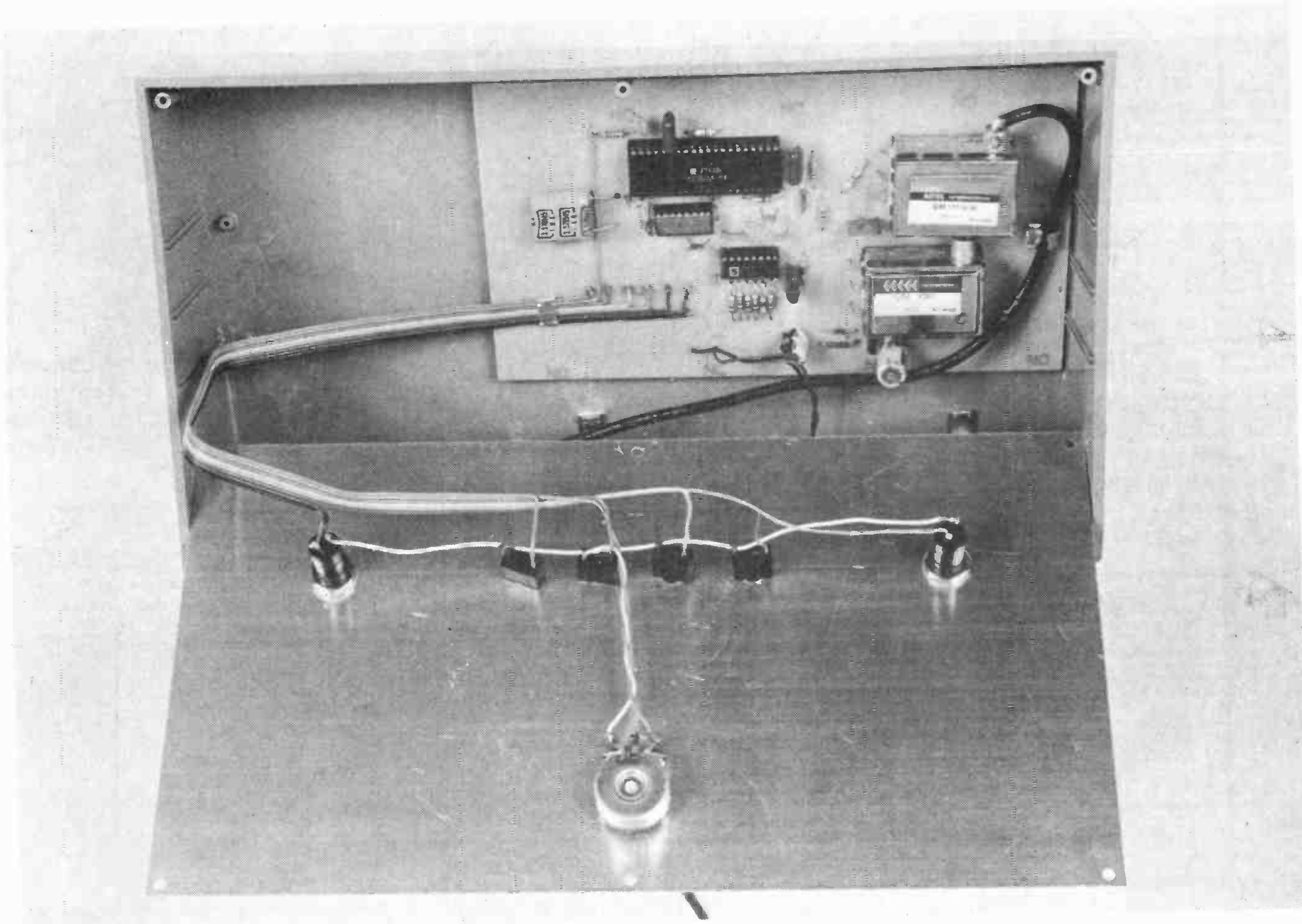


Fig 1. Full circuit diagram for the TV game unit. Note that no PSU circuit is given here.



Internal view of the unit, showing the space left to mount a PSU board should you desire to power it this way.

PARTS LIST

RESISTORS	all ½W 5%
R1	100R
R2	3k3
R3	1k0
R4	680R
R5, 6, 15	2k2
R7-12	10k
R13	100k
R14	1k5
R16	27k
CAPACITORS	
C1, 6, 7, 13, 14	100p polystyrene
C2, 3	220u 16V electrolytic
C4, 10, 12	100n polyester
C5	10n polyester
C8	470p polystyrene
Ca	4p7 ceramic
Cu	33p ceramic
SEMICONDUCTORS	
IC1	See text
IC2	2112
IC3	4019
Q1	BC 337
ZD1	5V1 400mW

MISCELLANEOUS
XTAL (3.57 MHz): Modulators
RV1 (250k linear) Box to suit
PCB

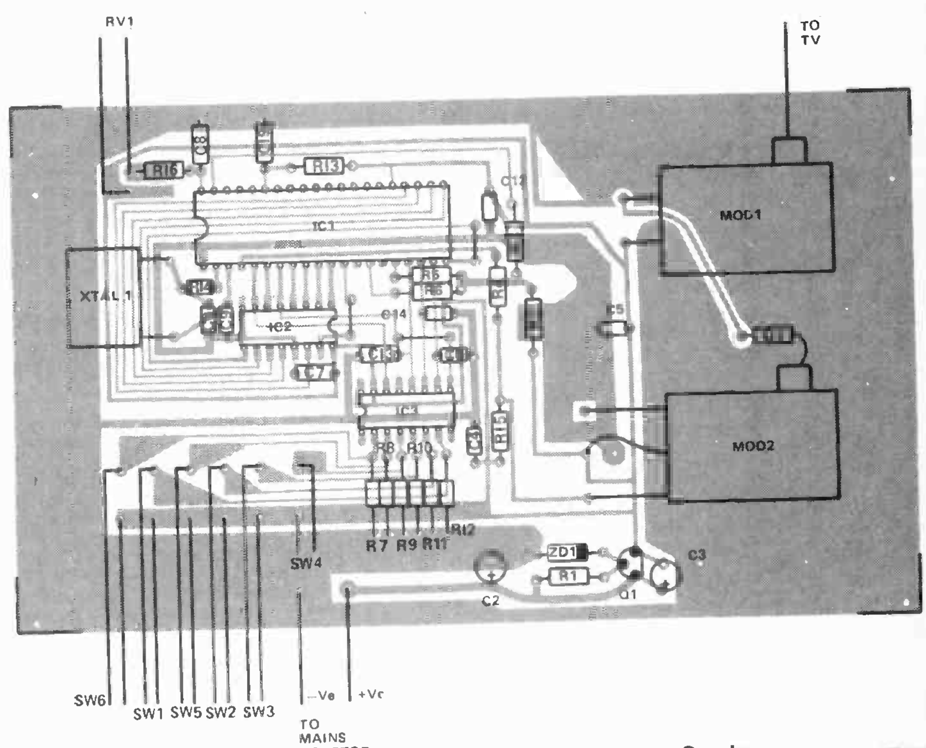


Fig 2. (Above) Component Overlay.

ETI

ANALOGUE DELAY LINES

Don't do now what you can put off for a few milliseconds. Need to delay a signal? Tim Orr shows you how to do it and suggests some applications for analogue delay lines.

THERE ARE MANY natural phenomena which are 'caused' by time delays. All acoustic instruments and, in fact, everything in acoustics is time related. It is, therefore, hardly surprising that several manufacturers produce electronic time delay integrated circuits. These are called analogue delay lines or sometimes, 'bucket brigade delay lines' as this accurately describes their operation.

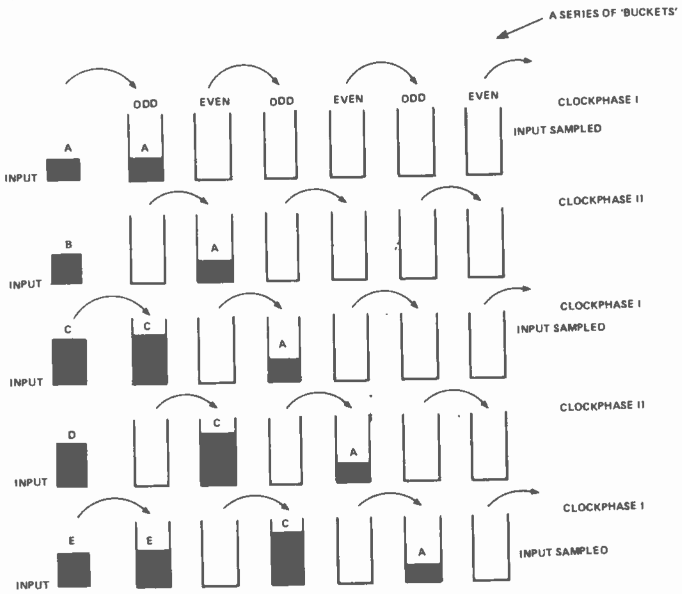


Fig. 1. Bucket Brigade delay lines.

Quantum Buckets

The device can be thought of as being a series of buckets containing water. (Actually it is a series of capacitors containing charge.) The signal presented to the input fills up the first bucket to the level of that signal. This occurs on phase I of a controlling clock signal. On the second clock (phase II), all the *odd* buckets tip their water into the *even* buckets. No input sampling occurs on clock phase II. On the next clock phase (phase I) the input is sampled and all the *even* buckets tip their water into the *odd* buckets. In this way a signal propogates down the delay line which represents the input signal as a series of 'samples'. The buckets are really analogue sample and hold units and the tipping is done with electronic switches. This technique is a cross between analogue and digital processes. The cross between analogue and digital processes. The charge stored (which is proportional to the input voltage) is truly analogue, but it is quantised into small units of time and so, in that sense, it is digital. If the delay line is, say, 512 stages long and the clock frequency is 512 Hz, then the delay time will be:

$$\frac{\text{number of stages}}{2 \times \text{clock frequency}} = 0.5 \text{ sec}$$

That is, after 0.5 sec a waveform representing the input signal of 0.5 sec earlier will appear at the output. In the example shown in Fig. 1, this signal would only appear at the output for the duration of clock phase II. To fill in the gaps, a second delay line connected in parallel with the first, but clocked in antiphase, is used, so that a delayed output signal appears on both clock phases.

Delay lines would seem to solve a myriad of electronic problems but with every solution comes a host of new problems. First, the maximum bandwidth of the delayed signal is proportional to the clock frequency. As the signal is sampled, then the 'sampling theorem' says that the signal bandwidth must be less than half the sampling frequency, which, for practical purposes, means about one-third. So, if you want to delay an audio signal of 10 kHz bandwidth by 1 second, then the number of stages delay needed is 60,000. This will cost you a few hundred pounds in delay lines. If you choose a lower clock frequency requiring fewer delay lines then you will have to make do on a reduced bandwidth. If this bandwidth is not controlled by use of an external lowpass filter, then a phenomenon called aliasing occurs which makes the delayed signal sound as if it has been 'ring modulated'. A typical delay line structure is shown in Fig. 2. A lowpass filter is used to band limit the input signal which prevents the aliasing effects. A second filter is used to recover the quantised output from the delay line by rejecting all the unwanted high harmonics.

The input signal level is always larger than that of the output signal because the buckets are leaky, although the leaks occur in both positive and negative directions. Also, the slower the clock frequency the longer the leakage time is and so the loss is greater. This is a major noise generating mechanism. The noise is broad band, being strong in low frequencies (just the area you are listening to), and becomes louder and more bassy as the ▶

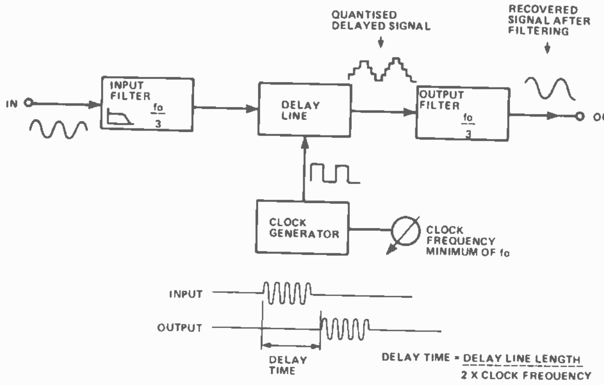


Fig. 2. Block diagram of a typical delay line system.

clock frequency is reduced. This results in signal to noise ratios of about 70dB for maximum frequencies. To overcome the poor performance at low frequencies a noise reduction system such as a compander can be used. The distortion caused by delay lines is typically about 1% and the overload characteristics are not at all good. Heavy overloads can cause the delay lines to stop producing any output at all. The solution is to limit the input level, with some simple sort of diode limiting. One other gremlin is that the output DC level varies with clock frequency which causes some awkward break-through effects. However, once you are fully aware of the limitations of delay lines, it is possible to design a wide range of interesting devices. Delay lines work surprisingly well when you consider that they move a very small packet of charge through several hundred memory stages with a corruption of only one part in 10,000 to 100,000!

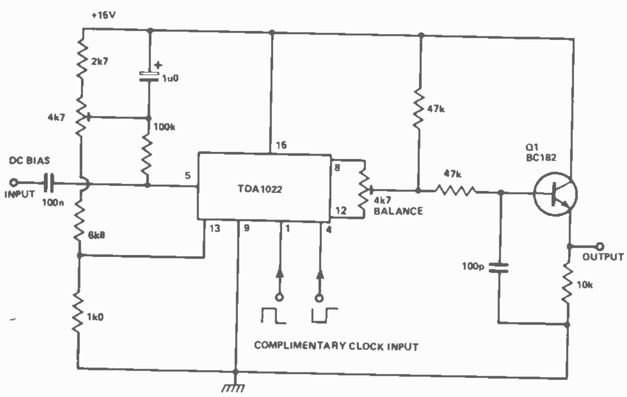


Fig. 3a. A delay line circuit based on the TDA1022.

DELAY TIME = 512 / 2 X CLOCK FREQUENCY

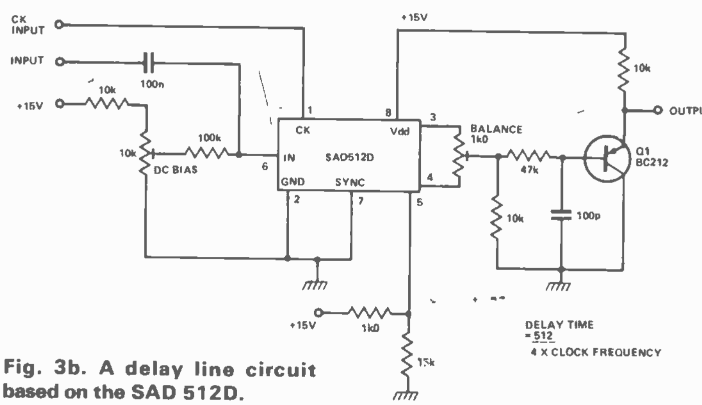


Fig. 3b. A delay line circuit based on the SAD 512D.

Some Delay Line Circuits

Two delay line circuits are shown in Fig. 3. The top one uses a delay line made by Mullard/Signetics. A two phase clock is needed. A preset adjusts the input DC bias so that when the device is overloaded, the clipping is symmetrical. A balance control on the output balances the two outputs for a minimum clock breakthrough. This preset is particularly useful when long delay times with audible clock frequencies are used.

The second delay line is the SAD512D made by Reticon. This device has the same two preset controls but only requires a single clock signal. There is a complementary clock generator (a divide by two flip flop) on the actual IC. The input clock must therefore be twice the calculated frequency.

If long delay times are needed, then there is the Reticon R5101 which will give you a 1 second delay at about 500 Hz bandwidth. This device gives a superb automatic double tracking effect (50 mS at 10 kHz bandwidth) but unfortunately it's rather expensive.

Clock Generators

A selection of clock generator circuits is given in Fig. 4. Circuit A is a standard CMOS relaxation oscillator. The IC costs only about 20p and generates complementary square waves; the minimum frequency of operation is about 1 MHz (with a suitable timing capacitor) and the manual control range is about 50 to 1. It is not very practical to voltage control the frequency of this oscillator.

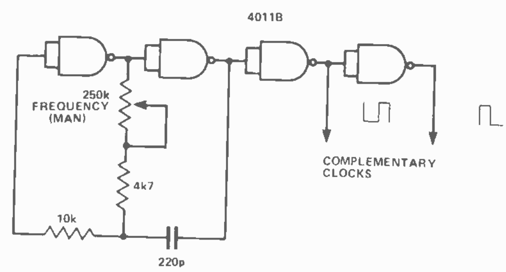


Fig. 4a. A standard CMOS relaxation oscillator.

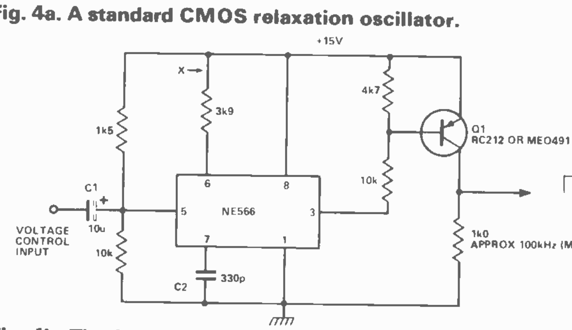


Fig. 4b. The frequency of this clock generator is determined by C1.

Circuit B uses an NE566 which is a voltage controllable oscillator IC. The frequency may be controlled via the capacitor C1 or by interposing a potentiometer or a controlled current source at point X. The output square wave needs to be level shifted and this is done with Q1. The maximum frequency using this circuit should be limited to about 100 kHz. For higher operation up to 1 MHz, a faster level shifter is needed.

Circuit C uses a CMOS Schmitt trigger and a couple of transistors. This oscillator can readily be controlled by a current generator. The output waveform is a short positive going pulse. A divide by two flip flop converts

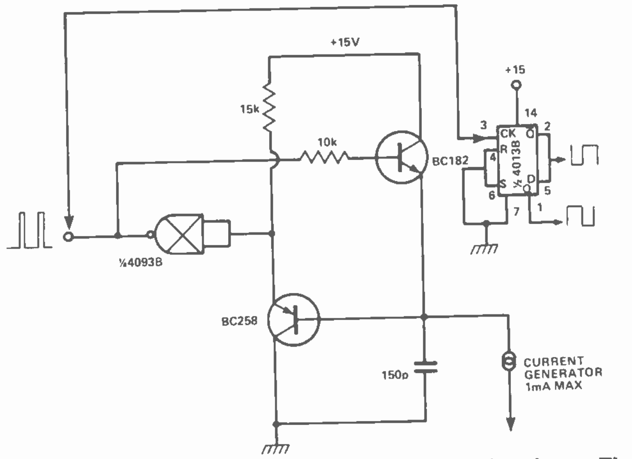


Fig. 4c. This clock generator uses a CMOS Schmitt trigger. The flip flop produces a pair of complementary square waves.

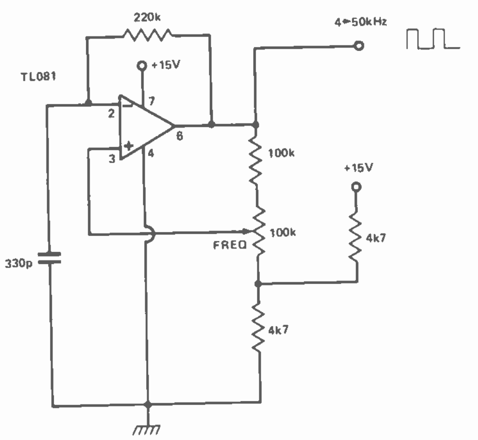
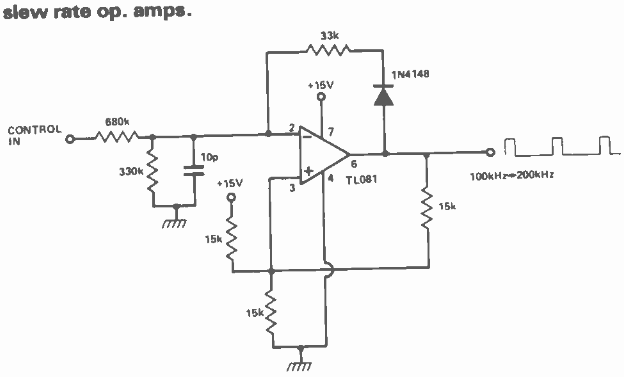


Fig. 4d. (above) and Fig. 4e. (below) show circuits using fast slew rate op. amps.



this pulse into a pair of complementary square waves.

Circuits D and E employ the fast slew rate (13 V/uS) of the Texas B1 FET Op Amp range. This enables them to oscillate at high frequencies and to generate square waves with fast edges. Circuit D is a manual control device and circuit E is voltage controllable.

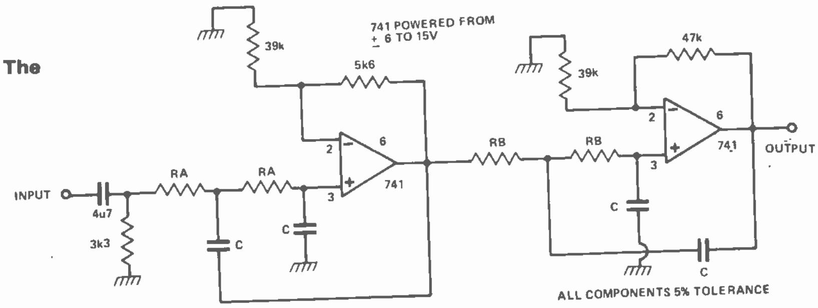
DIY Design

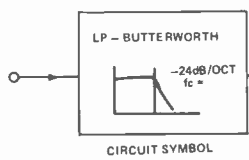
A 'do it yourself' lowpass filter chart is shown in Fig. 5. This filter is a 4th order Butterworth design. The roll-off slope is 24 dB/octave. This means that signals one octave above the cut-off frequency are attentuated by 24 dB (×0.06), at two octaves the attenuation is 48 dB (×0.004), etc. Also the filter has a pass band gain of 8.3 dB (×2.6).

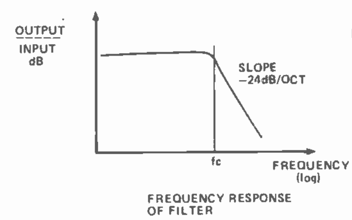
The design procedure for constructing delay line systems is as follows.

1. Select the correct length delay line for the job in hand. Decide on the signal bandwidth needed.
2. Design the low pass filters to have a cut-off frequency equal to the signal bandwidth.
3. Select a suitable clock oscillator that will generate the correct output (single or complementary) at a high enough frequency. Select a voltage controlled design if it is needed. Calculate the required clock frequency.

The following examples show delay line systems. The boxes depicting delay lines include suitable filters.







Cut off Frequency fc	RA & RB Calculated value	E12 value	C
250 Hz	40k64	39k	15n
500Hz	20k32	22k	15n
1kHz	10k66	10k	15n
2kHz	53k3	56k	1n5
4kHz	26k65	27k	1n5
8kHz	13k35	12k	1n5
16kHz	6k62	6k8	1n5

Fig. 5. A do-it-yourself design for a fourth order Butterworth filter.

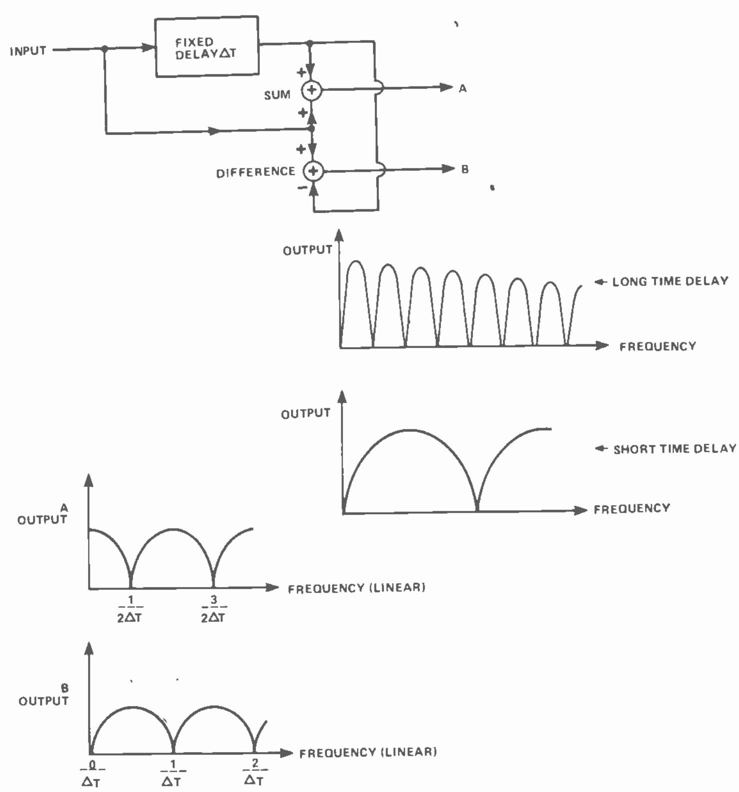


Fig. 6. By taking the sum and difference between the original and delayed signal, a comb filter response is generated. The notches are spaced at 1/(ΔT) Hz, where ΔT is the delay time. ▶

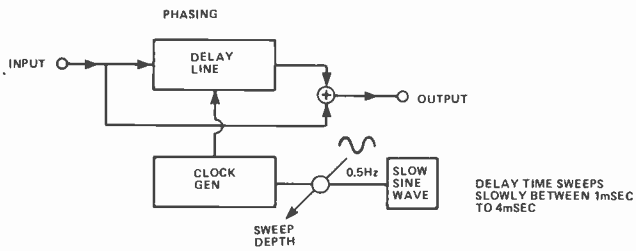


Fig. 7. Note that a long time delay produces lots of notches, a short time delay, only a few. A very popular musical effect is phasing. This uses a slowly sweeping comb filter. That is, the delay time, and hence the notch spacing, are modulated with a slow moving sine wave.

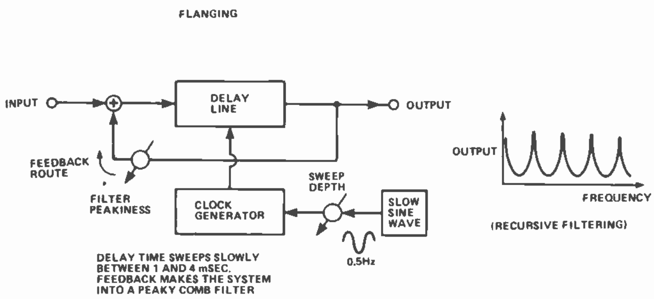


Fig. 8. Flanging is another similar effect, except that feedback is applied around the delay line. When this feedback is in phase with the input, a peak in the frequency response is generated. A pot is used to control the feedback and hence the amount of 'peakyness' of the filter. Flanging produces very strong colouration of the sound.

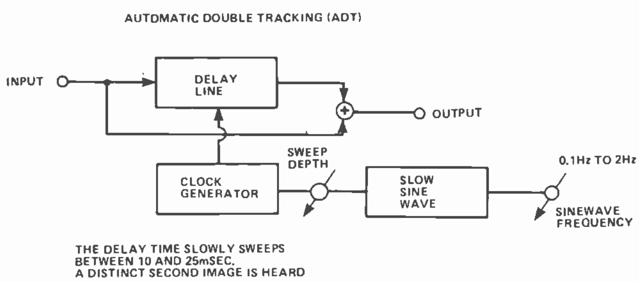


Fig. 9. Automatic double tracking (ADT) is used to add depth and a chorus quality to solo singers and musicians. The delay time is relatively long so that a distinct second image is heard. This image is slowly swept backwards and forwards in time thus adding to the chorus quality. It is such a useful effect that even my singing sounds good!

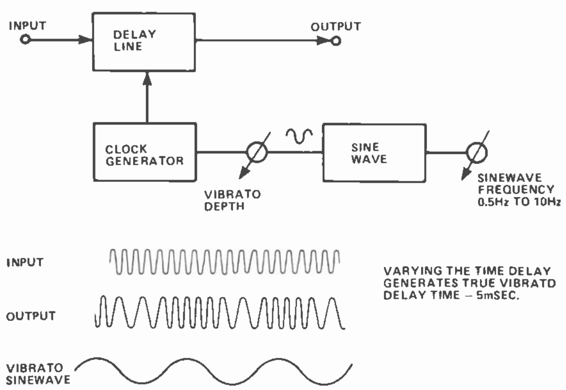


Fig. 10 shows a 'true vibrato' system. This produces a real frequency modulation acting upon all of the input signal. By rapidly modulating the clock generator frequency the time delay is similarly modulated. This causes the output signal to be compressed and expanded in time, resulting in vibrato.

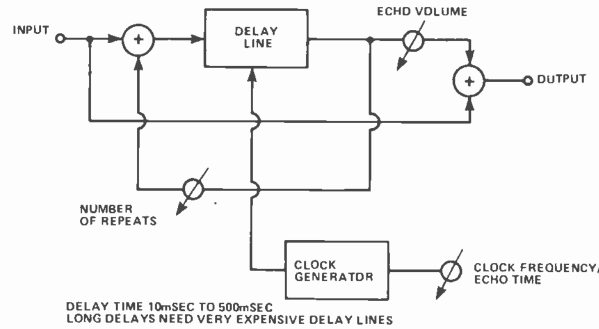


Fig. 11. All electronic echo is obtainable using long delay lines, although you generally have to trade off bandwidth for echo time. Electronic echo systems usually have three controls: time delay, echo volume and repeat level. This last control enables you to vary the echo from a single slap back echo to a long series of repeats.

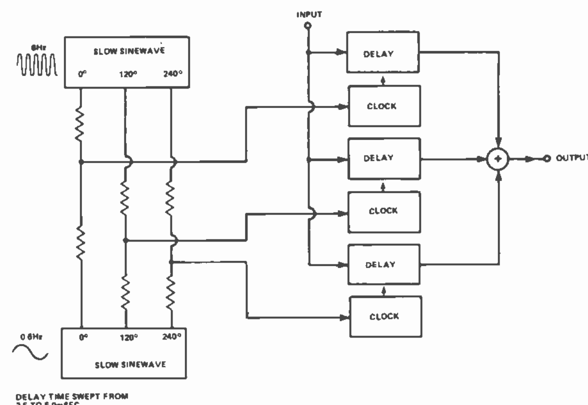


Fig. 12. Electronic string machines nearly always have a chorus/ensemble generator. This is a device that causes complex phasing on the string signal that converts it from a rather flat electronic signal to a rich string-like sound. This is done with three delay lines that have their delay times modulated by three low frequency sine-waves.

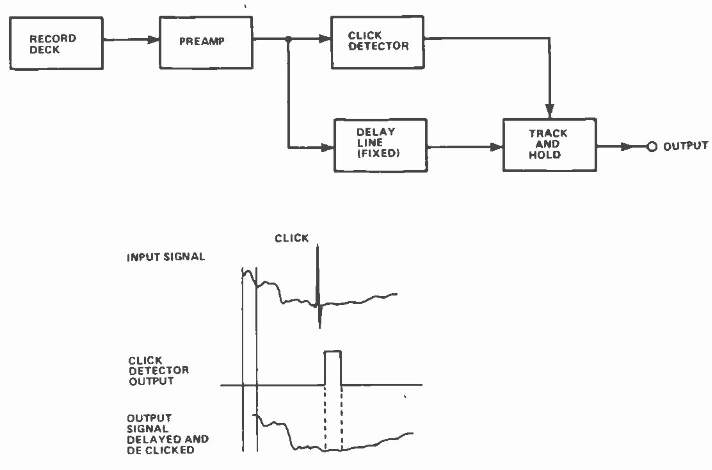


Fig. 13. It is possible to remove record scratches and clicks using a delay line. A scratch on a record is a relatively easy signal to discriminate from the music. However, once the scratch has been detected, the sound of the scratch has already left the loudspeakers and so it is too late to do anything about it. However if the sound is delayed then the scratch can be 'snipped out' using a track and hold circuit. The resulting gap is far less objectionable than the original scratch. ETI

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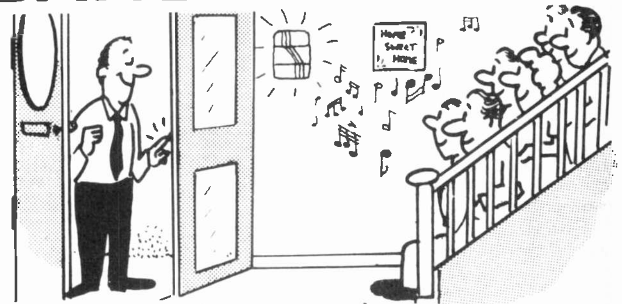

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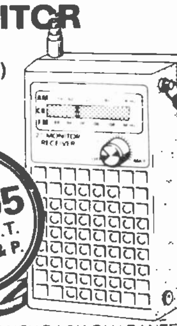

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2032	1 amp	£5.06	P.&P. 86p
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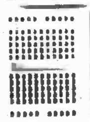

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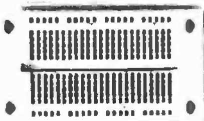

EXP.300.
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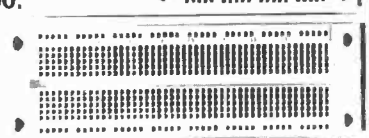

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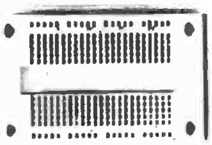

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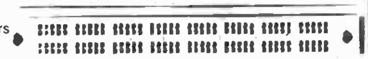

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800 THY1A/800	£0.67

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200 THY3A/200	£0.38
400 THY3A/400	£0.48
600 THY3A/600	£0.58
800 THY3A/800	£0.75

5 amp	TO 66 Case
Volts No.	Price
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200 THY5A/200	£0.58
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800 THY5A/800	£0.93

5 amp	TO 220 Case
Volts No	Price
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800 THY5A/800P	£0.93

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Volts No.	Price
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200 THY7A/200	£0.66
400 THY7A/400	£0.71
600 THY7A/600	£0.90
800 THY7A/800	£1.06

10 amp	TO 48 Case
Volts No.	Price
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400 THY10A/400	£0.81
600 THY10A/600	£1.14
800 THY10A/800	£1.40

16 amp	TO 48 Case
Volts No.	Price
50 THY16A/50	£0.62
100 THY16A/100	£0.67
200 THY16A/200	£0.71
400 THY16A/400	£0.89
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800 THY16A/800	£1.60

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Volts No	Price
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BT116	£1.73

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POTENTIOMETERS

CARBON POTS (Linear Track)
Single gang with wire end terminations, 6mm × 50mm plastic shaft 10mm bushes supplied with shake proof washer and nut. Tolerance 20% of resistance.

1831 1k ohms	1837 100k ohms
1832 2k2 ohms	1838 220k ohms
1833 4k7 ohms	1839 470k ohms
1834 10k ohms	1840 1 Meg
1835 22k ohms	1841 2M2
1836 47k ohms	**All at 30p each**

CARBON POTS (Log Track)

1842 4k7 ohms	1847 220k ohms
1843 10k ohms	1848 470k ohms
1844 22k ohms	1849 1 Meg
1845 47k ohms	1850 2 M2
1846 100k ohms	**All at 30p each**

Designed to fit 2.54mm pitch board. All tracks are linear law.
VC7

1816 100 ohms	1824 47k ohms
1817 220 ohms	1825 100k ohms
1818 470 ohms	1826 220k ohms
1819 1k ohms	1827 470k ohms
1820 2k2 ohms	1828 1 Meg ohms
1821 4k7 ohms	1829 2M2 ohms
1822 10k ohms	1830 4M7 ohms
1823 22k ohms	**All at 10p each**

DUAL CARBON POTS (Log Law)

1860 4k7 ohms	1865 220k ohms
1861 10k ohms	1866 470k ohms
1862 22k ohms	1867 1 Meg
1863 47k ohms	1868 2M2
1864 100k ohms	**All at 99p each**

SINGLE GANG SWITCHED (Lin Law)
These potentiometers are fitted with double pole on-off switches. The switch is incorporated within the rotary action of the pot. Specification of pot is as VC1. Switch rating 1.5 amps at 250v AC.

1870 4k7 ohms	1875 220k ohms
1871 10k ohms	1876 470k ohms
1872 22k ohms	1877 1 Meg
1873 47k ohms	1878 2M2
1874 100k ohms	**All at 75p each**

DUAL GANG LONG-ANTI-LOG POT
1888 Track specification as dual gang pots VC3, but tracks mounted to log-anti-log action 100k ohms £0.86

SPECIAL VOLUME CONTROLS
A miniature 16mm type replacement volume control, incorporating single pole on-off switch. Resistance value 5k ohms. Tolerance ± 20% 1/8 watt rating.
1889 **£0.31** VC8

MINIATURE ROTARY VOLUME CONTROL
5k ohms log with on-off switch, 20mm grooved spindle. Tag connections 17mm dia. Supplied with fixing nut. Used mainly for replacement.
1890 **£0.62** VC9

WIRE WOUND POTS
A range of wire wound single gang pots with linear tracks of 1 watt rating, fitted with 10mm bush and supplied with shakeproof washer and nut.
VC6

1891 10 ohms	1896 470 ohms
1892 22 ohms	1897 1k ohms
1893 47 ohms	1898 2k2 ohms
1894 20 ohms	1899 4k7 ohms
1895 220 ohms	**All at 92p each**

SWITCHED POT (Log Track)
Specification as VC2 but track having (log) law

1879 4k7 ohms	1884 220k ohms
1880 10k ohms	1885 470k ohms
1881 22k ohms	1886 1 Meg
1882 47k ohms	1887 2M2
1883 100k ohms	**All at 75p each**

PRE-SET POTS
HORIZONTAL MOUNTING
Miniature type for transistor circuits. The wiper of the preset is provided with a slot for screw driver adjustment. The tags of the preset will fit printed wiring boards with a pitch of 2.54mm. All tracks are linear law.
VC7

1801 100 ohms	1809 47k ohms
1802 220 ohms	1810 100k ohms
1803 470 ohms	1881 220k ohms
1804 1k ohms	1812 470k ohms
1805 2k2 ohms	1813 1 M ohms
1806 4k7 ohms	1814 2M2 ohms
1807 10k ohms	1815 4M7 ohms
1808 22k ohms	**All at 10p each**

PRE-SET POTS
VERTICAL MOUNTING
Miniature type for transistor circuits. Wiper adjustment is made by a screw driver slot.

SILICON RECTIFIERS

200mA	£0.07
IS920 50v	£0.07
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IS922 150v	£0.09
IS923 200v	£0.10
IS924 300v	£0.12
1 Amp	
IN4001 50v	£0.05½
IN4002 100v	£0.06
IN4003 200v	£0.07
IN4004 400v	£0.08
IN4005 600v	£0.09
IN4006 800v	£0.10
IN4007 1000v	£0.12
1.5 Amp	
IS015 50v	£0.10
IS020 100v	£0.12
IS021 200v	£0.13
IS023 400v	£0.15
IS025 600v	£0.16
IS027 800v	£0.18
IS029 1000v	£0.23
IS031 1200v	£0.29
3 Amp	
IN5400 50v	£0.16
IN5401 100v	£0.17
IN5402 200v	£0.18
IN5405 400v	£0.22
IN5406 600v	£0.24
IN5407 800v	£0.29
IN5408 1000v	£0.35
10 Amp	
IS10/50 50v	£0.22
IS10/100 100v	£0.24
IS10/200 200v	£0.26
IS10/400 400v	£0.40
IS10/600 600v	£0.48
IS10/800 800v	£0.59
IS10/1000 1000v	£0.69
IS10/1200 1200v	£0.79
30 Amp	
IS30/50 50v	£0.64
IS30/100 100v	£0.79
IS30/200 200v	£1.07
IS30/400 400v	£1.44
IS30/600 600v	£2.02
IS30/800 800v	£2.23
IS30/1000 1000v	£2.51
IS30/1200 1200V	£3.16
70 Amp	
IS70/50 50v	£0.86
IS70/100 100v	£0.97
IS70/200 200v	£1.38
IS70/400 400v	£2.01
IS70/600 600v	£2.59
IS70/800 800v	£2.88
IS70/1000 1000v	£3.45
BYX38/300 6A 300v	£0.52
BYX38/600 6A 600v	£0.69
BYX38/300 Rev 6A 300v	£0.52
BYX38/600 Rev 6A 600v	£0.69

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1943 15 watt high quality soldering iron totally enclosed element in a ceramic shaft fitted with 3/32" bit. **£4.83**
1947 Replacement element for 1943 iron **£2.19**
1944 iron coated bit 3/32" for 1943 iron **£0.53**
1945 iron coated bit ⅛" for 1943 iron **£0.53**
1946 iron coated bit 3/16" for 1943 iron **£0.53**
1948 General purpose 18 watt iron fitted with iron coated bit. **£4.54**
1952 Replacement element for 1948 iron **£2.19**
1949 iron coated bit 3/32" for 1948 iron **£0.53**
1950 iron coated bit ⅛" for 1948 iron **£0.53**
1951 iron coated bit 3/16" for 1948 iron **£0.53**
1931 Highly popular x25 25 watt quality soldering iron ceramic shafts to provide near perfect insulation breakdown voltage of 1500 volts AC and a leakage current of only 3-5uA and another shaft of stainless steel to ensure strength. **£4.83**
1935 Replacement element for 1931 iron **£1.84**
1932 iron coated bit ⅛" for 1931 iron **£0.58**
1933 iron coated bit 2/16" for 1931 iron **£0.58**
1934 iron coated bit 3/32" for 1931 iron **£0.58**
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1939 ST3 soldering iron stand. Stand made from high grade bakelite material, chromium plated strong steel spring, suitable for all models, includes accommodation for six spare bits and two sponges which serve to keep the soldering iron bits clean. **£1.73**

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400 mw (Bzy88) D007 Glass encapsulated range of voltages available. 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 39v.
No. Z4 9p each

1w-1.5w Plastic and metal encapsulated. Range of voltages available. 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v.
No. Z13 17p each

10w Metal stud type S010 case. Range of voltages available. 1.3v, 2.2v, 2.7v, 3.3v, 3.9v, 4.3v, 4.7v, 5.1v, 5.6v, 6.2v, 6.8v, 7.5v, 8.2v, 9.1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v.
No. Z10 40p each

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AL60	15-25 watt amplifier module	£5.39
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SPM120/45	Stabilised power supply (45V)	£6.67
SPM120/55	Stabilised power supply (55V)	£6.67
SPM120/65	Stabilised power supply (65V)	£6.67
SG30	Power supply for equaliser	£4.37

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MPA30	Stereo magnetic cartridge pre-amp	£4.42
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Stereo 30	Complete 7 watt 4stereo amplifier board	£22.66
BP124	Siren alarm module 5 watts	£4.02
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BARCLAYCARD VISA

AUDIOPHILE

Three reviews this month — from speakers to decks via heads. Ron Harris takes up pen and ink to explain . . .

FELICITY KENDAL. There — that saves you wondering what feeble excuse I can possibly dream up *this* month to mention the lovely lady. Anyway it's *my* column and if I want to bring a little beauty into this magazine I shall!

All of which leads on, not at all well, to a new cartridge called the Coral MC81. This is a moving coil unit which will retail at around £90 in your local emporium. A fairly low price that in these days of the strong pound and weak knees. It arrived here a little late in the magazine month for the last issue and its performance was such that I didn't want to go making comments until I'd had a better chance to evaluate at length (he said pompously. Well its better than admitting I was afraid of putting my foot in it — isn't it?)

A full review will appear in next month's Audiophile, once the MC81's matching head amp is available. First impressions were gained using a Sony HA55 and were very impressive indeed. It looks as though the MC81 could be the most exciting cartridge release for many a long year.

Slight doubt assails the editorial mind over the bass extension though. Anyway I refrain from further eulogising until next issue by which time the head-amp (H300) it is designed to work with should have been introduced to it (and me!).

SUPEREX CLASSIC HEADPHONES

The Superex classics caught the ear at a hi-fi show many moons ago and so many buffalo have crossed the plains since then that it came as a distinct surprise to find them occupying my desk top one cold and foggy morn.

Now I am never *fully* sentient at the best of times, but pre-tea in the early morning light there is not a hope in Hades of the memory cells functioning — beyond remembering which train to get on. It is as well some clever PR person had marked the box 'Audiophile Review' else some nameless fate might have overcome them . . .

A limited range of Superex headphones are being imported by Goldring Products, and the Classics sit a comfortable second in the range. They originate in America — and it shows! Who else would fit a clip to the lead so that you can anchor the phones to your belt to prevent them being yanked from your head? (The amplifier does a swan dive off the shelf instead, pulling deck and arm along with it).

The finish is very good indeed, the headband being comfortable and easily adjusted. The fit over the ears is OK but not tight enough — of which more later. As you can see from the photo the Classics are neither bulky or obtrusive. No-one complained they were uncomfortable during tests.

The efficiency is around average and well nigh all amplifiers will provide enough volume to cause as much pain as you wish to inflict!

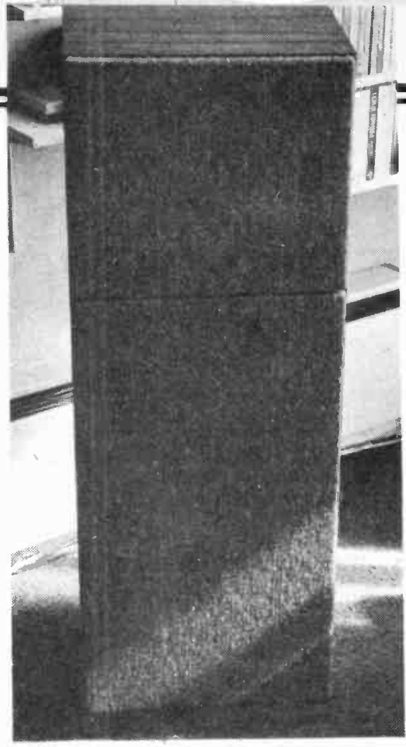
Sound quality is very high, being characteristically dry in presentation. The Classics push the music at the listener, and manage to set up a good 'out of the head' image. First impressions, however, were that the units were very bass light — investigation proving that this was entirely due to poor coupling to the head.

The transducers themselves were faultless here, but the headband and ear pads work *against* the phones! It took a great deal of bending and shaping to get the Classics to 'grip' sufficiently to provide convincing bass response. This naturally made them less comfortable.

I found this surprising for a 'closed' type of headphone, usually the coupling is good with this configuration and bass response is the *last* thing missing!

This is a shame really as I liked the sound of the Classics — they are both open and fairly accurate I feel — and would suit a wide audience as they respond well to all types of music. But that headband will *have* to be altered either by Superex or the purchaser to do the transducers justice. Once done the Classis CL1 is a fine headset.

Imported by Golding Products Ltd, Anglian Lane, Bury St Edmunds. Price: circa £30.



Left: the Superex Classics being worn, somewhat dreamily, by ETIs Miss Dee. The headphones are fairly small and light, but the headband needs work.

Right: the Ditton 662 dressed and naked. The sheer size can be appreciated from the twelve inch bass units shown in the second shot.

CELESTION DITTON 662

Most of the air disturbances corresponding to grooves in plastic which have taken flight across my living room in recent years have emanated from the cones of Celestion Ditton 66s — which is as wierd a way of saying that I am well used to them as you are gonna hear.

Any new variation upon this well-loved theme was thus to be treated with a keen interest, honed by a suspicion born of not wishing to see a winning line changed.

The 662 I had heard on the hi-fi show circuits, but always in temperatures in excess of 80°F in rooms carpeted with wall-to-wall people. Better conditions were called for, and a pair was kindly provided for review by Celestion themselves.

Like their predecessors the 662s are BIG speakers and will refuse utterly to blend in the wallpaper. They stand out. However they are nicely finished and of not unattractive appearance either grilled or naked! Their height places both midrange and tweeter above obstucting furnishings and provides a good amount of 'direct sound' to the listener which in theory means a good stereo image.

Place For Everything

Positioning of the enclosures is vital to get the best from them — as it is with all speakers really — and Celestions accompanying leaflet provides some sound guidance here and should be well digested. Anyone paying around £450 for a pair of these speakers should not fear to move grannies favourite armchair if need be. Half a grand buys a lot of sticks of stones . . . .

Now came the moment of truth. Having suitably heaved the beasts into place, what sort of sound were they producing? I don't know what I'd expected from my previous listenings but whatever it was they still surprised me! The Ditton 66 is 'forward' in nature and has an excellent bass extension and quality, of which the only possible criticism is that the control could be better at upper-bass frequencies. In addition the mid and top is excellent although totally merciless to poor quality recordings or ancillary equipment.

Against this the 662s were totally and utterly different. A different pact with the Devil has been struck for this example of the black arts. The bass control is much improved, without sacrifice in quality or extension. (These units can rattle windows with the best of 'em!)

The sound is more recessed than the 66, but spaces out the image better. Mid-range is a little recessed in absolute terms but is very detailed and smooth. The treble is best described as simply 'good'. No unusual characteristics at all. The bass response is nothing short of phenominal!

Over a period of time you come to appreciate just how good these big Celestions really are and even at £450 a pair they must be excellent value for money. The sound balance is a shade too full if anything, and I prefer the HF2000's version of high notes to that provided by the new HF3000 tweeter employed here. However this unit does make the enclosures as a whole much more tolerant of lesser quality records etc.

One can 'listen though' the 622's to the music very easily indeed as they stand the sound out from the boxes, providing good depth and imaging in the process. As you can see from the test results no 'nasties' showed up under scrutiny and all around the 622 can be thoroughly recommended.

Manufactured by Celestion Ltd, Ditton Works, Foxhall Road, Ipswich, Suffolk IP3 8JP. Price: circa £450. ▶

TECHNICS SL 150 II

Turntables continue to cause no end of heated argument. A studious perusal of a typical months magazines might well lead you to believe that only one record turning machine is worth a second look.

However there are in fact a very appreciable number of decks of the highest quality available and for which any order of merit must be based purely on personal preferences. Let the buyer decide.

One such machine concerns me here — the Technics SL 150 II motor unit. Lying second in the range to the awe inspiring SP 10 is no disgrace, and the 150 has much to recommend it. I used one of these units for a month or so a while back and resolved then to devote some lines to it as soon as possible.

The finish is an excellent mettalic grey, with the control panel black and silver (buttons). The turntable itself is a weighty construct which has the motor magnet fixed to the underside. As always for Technics the standard of construction is nothing short of excellent.

Only one complaint so far — the mat (again). This if of the ribbed and grooved variety designed to minimise record support and maximise resonance. Both the Spectra and GA Audio (glass) mats significantly improved the sound quality of the 150 II. All listening tests were done with the latter platter on the deck and the Technics mat still in its box.

Direct Drive Of Quartz!

Quartz locked speed control is employed — almost compulsory these days it seems — and a frequency synthesiser allows speed variation of up to ± 9.9% upon reference. Two sets of seven segment LEDs read out selected speed and pitch variation — in increments of 0.1%. This I **don't** see the point of. Why not simply read out the speed the deck is actually turning at, and ditch the second set altogether? There is a strobe too — and the line of LEDs is just about visible through the little window in the control panel!

All this to check the speed of just about the most accurate control system there is! Come on Technics, have some confidence in yourselves!

The controls are lined up such that they will be outside the lid once closed and thus easier to get at. Operation is smooth — the switches are superb to operate — and (another) LED **inside** each verifies the very light action. On switch off electronic braking is applied to slow the deck. The effectiveness of this can be gauged by turning the power off and watching the platter spin to rest itself in what *seems* like hours — an excellent bearing, no sign of play at all is responsible for this.

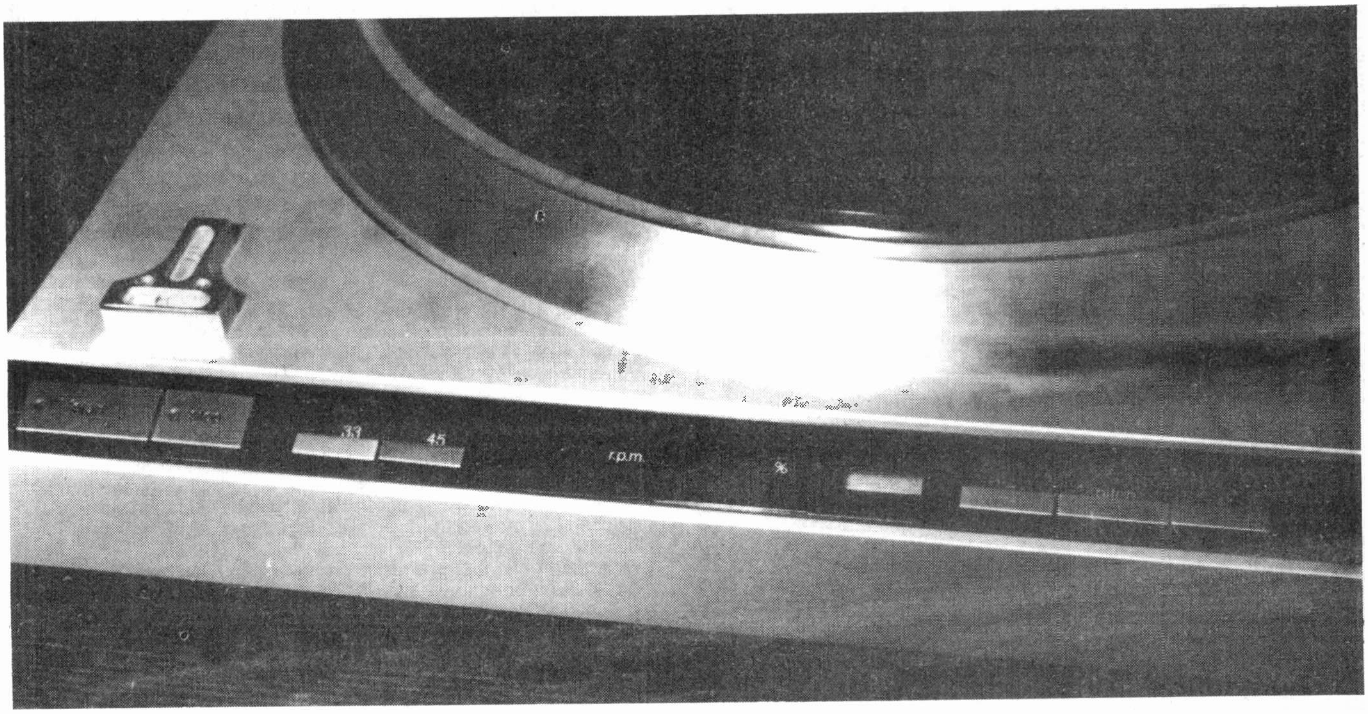
Armed And Firing

The arm mounting panel deserves a mention — it is composed of a two inch thick block of wood, into which are set hexangle bolts to hold it securely in place. Nice and massive with little or no chance of anything moving around. Full marks there.

For the purposes of testing the SL150II was fitted with an SME Series III which necessitated the fitting of the leg spacers provided with the deck to ensure that the lead out did not foul the shelf.

It is probably a good idea to fit these pads in any event as they are good isolators too and will only assist the deck in ignoring the surrounding universe. Other than fitting the arm and turntable there is no setting up to be done — a huge advantage over fiddly belt-drives which have to be optimised for best performance.

The review SL150 set up with an SME 3 and Coral MC81 (more next month on that). The spirit level is *not* part of the deck!



Above: Close up of the Technics control panel showing the LED readout windows, pitch and speed controls. Note the LEDs on the start/stop switches. These are a positive pleasure to use.

TEST RESULTS

CELESTION DITTON 662

Frquency response:	**50Hz-20kHz ±4dB**
Distortion:	**1.3% (100Hz)**
	<0.4% (1kHz-20kHz)
Minimum impedance:	**7 ohms**
Size:	**1000×400×300mm**
Weight:	**75 lbs**

TECHNICS SL150 Mk2

Wow and flutter:	**<0.02% peak (IEC 98A weighted)**
Rumble:	**<—75dB (IEC 98A weighted)**
	<—50dB (IEC 98A unweighted)
Time to full speed:	**< ¼ rotation**
Long term drift:	**<0.001%**

My thanks to Dr Adamson and his department for their assistance in compiling these figures. Cheers lads!

Technics Technically

On the test bench the SL 150 makes you wish you hadn't bothered. It comfortably exceeded spec (and test gear limits) on just about everything. It says if all if I say that rumble, wow and flutter will never bother an SL 150II owner. Figures given in the Test Report section.

Isolation from acoustic feedback was not as good, however, and the unit has to be used on a solid shelf. A coffee table will not do. With the feet fitted and a good solid mounting, though, feedback did not affect the sound audibly, even at ear compressing volumes.

Ear We Go

So how did sound? In a word — silent! The unit influenced the system sound very little indeed. Switching back and forth between the 150 and an STD 305M showed very little change indeed. Both gave good detailed results with outstanding bass response and a clear mid-range. If anything at all the 150 was the cleaner sounding all round, and I preferred the top end served up on the Technics platter.

Using a range of cartridges; Shure V15 IV, Coral MC81, Goldring G900SE Mk2 and Entré failed to show up any problems with hum etc. and so the unit can be wholeheartedly recommended as being of the highest quality and one which should be included in any shopping list where the aim is quality first. The price is high — about £240 but considering the prices its competitors sell for and the facilities offered the SL 150 II looks like good value for your money.

Technics Sales, 107-109 Whitby Road, Slough, Berks SL1 3DR. Price. circa £240.

ETI

Cambridge Learning Enterprises

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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 programme structure.
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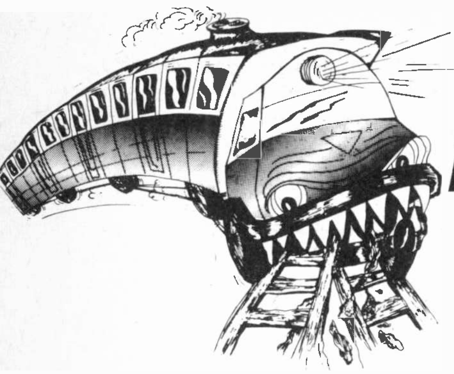


MODEL TRAIN CONTROL SYSTEM

ETI proudly presents 'The Beast', the ultimate in model railway control systems. It gives ultra-fine speed control to your locos, has built-in track cleaners, uses capacitor discharge units to control up to sixteen sets of points on each track, has full remote-control facilities, and can drive one to four track layouts.

'The Beast' is a model railway control system that gives a performance vastly superior to any presently-available commercial system, and is at least two years ahead of the microprocessor-based 2-wire control systems presently under development by the industrial giants.

'The Beast' is not microprocessor based. It is not a '2-wire' control system. It IS a sophisticated multi-unit control systrem in which each unit can be used to replace an existing conventional controller without need for alteration of exisiting track wiring and without modification of locomotives. The system can be used on all track gauges froim the diminutive 'N' to the large scale 'O'.

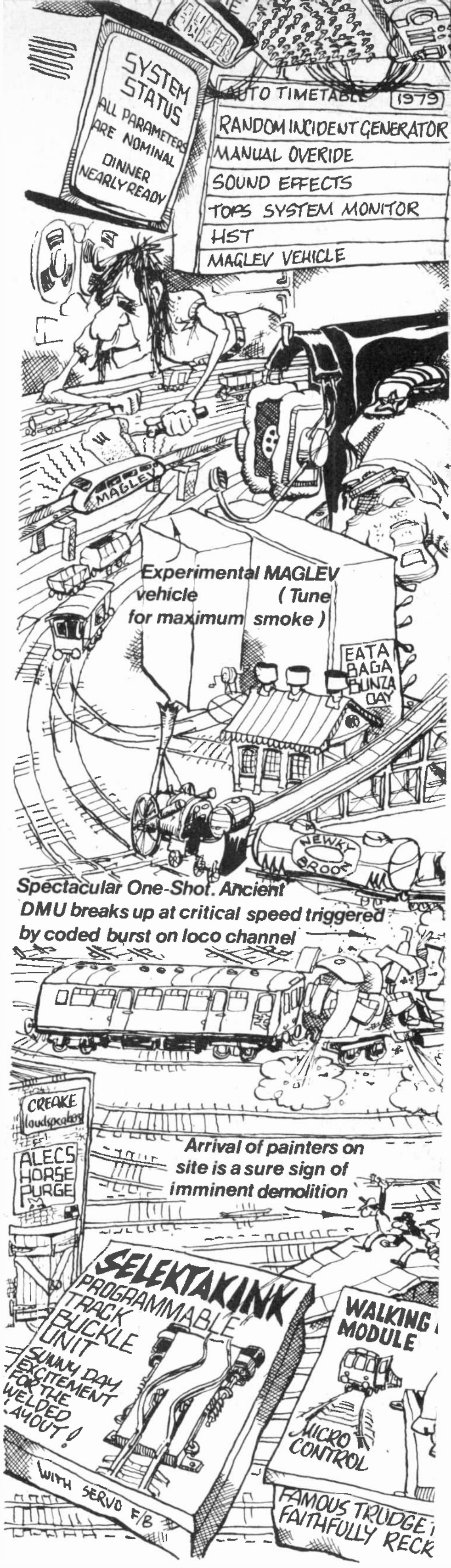
The system contains a train-control unit and a 16-way points contol unit for each track. The full system can control as many as four track layouts. All units are fed from a common power supply unit, but are otherwise independent and self-contained. All units are provided with remote remote control input connections. The complete system includes a remote control facility that enables the user to select any one of the four sets of track units and gain full control over the loco and points on that track.

Versatility is a keynote of the systrem. The user can start the system off with a power unit and one simple train-control unit, and then progressively expand the system up to full capability by adding extra train- and points-control units and perhaps the full remote-control facility as cash and inclination allow.

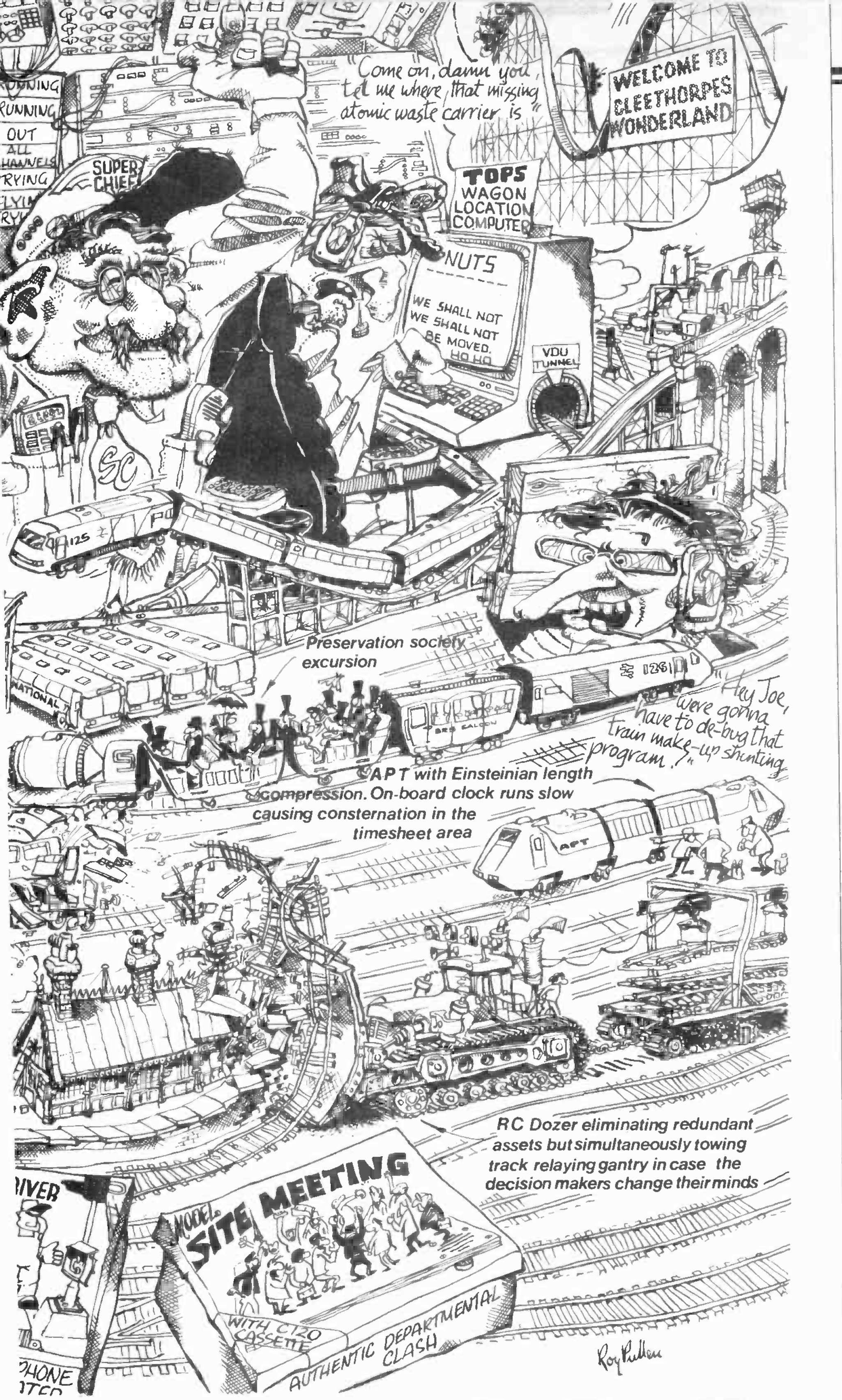
A resume of the features of the individual units of the system is as follows:

The Train Controller

The train control unit uses a unique method of pulse-plus-voltage drive to the track that gives exceptionally fine speed control from 'crawl' to 'full belt' rates, but with no sign of the motor overheating and high noise levels that are associated with normal pulse-width control systems. The control signals are fed to the track via a high-voltage (about 800 V peak-to-peak) track cleaner, which breaks through any oxides or sludge that forms on the track, pick-ups, or motor brushes, etc., and thus ensures excellent track-to-track contact under all running conditions.



In its simplest form, the train contoller speed is adjustable via a pot. In the advanced version of the controller the pot is replaced by electronic circuitry that enables the speed to be selected via an accelerate or decelerate (up/down) switch that also simulates momentum: an emergency brake facility is also



incorporated. Both versions of the controller incorporate full overload protection, and give sufficient output power to run double-headed trains. The system is NOT designed to give simultaneous and independent multi-train control on one track.

The train controller is provided with remote-control input connections, which operate in the OR mode with the normal controls.

The Points Controller

The points controller is a fast acting (it can activate several times per second) capacitor-discharge unit that is desinged to control up to sixteen sets or points or relays, etc. In it's simplest form, the unit contains little more than one capacitor, a transistor, and a few resistors and diodes, and can use conventional points switches to select and activate the points. In the advanced form of the unit the points can be selected via a switch-driven up/down counter, and the points can be set or reset via a second switch and a bank of Darlington power transistors. In this latter form, the semiconductor count can rise into the hundreds region. This version of the unit has provision for remote-control inputs, and all inputs operate in the OR mode.

The Power Supply Unit

The main power supply unit has electronic overload protection on its output, which is rated at 50 VA and is capable of powering four sets of track systems simultaneously. The unit produces a regulated 18 volt DC output only.

The Remote Control System

The complete system incorporates an optional 2- or 3-wire remote-control facility that enables any one of the four track control systems to be operated via a free-ranging hand-held control box, thus freeing the operator from the main control panels and enabling him to exercise control from any position around the layout or even, if he wishes, from the comfort of an armchair.

The control system uses a 15-bit serial code. The first two bits select the desired track system, the next six bits control the train speed, direction, and braking, and the remaining seven bits select and activate the available (up to 16) points and relays on the selected track system. The hand-held controller has a built-in 16-LED indicator unit that identifies the point or relay that has been selected.

The signal from the hand-controller is fed via a 2- or 3-wire 'link' to a decoder and data-distributor unit that in turn feeds the control signals to the individual track control units.

A feature of the remote control system is that its outputs operate in the OR mode with the normal system control switches. The operator can thus shift from local to remote operation without having to operate change-over controls, etc.

The System Design Concept

As all model railway enthusiasts will know, Hornby and Airfix are ▶

currently developing microprocessor-based 2-wire model railway control systems that are capable of independently controlling up to four locomotives on a single track.

In these systems each locomotive is fitted with a small pre-coded electronic control module, and the master control unit sends control signals to these modules along the track, which also carries a 20V AC power signal. The control signals can be used to pick out a particular locomotive and instruct it to move in either direction at any one of sixteen different speed levels.

Although neither the Hornby or the Airfix systems are currently in production, they clearly have certain intrinsic advantages to the model railway user. We at ETI are well aware of these developments, yet rejected the 2-wire control concept when we designed our model railway control system. Why? These are the reasons:

(1). We wanted a system that could be used with any gauge of model locomotive, even an 'N' gauge Tank. The size of the control modules used in 2-wire systems precludes their use even on some 00/HO Tanks.

(2). We wanted a system that gives very fine low-speed control of the loco, but without the motor overheating and high noise levels that are inherent with conventional pulse-width control systems: 2-wire systems use pulse-width motor control. So we devised a completely new motor-drive technique.

(3). We reckon that the most important factor in obtaining good low-speed performance from a locomotive is the maintenance of good electrical contact between the power source and the motor. Using exisitng technology, the best way to achieve this is to use a so-called 'track cleaner' system, in which a high-voltage (800 volts peak-to-peak) high impedance (tens or hundreds of kilohms high-frequency (tens or hundreds of kHz) signal is imposed on the power source signal, thus ▶

HOW IT WORKS

THE SYSTEM

THE BLOCK DIAGRAM of the model railway control system is shown in Figure 1. Note that only one of four (maximum) train- and points-controller units are shown in the diagram. All units are powered from a common 50 VA power pack that delivers a stabilized and overload-protected 18 volt DC output.

Each train controller unit incorporates a voltage-driven speed controller circuit. The voltage drive can be obtained from either a conventional pot, or an electronic 'pot' with momentum and brake simulation. The output of the speed controller is fed to the track via a high voltage track cleaner circuit. The direction of the train is controlled via a double-latching relay circuit. Each train controller unit has provision for interfacing with an optional remote-control facility. One train controller unit is required for each track of a layout (up to a maximum of four tracks).

The Points Controller unit uses the capacitor-discharge operating principle. Each unit can drive a maximum of sixteen points and/or relays. The points can be selected and set/reset via either conventional points switches or via an all-electronic system that can also be interfaced with the optional remote-control facility. A minimum of one Points Controller unit is required for each 16 sets of points used in a complete railway layout.

The remote control facility uses a 15-channel (15-bit) hand-held encoder/transmitter. The signals from the transmitter are fed to a decoder via a 2- or 3-wire flexible link, and are then coupled to the train and points controller units via a data distributor. The system allows the operator to select any one of four track control systems, and exercise full control over the train and points on that track system.

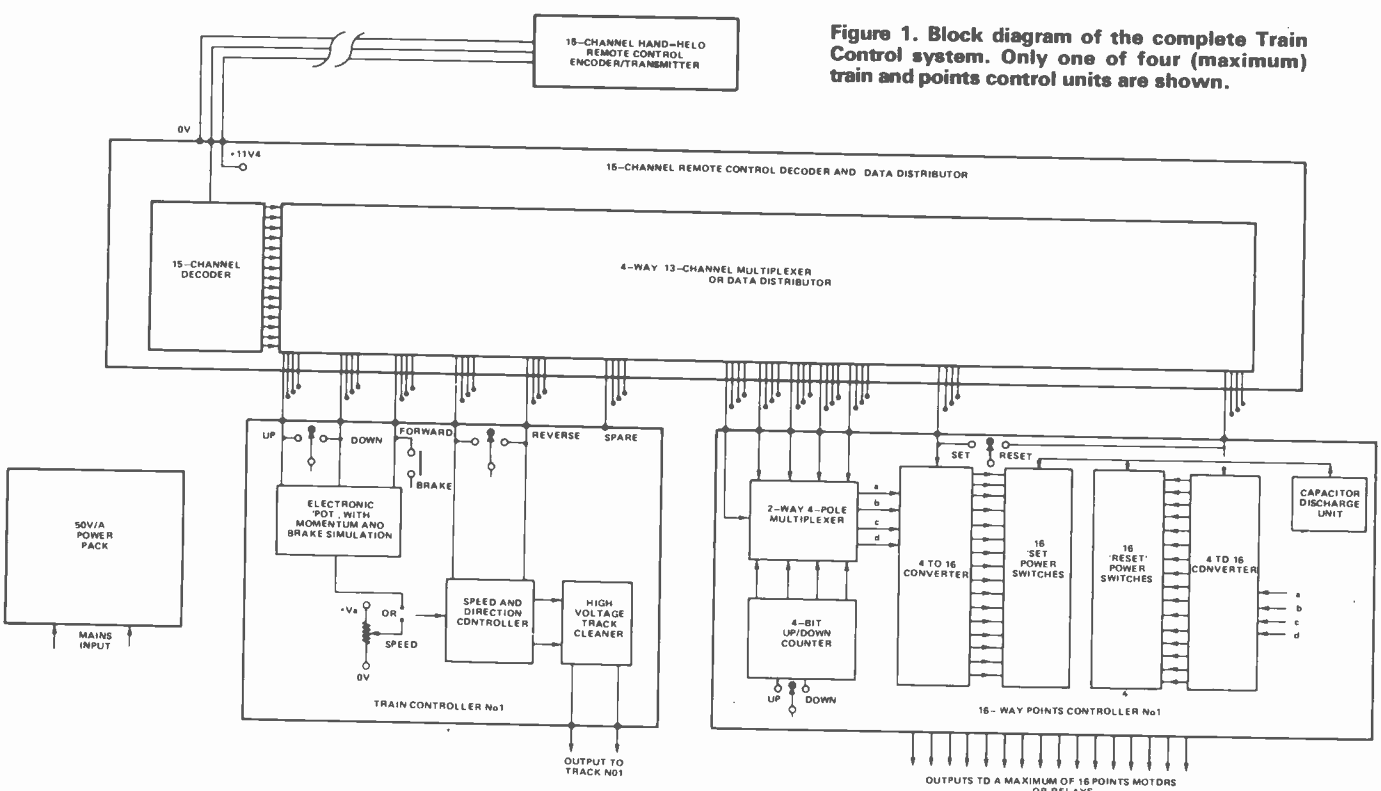
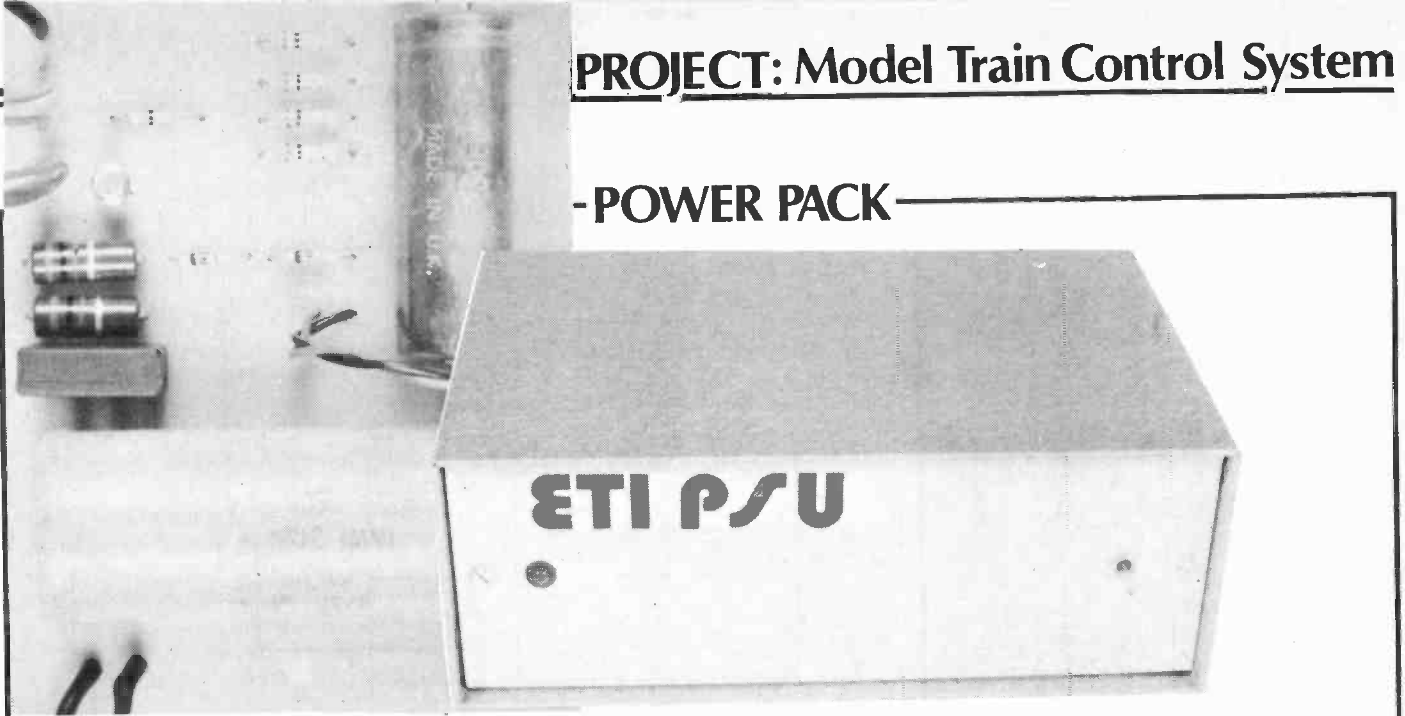
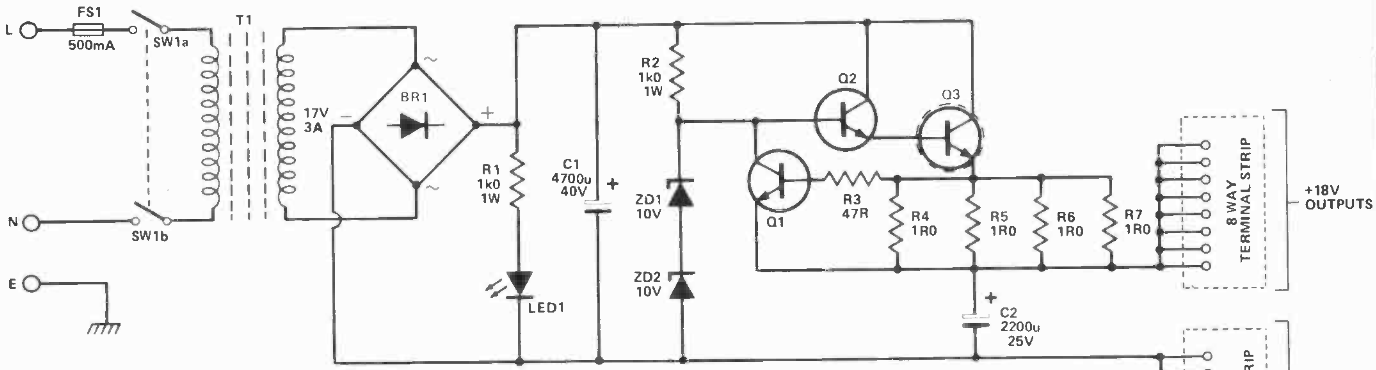


Figure 1. Block diagram of the complete Train Control system. Only one of four (maximum) train and points control units are shown.

PROJECT: Model Train Control System

-POWER PACK





NOTE:
BR1 IS 50V, 4A BRIDGE RECTIFIER
ZD1 & ZD2 ARE 10V, 400mW ZENERS
Q1 IS BC109
Q2 IS 2N3054
Q3 IS 2N3055
T1 HAS 17V, 3A SECONDARY

Fig. 2a. Circuit of the Power Pack.

HOW IT WORKS

THE POWER PACK

The circuit of the power pack is shown in Figure 2. Transformer T1 gives a 17 V 3 A output that is bridge rectified by BR1 and smoothed by C1. The resulting DC is passed on to series regulator Q2-Q3, which has overload protection provided via R4-R7 and Q1, and appears at an 18 volt level across C2. The 18V output of the unit is made available to the external units via a pair of 8-way terminal strips.

PARTS LIST

Resistors ½W 5% unless specified

R1,2	1k0 1W
R3	47R
R4-7	1R0

CAPACITORS

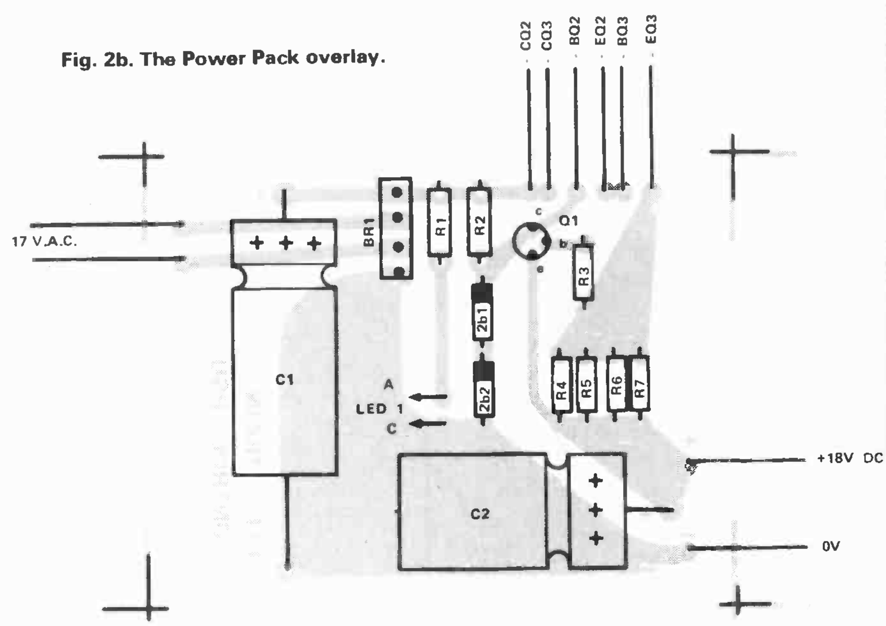
C1	4700u 40V electrolytic
C2	2200u 25V electrolytic

SEMICONDUCTORS

Q1	BC109
Q2	2N3054
Q3	2N3055
BR1	50V 4A bridge rectifier
LED1	TIL 209
ZD1,2	10V, 400mW zeners

MISCELLANEOUS
T1 17V 3A secondary, 500 mA fuse.
SW1 double pole mains switch.

Fig. 2b. The Power Pack overlay.



ensuring that the power signals are unimpaired by oxides and gunge on the track, pick-ups, and motor brushes. The track cleaner system can not be used with 2-wire controllers.

(4). We wanted a capacitor-discharge points control system that could be operated either locally or via a full remote-control facility. Similarly, we wanted a facility for remote controlling locomotives, selecting track layouts, etc., via a hand-held unit, thereby freeing the operator from the confines of the main control panel. 2-wire systems offer no advantages in any of these respects.

One final point about the concept of our control system relates to the remote control technology. If you look at the circuit diagrams of the encoder, decoder, and data distributor you'll notice that our system uses rather a large number of components. Some readers may be tempted to ask ''Why didn't we base our system on those single chip multi channel coders and decoders that are currently available for remote control of TV's etc?'' The answer is that those single-chip circuits use 6-bit code systems, which potentially give only 6 simultaneous or 64 non-simultaneous decoded output states. Our system needs and uses a 15-bit code, which potentially gives 15 simultaneous or 32768 non-simultaneous decoded output states.

BUILDING THE 'BEAST'

It is important to appreciate the flexibility of this ETI model railway control system. The Train Controller ▶

TRACK CONTROLLER

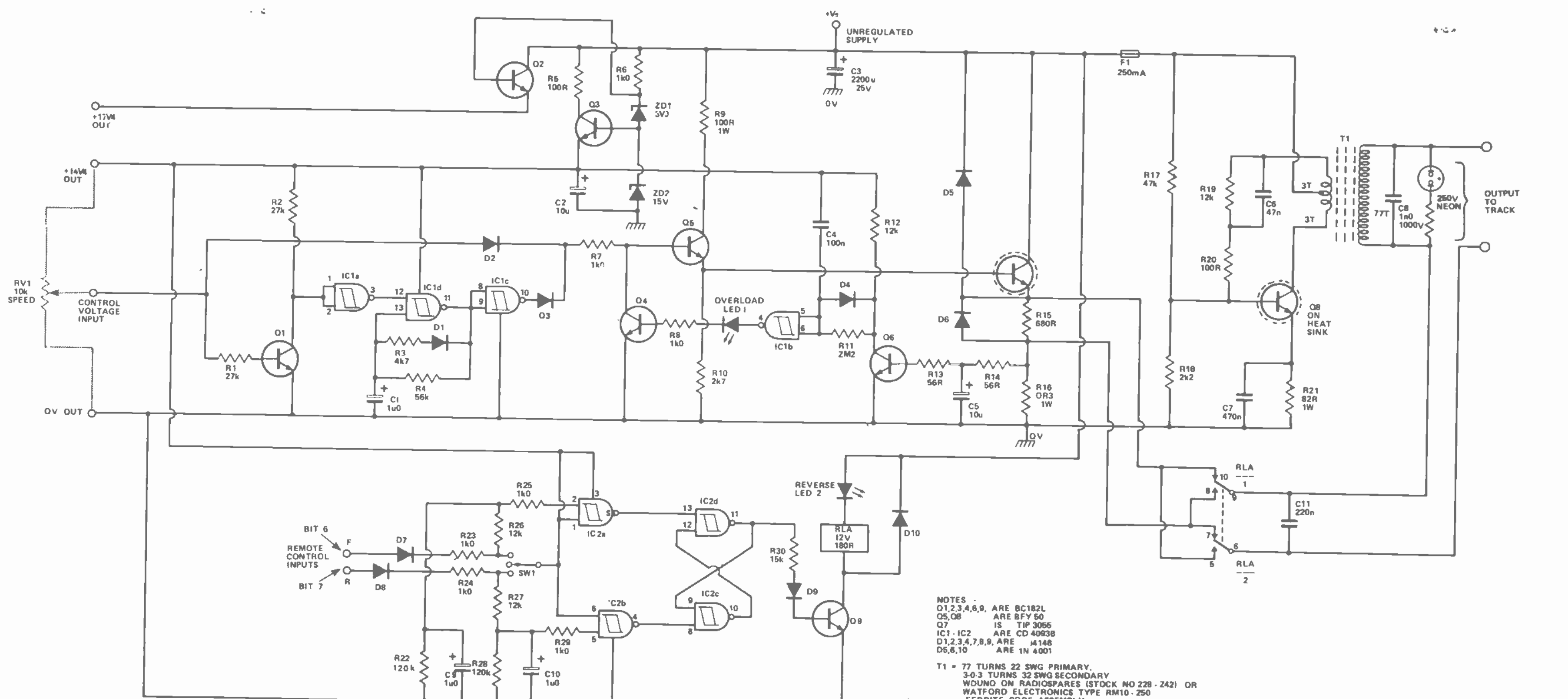


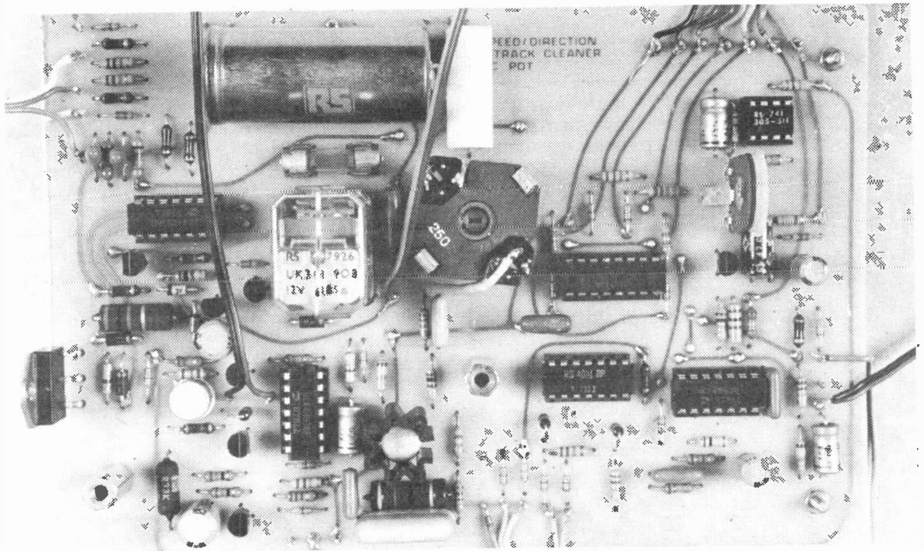
Fig. 3. Circuit diagram of one Train Speed-Direction Controller and Track Cleaner unit.

DISPLAY BOARDS TABLE

There are three identical display boards employed in this project. The overlay on p.49 is for the one used in the speed indicator. The table below gives the component changes for the other two boards. Values remain identical, but the numbering alters thus:—

TRACK SPEED INDICATOR	POINTS CONTROLLER	REMOTE ENCODER
R57 – R72	R34 – R49	R21 – R36
R53 – R56	R29 – R32	R16 – R18
R73	R33	R20
LED 3 – 18	LED 1 – 18	LED 1 – 16

New circuit number reference to relevant circuit diagrams.



The main track controller board.

HOW IT WORKS

TRAIN SPEED & DIRECTION CONTROLLER (Fig 3).
The Train Speed Controller gives excellent motor control all the way from near-zero to maximum speed, but does so without the usual motor overheating and high noise problems that are associated with conventional pulse-width motor speed control systems. The secret of this performance is a unique 'pulse-plus-voltage' motor drive technique developed by the ETI design team. The system operates as follows:

At the 'minimum' speed setting a fixed 3 mS pulse with a repetition period of about 30 mS and a peak amplitude of 12 V is fed to the loco motor via the track. This pulse produces high instantaneous but low mean energy and, just like a normal pulse-control system, causes the motor to turn over very slowly but with high torque. Under this condition the locomotive moves at an almost imperceptible 'crawl' speed. Most of the high pulse energy is absorbed in producing the 'start' current for the motor.

As the speed control is moved progressively above the 'minimum' setting a DC voltage is proportionally imposed on this fixed pulse, so the mean power to the motor, and thus the motor speed, also increases. This power, however, also ensures that the motor remains in the 'started' mode, so the instantaneous energy from the fixed 3 mS pulse progressively decreases as the motor speed rises. Motor noise and overheating problems are thus eliminated by the system, which still retains the low-speed performance advantages of the conventional pulse-width control system.

The full circuit of the speed and direction controller is shown in Figure 3. The speed of the train is determined by a CONTROL VOLTAGE INPUT, which can be derived from a conventional pot (RV1) or from the 'electronic pot' shown in Figure 4. The IC1a to IC1c network is a gated non-symmetrical astable multivibrator, and produces the 3 mS pulse at a 30 mS repetition period. At the ZERO speed setting, this circuit is gated off via Q1, but turns on when the control voltage input rises above 600 mV or so. As the input voltage is further increased it is superimposed on the pulse waveform via the D2-D3 network, and the composite waveform is reduced to a very low impedance level via Q5 and Q7 and is then passed on to the track via the contacts of relay RLA and via the track cleaner circuitry.

The speed controller is provided with efficient overload protection via the R16-Q6-IC1d-Q4 network. If an overload occurs at the output of Q7, Q6 switches on via R16 and simultaneously turns Q5 and Q7 off via IC1d and Q4 and stores an analogue memory of the overload in C4 via D4. At the end of the 'memory' period Q5 and Q7 again turn on and R16 'samples' the load condition: if the overload still exists, Q5 and Q7 again turn off; if not, they remain on. This 'sampling' system causes Q7 to turn on and off with a time ratio of about 1:100, thereby ensuring that Q7 dissipates very low mean power under the 'overload' condition. LED 1 illuminates when an overload occurs.

Note that Q3 provides a stabilized 14V4 supply to the speed, etc, control circuitry, and also to the optional 'electronic pot' of Fig 4. Q2 is used to provide a MAXIMUM of 17V4 to part of the Fig 4 circuit: this component is incorporated to ensure that the electronic pot circuit will not suffer damage if the system is operated from an unauthorised power supply with an excessive output voltage.

The direction of the train is determined by the state of relay RLA, which simply reverses the controller-to-track connections when it is switched from the off (forward) to on (reverse) state. The relay is activated via the IC2 bistable circuit, which in turn can be set or reset via SW1 or via external command signals. The rather elaborate configuration of the bistable was found to be necessary to ensure fully reliable operation in a highly hostile environment, and to give virtually fool-proof interfacing with external control circuitry.

THE TRACK CLEANER (Fig 3).
The track cleaner is designed around Q8, which is wired as a modified blocking oscillator. The circuit is tuned by the T1 inductance and by C6 and C8, and oscillates at rougtly 100 kHz. The C8 value is large enough to minimise the effects of track capacitance. Several hundred volts peak-to-peak are developed across T1 secondary, but are produced at a fairly high impedance (harmless) level.

The secondary of T1 is wound with fairly heavy guage (low resistance) wire. The train controller signals are fed to the track via this winding. Consequently, when a heavy load (a locomotive motor) is placed across the track the resulting low impedance 'kills' the oscillator output, and only the train control signals reach the track. When, on the other hand, a high impedance appears across the track (due to loss of contact with the locomotive) the oscillator becomes functional, and the high voltage plus train control signals are fed to the track. The resulting high-voltage high-frequency signal is sufficient to break through most thin films of dirt, oil, and oxides, and restore contact with the locomotive motor.

Capacitor C11 is wired across the 'input' side of the train controller signal line to prevent the high-voltage signal from reaching the electronic control circuitry. A neon lamp illuminates when the track cleaner is functional, thus indicating loss of contact with the track. The track cleaner circuitry is protected with a 250 mA fuse.

TRACK CONTROLLER

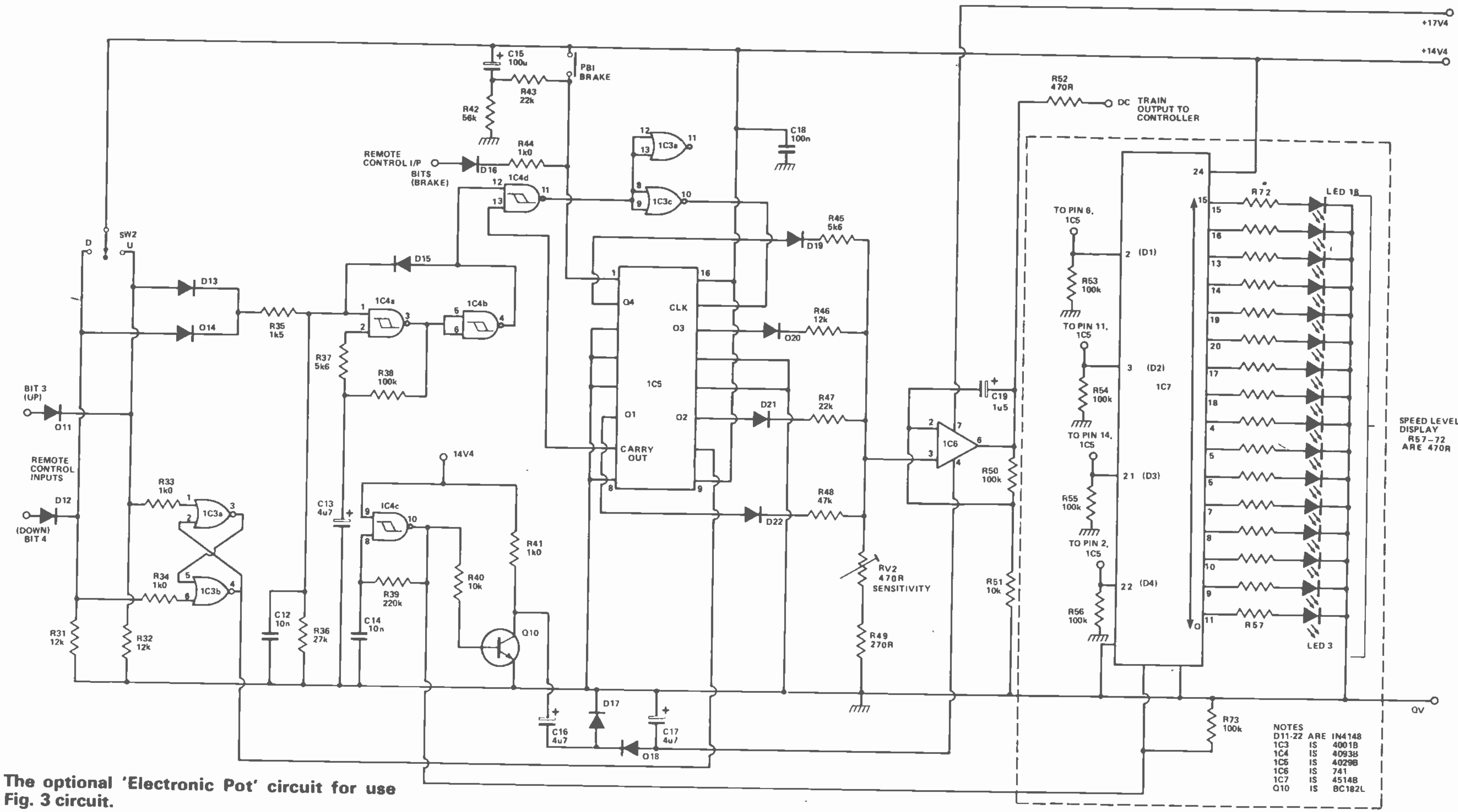


Fig. 4a. The optional 'Electronic Pot' circuit for use with the Fig. 3 circuit.

HOW IT WORKS

THE 'ELECTRONIC POT' (Fig 4)

The 'electronic pot' circuit of Figure 4 can be used to replace the conventional train-speed controller pot (RV1) of Figure 3. It has the advantage of offering 'push button' control of speed with automatic 'momentum' simulation, plus an 'emergency brake' facility, and is designed to interface with the optional remote control facility.

The heart of the unit is binary up/down counter IC5. When an UP (accelerate) or DOWN (decelerate) command is given via SW2 or via the remote control inputs, clock generator IC4a-IC4b is enabled and bistable IC3a-IC3b determines the count direction of IC5. IC5 then slowly counts in the desired direction for the duration of the command, and its binary-coded outputs are converted into analogue form via IC6 and its associated diode-resistor network, to produce a DC output voltage from R52. The binary outputs of IC5 are also decoded by IC7 and used to drive a line of sixteen LEDs, which give a visual indication of the effective output voltage (train speed) level.

The slow operating speed of the clock generator produces a simulation of 'momentum', since the counter takes about four seconds to run from the empty (zero volts output) to the full (maximum volts output) state. The counter can be reset to zero, to give an 'emergency brake' simulation, by operating PB1 or via one of the remote control input terminals.

Gates IC4c and IC3c are used to prevent the counter over-spilling, and lock out the clock signal when IC5 reaches maximum count in the UP mode or minimum count in the DOWN mode. IC4d and the Q10-C16-D17-D18-C17 network generate a neative supply voltage, which is used to provide one of the supply rails of the IC6 op-amp.

PARTS LIST

Resistors 5% ¼W unless marked

R1,2	27k
R3	4k7
R4,42	56k
R5,20	100R
R6,7,8,23,24,25,29,33,34,41, 44	1k0
R9	100R 1W
R10	2k7
R11	2M2
R12,19,26,27,31,32,46	12k
R13,14	56R
R15	680R
R16	0R3 1W
R17,48	47k
R18	2k2
R21	82R 1W
R22,28	120k
R30	15k
R35	1k5
R36	27k
R37	5k6
R38,50,53-56,73	100k
R39	220k
R40,51	10k
R43,47	22k
R45	5k6
R49	270R
R52,57-72	470R

CAPACITORS

C1,9,10	1u0 35V electrolytic
C2	10u 35V electrolytic
C3	2200u 25V electrolytic
C4,18	100n polyester
C5	10u 25V electrolytic
C6	47n polyester
C7	470n polyester
C8	1n 1000V
C11	220n polyester
C12,14	10n polyester
C13,16,17	4u7 35V electrolytic
C15	100u 35V electrolytic
C19	1u5 35V electrolytic

POTENTIOMETERS

RV1	10k log
RV2	470R lin preset

SEMICONDUCTORS

Q1-4,6,9,10	BC182L
Q5,8	BFY 50
Q7	TIP 3055
IC1,2,4	CD4093B
IC3	4001B
IC5	4093B
IC6	741
IC7	4514B
D1-4,7-9,11-22	1N4148
D5,6,10	1N4001
ZD1	3V0,400mW
ZD2	15V,400mW
LED1-18	TIL 209

SWITCHES

SW1,2	SP, changeover biassed to off
PB1	push to make

MISCELLANEOUS

T1 : 77 turns 22SWG primary, 3-0-3 32SWG around on RS 228-242 or Watford Electronics RM10-250. Neon (with resistor) heatsink for Q8. RLA : 12V at 180R.

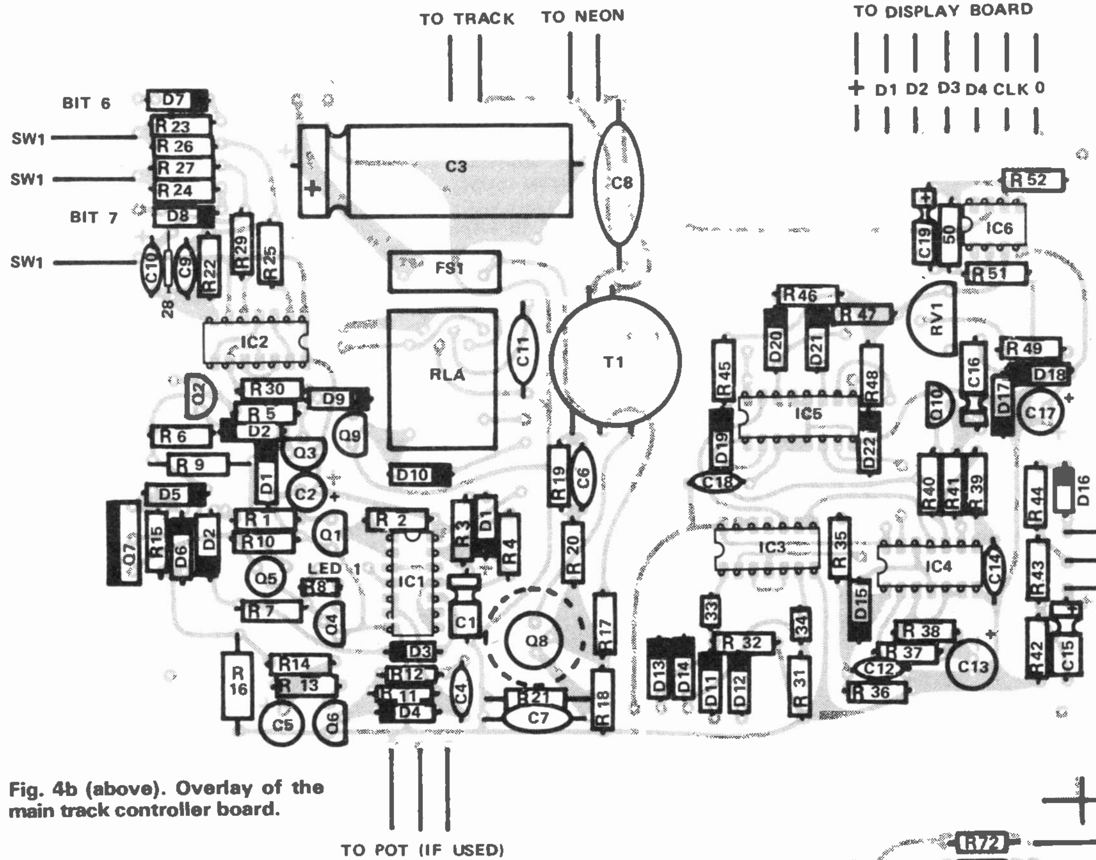
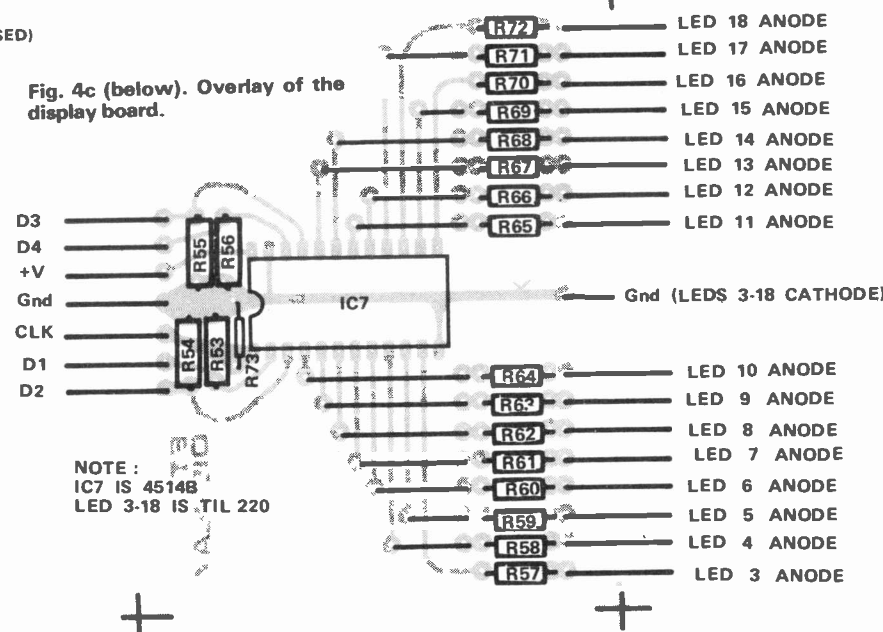


Fig. 4b (above). Overlay of the main track controller board.

NOTES :
IC1,2,4, IS 4093B
IC3 IS 4001B
IC5 IS 4029B
IC6 IS 741
Q1,2,3,4,6,9,10 IS BC182L
Q5,Q8 IS BFY50
Q7 IS TIP3055
D5,6,10 IS IN400
D5,6,10 IS In4001
D1,2,3,4,7,8,9,11-22 IS IN4148

Fig. 4c (below). Overlay of the display board.



POINTS CONTROLLER

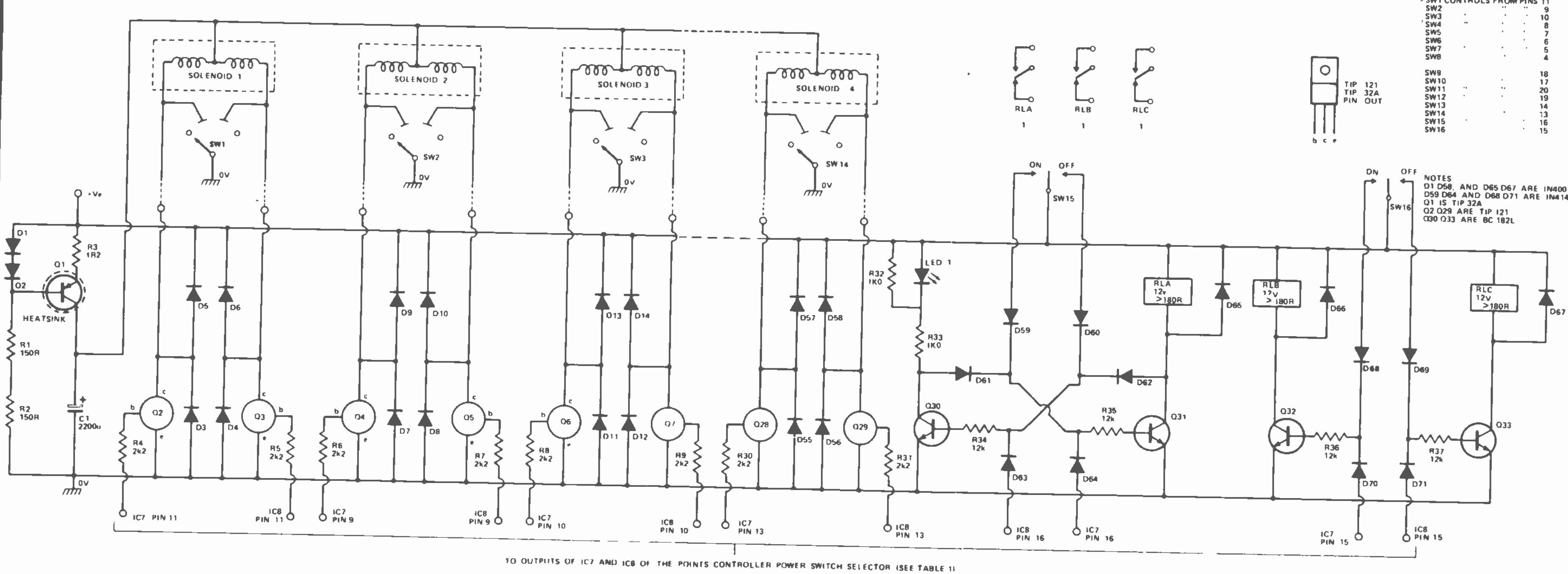


Fig. 5a. Circuit of the capacitor-discharge points controller, with optional power switches and relay activators.

HOW IT WORKS

CAPACITOR DISCHARGE POINTS CONTROLLER (Fig 5)

Conventional points motors or solenoids typically draw 2 or 3 amps from 16 volt supplies, and are easily burnt out if their operating switches are held in the ON position for more than a few seconds. The capacitor discharge system offers a solution to the burn-out problem. Here, a large capacitor (2200u) is charged up to 16 V at a rate of a few hundred milliamps, and is discharged into the motor/solenoid when the appropriate points switch is closed: the capacitor provides adequate initial energy to operate the motor/solenoid, but the available current rapidly falls to a few hundred milliamps as the capacitor discharges, thus eliminating the posibility of burn out.

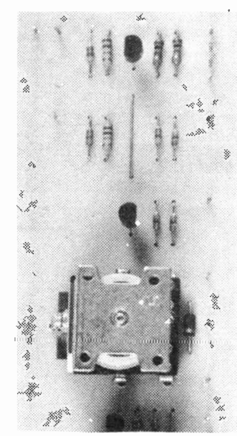
The full circuit of the capacitor discharge points controller is shown in Fig 5. Here, Q1 is configured as a constant-current generator that charges C1 at a rate of about 600 mA, typically taking about 30 mS to fully charge the capacitor. The capacitor can be discharged into the external points motors/solenoids via conventional points switches (represented by SW1 to SW14) or via solid-state switching circuitry (represented by power Darlingtons Q2 to Q29) and electronic command signals. The circuit is capable of providing several solenoid operations per second.

In the diagram we've shown connections for fourteen sets of solenoids, plus two sets of relay-driving circuitry, but in practice the unit can be used with any number of solenoids, or any combination of solenoids and relays, up to a maximum total of sixteen.

In the electronically-fired version of the circuit, each solenoid is coupled to a pair of power Darlington transistors. The solenoid can be SET or RESET by applying a 'high' command voltage to the 2k2 base resistor of the appropriate transistor. These command signals are obtained from the Power-Switch Selector & Trigger circuit of Fig 4.

The two relay-driving circuits shown in Fig 5 are presented as suggestions only. They can be omitted, duplicated, or expanded to suit the reader's own particular model railway requirements. The two circuits are designed to interface with the Fig 6 circuit, which in turn is designed to interface with a remote-control facility.

Relay RLA is wired in a bistable or double-latching mode, and can be set or reset by a momentary command signal from SW15 or from the Fig 6 circuit. Relays RLB and RLC give non-latching operation, and turn on only for the duration of a command signal from SW16 or from the Fig 6 circuit.



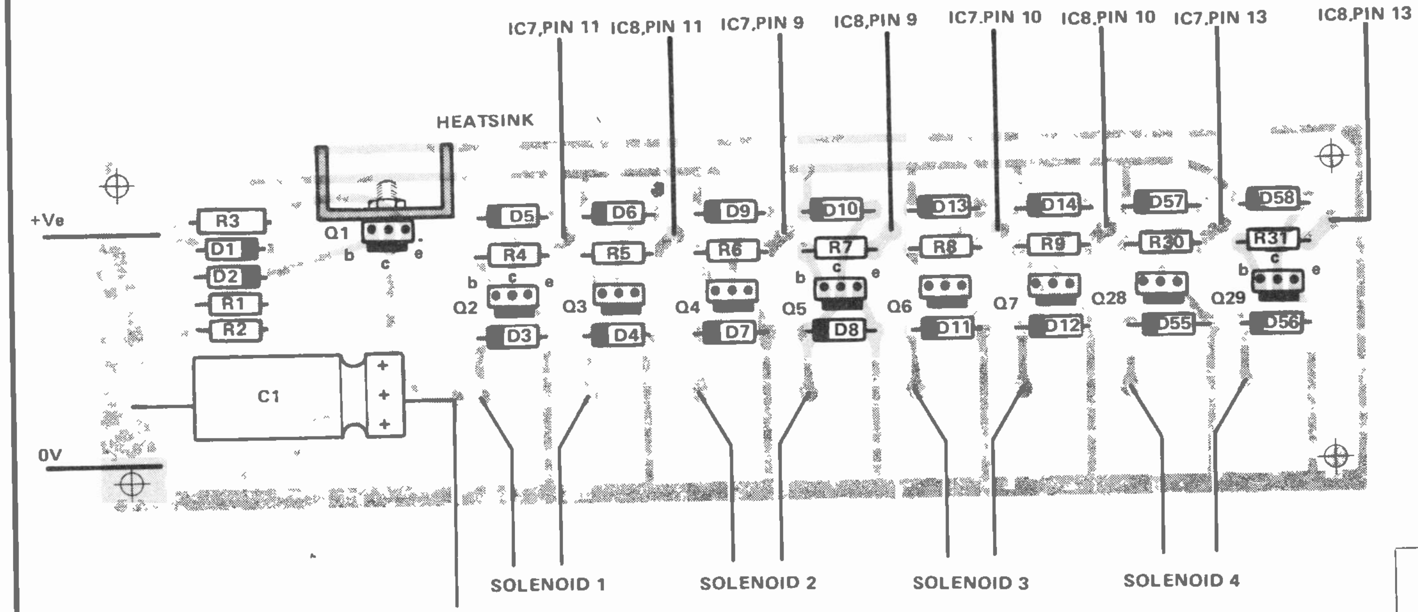


Fig. 5b. Overlay of the basic points controller board. The board can drive four sets of points.

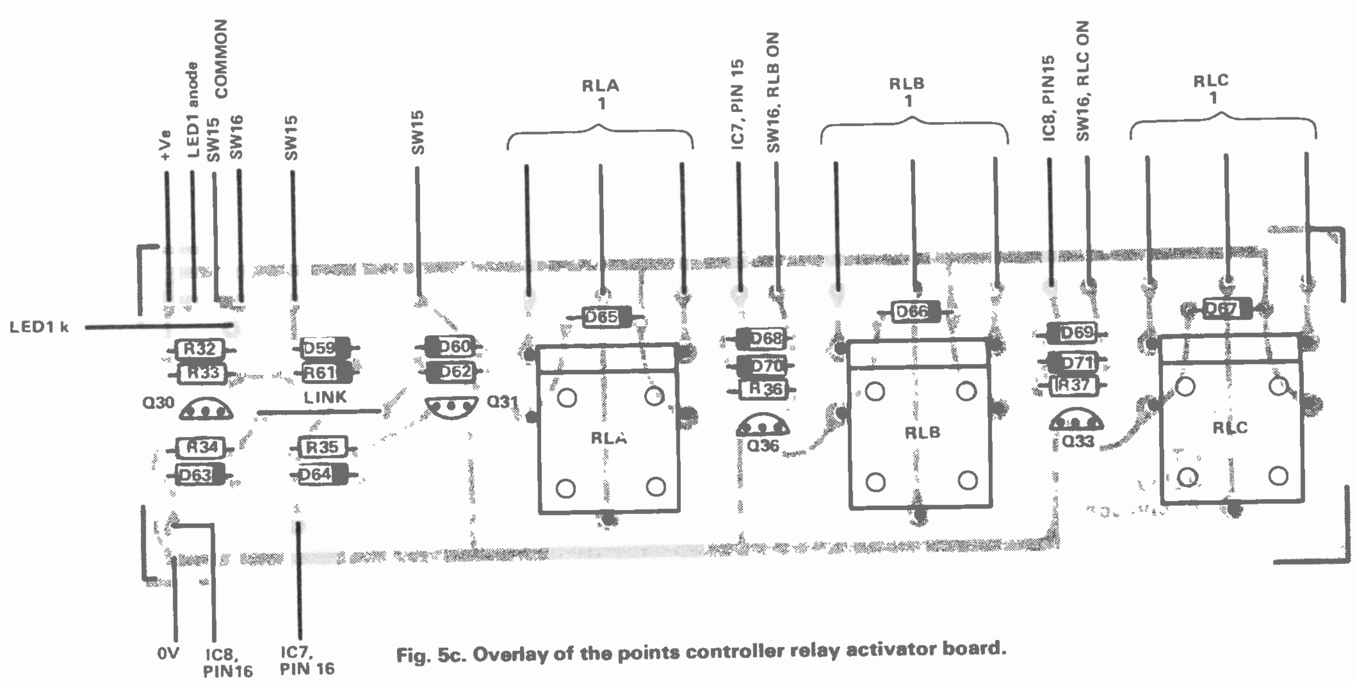
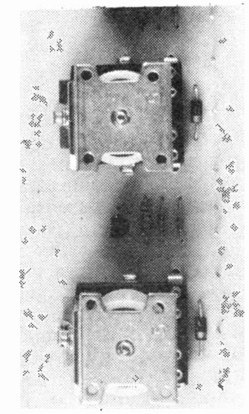


Fig. 5c. Overlay of the points controller relay activator board.



The relay activator board.

PARTS LIST

Resistors all ¼W 5%	
R1,2	150R
R3	1R2
R4-31	2k2
R32,33	1k0
R34-37	12k
CAPACITORS	
C1	2200u 63V electrolytic
SEMICONDUCTORS	
Q1	TIP 32A
Q2-Q29	TIP 121
Q30-Q33	BC182L
D1-58,65-67	1N4001
D59-64,68-71	1N4148
RELAYS	
RLA1-3	12V/180R
SWITCHES	
SW1-SW14	single pole points switches
SW15,16	SPST changeover
MISCELLANEOUS	
Solenoids to suit points units, heatsink for Q1.	

POINTS CONTROLLER

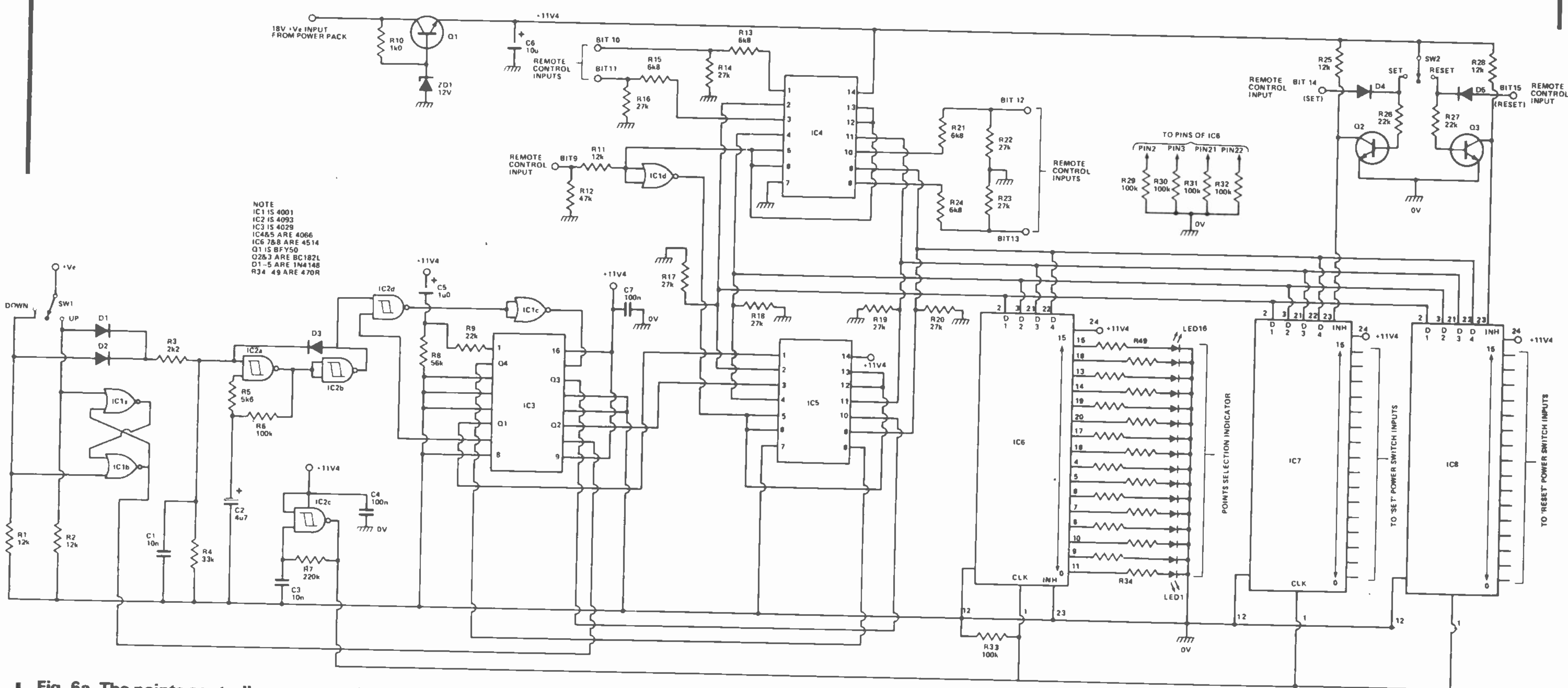


Fig. 6a. The points controller power-switch selector, trigger, and readout unit.

HOW IT WORKS

POWER-SWITCH SELECTOR & TRIGGER, ETC (Fig 6)

This circuit is designed for use with the points controller circuit of Fig 5, and enables the points and/or relays to be selected and set/reset either locally or via a remote control facility by one SELECT switch and one SET/RESET switch.

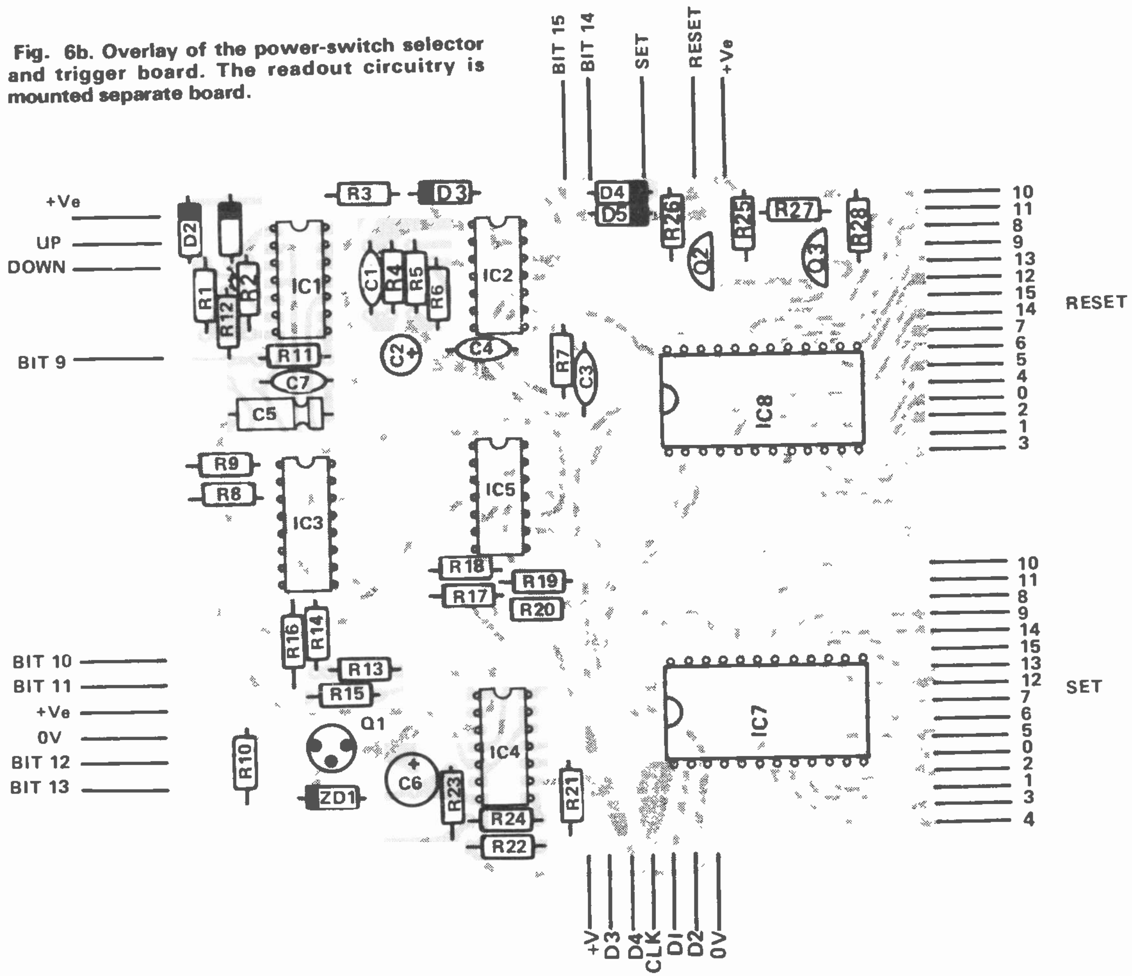
The operating principle of the unit is fairly easy to understand. To select any one of sixteen (maximum) points, a local or remote binary-coded 4-bit up/down counter is clocked in the appropriate direction. The 4-bit output of the counter is fed to three 4-to-16 decoder circuits. One of these decoders has its output permanently enabled and fed to a line of sixteen LEDs, which give a visual indication of the number of the point that has been selected. The outputs of the other two decoders are normally disabled (the decoders have 3-state outputs) and are fed to the inputs of either the SET or RESET transistors of the Fig 5 circuit. Once a desired points solenoid has been selected, it can be set or reset by simply enabling the output of the appropriate decoder, thereby turning on the appropriate power transistor in the Fig 5 circuit.

The practical circuit of the unit is shown in Fig 6. IC3 is the local up/down counter, which is clocked via the IC2a-IC2b astable. IC2d and IC1c are used to prevent counter overspill, and IC1a-IC1b are used to implement the UP or DOWN mode. IC6, IC7 and IC8 are the 4-to-16 decoders, and are clocked by IC2c. The 4-bit inputs to these decoders are derived from multiplexers IC4 and IC5.

Normally, when a '0' is fed to the input (BIT 9) of IC1d, these multiplexers feed the decoders with the 4-bit output of IC3. When, on the other hand, a '1' is fed to the input of IC1d, the multiplexers feed the decoders with BITS 10 to 13 of the remote control signal, and these bits are derived from the remote up/down counter, which has its own visual display unit. BIT 9 automatically sets to '1' when the remote control unit is turned on, so the points controller automatically changes from LOCAL to REMOTE control whenever the remote control unit is activated.

The points can be SET or RESET locally via SW2, or remotely by code BITS 14 and 15: activation is in the OR mode.

Fig. 6b. Overlay of the power-switch selector and trigger board. The readout circuitry is mounted separate board.



PARTS LIST

Resistors all ¼W 5% unless marked

R1,2,11,25,28	12k
R3	2k2
R4	33k
R5	5k6
R6,29-33	100k
R7	220k
R8	56k
R9,26,27	22k
R10	1k0
R12	47k
R13,15,21,24	6k8
R14,16-20,22,23	27k
R34-49	470R

CAPACITORS

C1,3	10n polyester
C2	4u7 25V electrolytic
C4,7	100n polyester
C5	1u0 25V electrolytic
C6	10u 25V electrolytic

SEMICONDUCTORS

IC1	4001
IC2	4093
IC3	4029
IC4,5	4066
IC6-8	4514
Q1	BFY50
Q2,3	BC182L
D1-5	1N4148
LED1-16	TIL 209

units can, for example, be built with either conventional or electronic 'pot' speed control. The capacitor-discharge points controller can either be built in very simple form for control via conventional points switches only, or can be built in advanced form for control via press-operated or remote control switches: the unit can be built to control up to 16 sets of points, or any combination (up to 16 maximum) of points or relays. The remote control facility, with its complex encoder, decoder, and data distributor circuitry, is entirely optional.

Similarly, great flexibility is possible in the combination of control units that are used on a practical model railway layout. If, for example, you have a 3-track layout with an average of 5 points per track (or some other total that is less than 16), you can either allocate one train controller and one points controller unit to each track or, more eeconomically, allocate one train controller to each track but only one points controller to the entire system.

Thus the potential builder is strongly advised to sit down and carefully plan out exactly what he wants his system to do before he actually contemplates constructional work. Remember, if you start your system off with just one basic train control unit, you can always expand the system up into a more advanced form at a later date when cash and inclination allow.

Once you've decided what you want, note that some of the PCB's used in the project are double-sided jobs: if you are reasonably confident of your PCB-production capability, you can try etching these yourself: if not, you cab buy the boards in ready-made form.

CONSTRUCTION: THE POWER PACK

All components except T1, Q2, and Q3 are wired up on a single-sided PCB, and construction should present no problems. Note that Q3 needs to be mounted on a fairly hefty heat sink: we bolted ours directly to the rear panel of the power pack case.

Transformer T1 is a 'special'. Its a 50 VA device, with a 17 Volt, 3A secondary. We built our prototype from a Radiospares 50 VA transformer kit (stock number 207-554), using 92 turns of 1mm ▶

DATA DISTRIBUTOR

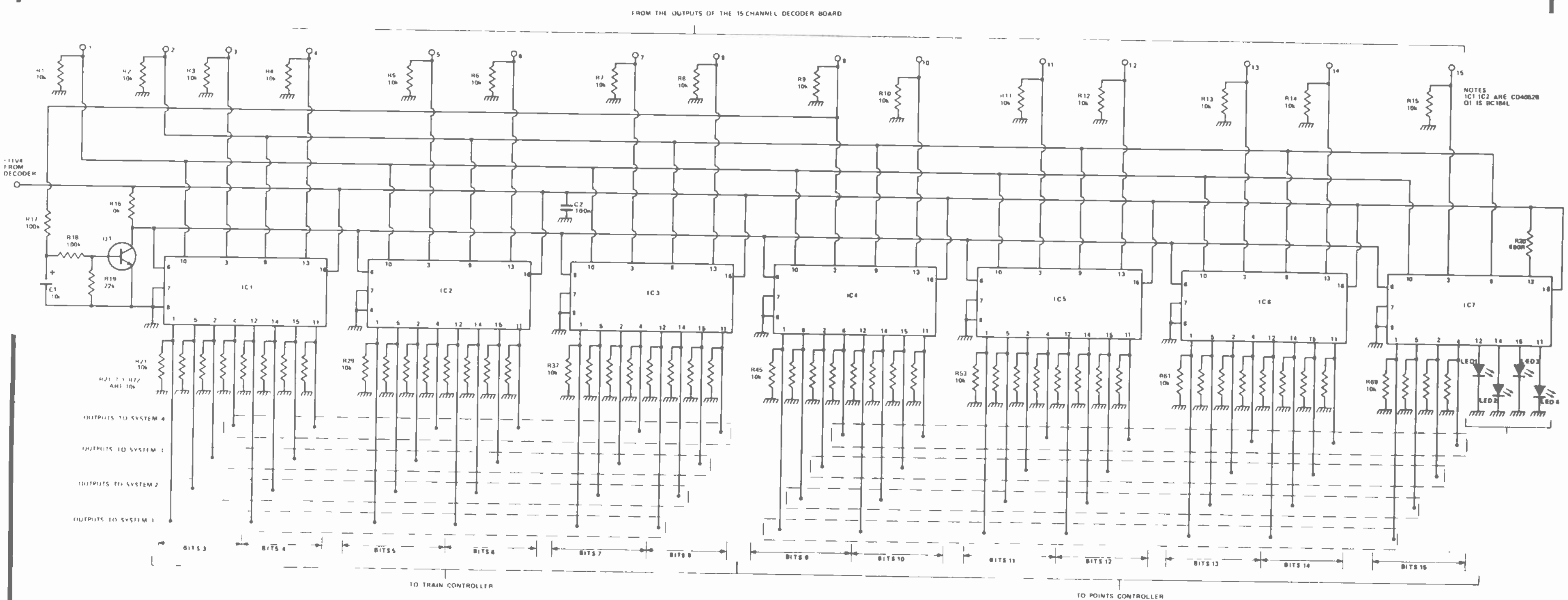


Fig. 7a. Circuit of the Data Distributor. This unit forms part of the remote control facility.

HOW IT WORKS

THE DATA DISTRIBUTOR (Fig. 7).

The purpose of the data distributor is to route the decoded outputs of the remote control system to the appropriate control units on the selected one of four possible track systems. This is achieved by feeding each decoded signal through the electronic equivalent of a single-pole 4-way switch: all 'switches' are ganged together.

The circuit uses seven CD4052B multiplexer ICs. Each of these ICs can be regarded as a dual single-pole 4-way switch. The switch positions can be selected via 2-bit binary coded DC levels fed to pins 9 and 10. The switch outputs can be inhibited by a logic '1' on pin 6.

The circuit of the data distributor is shown in Fig. 7. The first two bits of the decoded input signal are used to control the multiplexer switch positions, and thus select the desired track layout. The number of the selected track system is indicated by LEDs 1 to 4. Note that in the absence of a control signal the multiplexers will always be in the 'select system 1' position.

The outputs of all multiplexers are normally inhibited via Q1 and R16. Q1 is a simple time-delay circuit that is driven from BIT 9 of the decoded signal. It will be remembered that BIT 9 is always high when the transmitter/encoder is in use. This Q1 circuit ensures that the outputs of the multiplexers will be enabled only if BIT 9 is present for roughly 30 consecutive frame cycles (typically about one second), thereby eliminating any possibility of false signals reaching the output of the distributor when the transmitter/encoder is turned off, and thus ensuring reliable operation even on units that are connected to output 'system 1'.

The 'distributed' decoded outputs of the unit are fed to their respective train- or points-control units via multi-way sockets, there being two sockets to each 'system,' and a total of four 'systems' available.

PARTS LIST

Resistors all ¼W 5%

R1-16,21-72	10k
R17,18	100k
R19	22k
R20	680R

CAPACITORS

C1	10u 15V electrolytic
C2	100n polyester

SEMICONDUCTORS

IC1-7	CD4052B
Q1	BC182L
LED1-4	TIL 209

The remote control decoder and data distributor unit under construction.

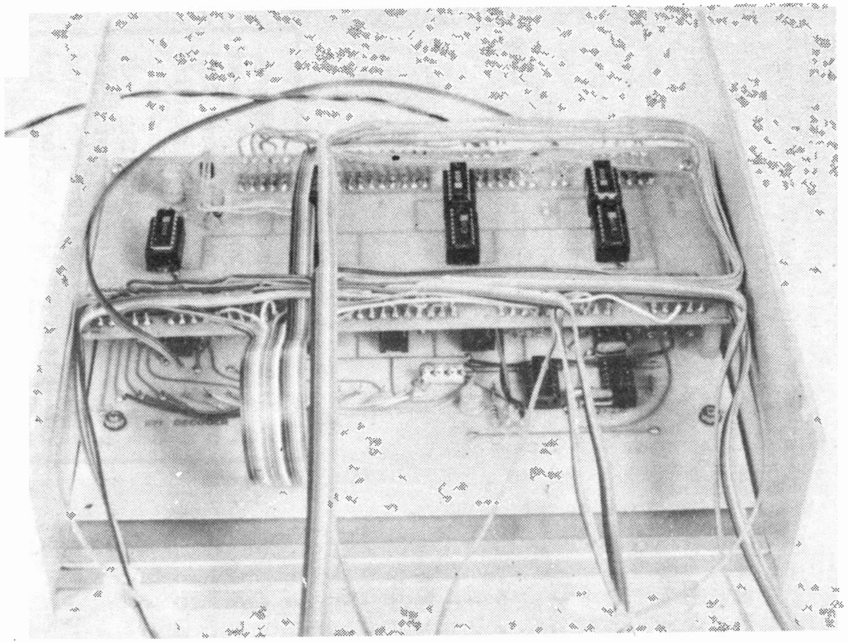
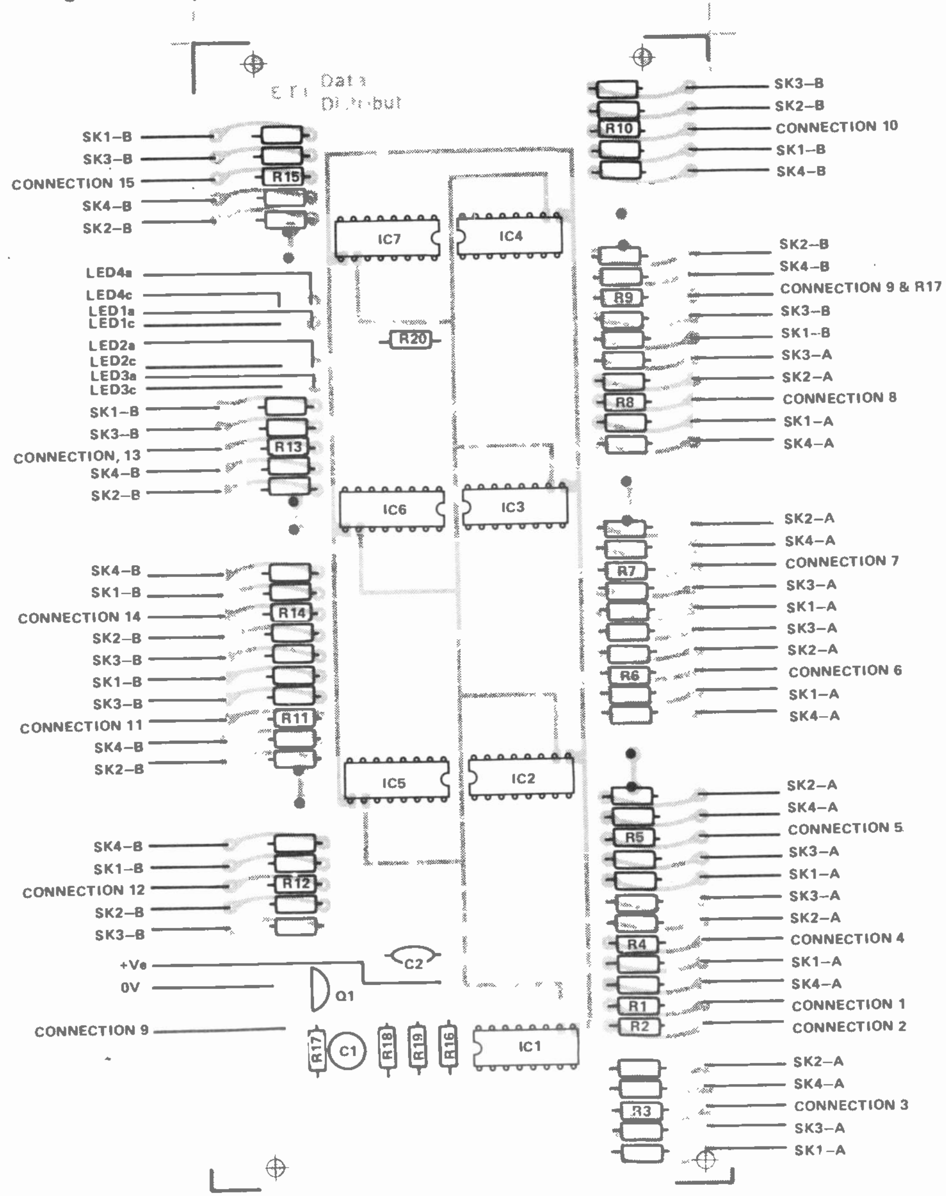


Fig. 7b. Overlay of the Data Distributor board.



BUYLINES

ALL components used in the train controller can be obtained from major stockists that advertise in this issue.

The cases are available from the following suppliers:

Boss Industrial Mouldings Ltd for the train controller (Order No. 7154 Code B) and points controller (Order No. 7304 Code B). West Hyde Developments Ltd for the remote control unit (Order Boc 680).

BOSS INDUSTRIAL MOULDINGS LTD,
HIGGS INDUSTRIAL ESTATE,
2 HERNE HILL ROAD,
LONDON SE24 0AU.

WEST HYDE DEVELOPMENTS LTD,
UNIT 9,
PARK STREET INDUSTRIAL ESTATE,
AYLESBURY, BUCKS HP20 1ET.

insulated copper wire for the secondary. We've arranged for an electrically identical transformer (ready-built) to be made available from Watford Electronics (see Buylines).

Construction: The Train Controller

This unit is built up on two PCBs, and incorporates the full circuits of both Figs 3 and 4. One of the PCBs is double-sided. The other PCB is single sided, and holds only the 16-LED display-driving components: the 16 LEDs are mounted off-board. If you intend to build the manually pot-controlled version of the unit, you can ignore the single-sided PCB, and all components shown in Fig 4.

Construction of the unit calls for a good deal of care, but otherwise should present no great problems.

Note that Q8 (in the track-cleaner circuit) needs a clip-on heat sink. Output transistor Q7 needs to be bolted to a large heat sink: we bolted ours to the train-controller case. The blocking oscillator (track cleaner) transformer is a 'special' that you will have to wind for yourself. The ferrite ▶

core assembly is a Radiospares (stock number 228-242) or Watford Electronics type RM10-250 kit. The 'primary' is wound first, using 77 turns of 22 SWG insulated copper wire. This can then be covered with a thin layer of insulated tape. The 'secondary' comprises 6 centre tapped turns (3-0-3) of 32 SWG insulated copper wire. The completed transformer is fixed to the PCB 'upside-down', with its connection tabs sticking upwards. Note that in use Q8 is connected to the 'secondary' of T1, and the output is taken from the 'primary'.

We recommend building the unit in logical sections, fully testing each section before proceeding to the next. Start with the train speed controller circuitry, and then check that it works correctly using a pot (RV1) input. Next, build and check the track cleaner, and then the direction controller. Finally, you can proceed with the construction of the electronic pot.

Once you've built the two boards you can secure them in a manner suited to your own case arrangement. On our prototype we mounted the small board on top of the larger one, using stand-off pillars. We then bolted the assembly into the case; with power transister Q7 bolted to the case rear. We then mounted the 16 LEDs into the case top and connected them to the small board.

Power connections to our unit are made via twin flex. Connections to the track are made via a couple of spring-loaded terminals: note that these terminals must have a breakdown rating greater than 800 V. The remote control connections to the unit are made via a multi-way socket on the rear of the unit.

Construction: The Points Controller Unit

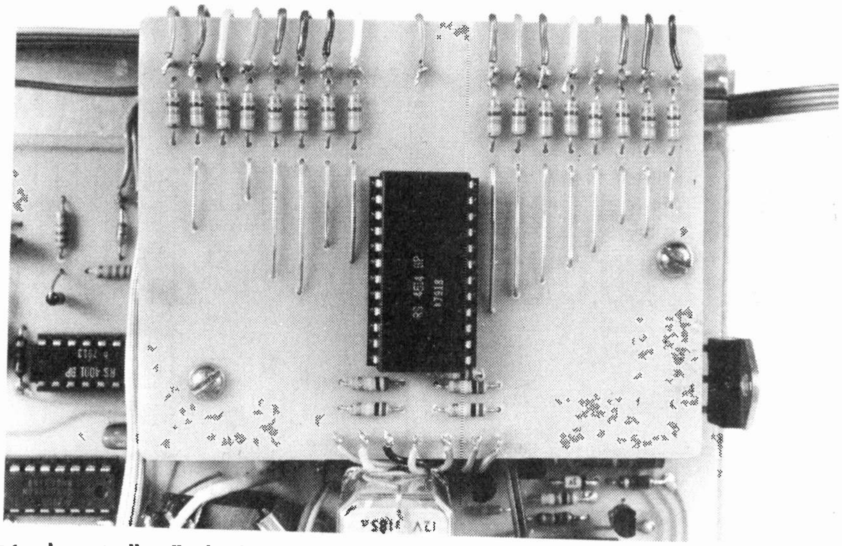
You need to give great thought to your own specific 'points control' requirements before starting work on the construction of this unit. If you want to build the ultra-simple version, consisting of a capacitor discharge unit that is fired by conventional points-control switches only, ignore our PCBs, hook up the D1-D2-R1-R2-R3-C1-Q1 section of Fig 5 on a board of your own design, and wire the resulting unit into your points system following the connections shown in Fig. 5.

To allow for maximum flexibility in the system, we've provided two PCB designs to facilitate implementation of the full Figure 5 circuit. One of these is a Relay Activation board, and incorporates all of the circuitry associated with Q30 to Q33. If you decide to build this board, use only the relay types specified. The board is single sided, and construction should present no problems.

The second PCB is marked as the CD Points Controller. It holds the capacitor discharge circuitry, plus all power transistors and diodes necessary for operating four sets of points electronically. To operate additional sets of points, use the same PCB but ignore the capacitor discharge circuitry. For a 16-points system, you'll need four of these boards. The boards are single-sided, and construction should present no problems.

The Figure 6 Power Switch Selector and Trigger circuit is implemented on a double-sided PCB, with the LED Readout circuitry implemented on an additional single-sided board. Construction of these boards should present few problems, providing the overlays are followed with due care. Test these boards carefully when construction is complete, referring to the 'How It Works' section when necessary.

When construction of the individual boards is complete, fit them in a suitable cabinet, and complete the interwiring. Power connections to the completed unit can be made via twin flex. Connections to the external points solenoids and to the points switches (if used) can be made via multi-way terminal blocks fitted to the rear of the cabinet. Remote-control connections can be made to the unit via a multi-way socket, also mounted on the rear of the cabinet.



The track controller display board. An identical board is needed in the points controller, and another in the remote controller.

Construction: The Data Distributor

The data distributor (Fig 10) circuit is also built on a double-sided PCB. Note that this board uses wire-wrap IC holders, to enable solder connections to be made to tracks on either or both sides of the PCB where necessary. Apart from this, construction should present few problems.

When construction is complete, fit the already-tested decoder board and the newly-built data distributor into a suitable cabinet, carefully interwire the two boards, and give the assembly a full functional check. When all is well, complete the wiring to the eight multi-way output sockets.

The train control system project will be concluded next month, when we present full details of the remote control encoder and decoder circuitry.

We haven't shown the foil patterns in this issue, but don't despair. Send us a large sae and you'll receive the patterns by return.

MICROFILE

This month micro-man Henry Budgett has a bee in his bonnet about standards and makes the postman redundant by suggesting we link up our home computers by telephone.

IT IS A FAIRLY accepted fact that such computer things as the BASIC language have a standard origin but no two are ever exactly the same because of the way they are implemented on a system. What really bugs me, however, is the way a wide variety of different fundamental standards are misused or even ignored. Bemused? I'll explain. Take a simple example — the size of computer memory.

Any computer engineer worth his character generator knows that, as computers work on the binary system, you can't have exact decimal type numbers. Hence 2 to the power 10 is 1024, or what we tend to call 1K. However, certain people always seem to call it 1k, which means 1000 ohms. Instant confusion. Even more often we find that a micro is quoted as being capable of supporting 64K of memory, that's 2 to the power of 16, which is actually 65536 bytes. Some companies say that their computer has 65K of memory, it looks bigger but of course it's not. Please can we standardise on 1K being equal to 1024 bytes? You wouldn't believe the number of letters I get from confused people.

The other main moan that I have with computer "jargon" is the fact that people use it quite glibly without having much knowledge of the real meanings. Take for example the acronym VDU. We had a great debate in the office about this one. The actual definition is Visual Display Unit. The dictionary further says "an output device presenting character or graphical data on the face of a cathode ray tube under program control. May also have a keyboard for data input." So your telly doesn't qualify unless it has a character generator built in!

Whilst on the subject of acronyms it often appears to me that a degree of standardisation is needed here as well. For example, you often see a certain computer language written as basic or even Basic. Unfortunately the name of the language is Beginners All-purpose Symbolic Instruction Code, and because this is a bit of a proverbial mouthful we give it an acronym 'BASIC'. The spelling is all in capitals to indicate that it *is* an acronym! The same problem occurs with Random Access Memory and its many brothers, we give them all acronyms such as RAM and ROM but you wouldn't believe that from the letters and articles that I receive for CT.

Before I bore you all to death I would like to make one other little point, we are all hearing about a new language for home computers called PASCAL. It was named after a certain Blaise Pascal, who was around in the seventeenth century. Unfortunately it is NOT repeat NOT an acronym for anything and (I reckon) should be spelt Pascal. I hope this generates some correspondence as I would like to hear your views, or indeed any suggestions for standardisation in the business. I hope we are not too late to put a little logicality back into what is after all a very logical business.

The Great Tape Rip Off?

I received a letter from a worried reader this month about the proposed levy on cassette tapes. For those of you who did not see the article in the Observer on 26th August the proposal is as follows. The British Phonographic Industries, the representative of the record companies, is discussing ways of beating the home taping business which is currently costing the recording business about £150 million a year. If you are wondering how this affects you as a home computer user the answer is this. The proposal is to put a levy on blank cassettes, and computers use cassettes! I contacted the BPI and they are aware that there are cases in which cassette tapes are used legitimately — education, language courses, etc. and it appears that they now know about home computers as well. The spokesman for the BPI said that the proposals will probably not be implemented for at least "a couple of years" and it is hoped that a way will be found to allow those parties who use cassettes legally to avoid paying the levy. The only suggestion that I could think of, which I passed on to the BPI, was that any cassette under C30 should be free of the levy. They have promised to keep us informed of the situation and I'll let you know if anything happens.

Duped On Tape

Another aspect of the cassette tape market has appeared in my post this month, a copying service. Run by Simon Stable Promotions of 46 West End, Launton, Oxon, it offers cassette duplication of programs at a cost of 33p per tape in quantities of ten or more. This should be ideal for clubs who wish to distribute members software and Mr Stable can cope with any tape system, CUTS, Kansas City, TRS-80, etc. The tapes are supplied without library boxes, although these are available at 10p each in order to keep postal costs down. He also offers a 'one-off' test service at 50p and will replace any faulty cassettes. One point should be noted before you start to send off all your commercial software. You have to sign an indemnity form accepting responsibility for any copyright laws you may break and these penalties could be heavy. You have been warned!

Club Call

Only a couple of items of news this month as I suspect everyone is away on holiday. Firstly there is news of a program exchange newsletter being set up to cover such micro's as Superboard, Nascom and the Sorcerer. A small charge will be made for the service to cover printing costs, etcetera and the publication will be known as Micro News. If anyone has a program they want to share or is otherwise interested in the project they should contact Martin Black at 11 Moorland Avenue, Crumpsall, Manchester 8. The Thames

Can't use the phone, dear, Pet's been chatting to the Smith's Apple all morning.

Valley Amateur Computer Club are very active this Autumn. Their agenda includes presentations on Shugart disks, an 808 homebrew, TRS-80 software and Hewlett Packard systems. The club meets on the first Thursday of each month at the 'Southcote' in Southcote Lane off the Bath Road in Reading at 7pm. For further information please ring Brian Quarm on Camberly 22186. It looks as though the INMC have finally started with a vengeance, we have just received the third newsletter from them. The quality of the contents has improved with some nice software on offer.

Micro Modem

The other evening I bumped into one of my ex-colleagues who still works for a certain Government department. He is an avid reader of both Microfile and CT and, whilst being a computer professional, he still has an active interest in home computing. The outcome of our meeting was the basis of a rather interesting project for any home computer owner and I am appealing for help. The idea that he proposed was to interconnect two computers via their cassette ports and the PO telephone lines. Simplicity itself really as I reckon that the phone lines can support the frequencies used by most of the various cassette standards. However, some hardware would be necessary to boost the level of the interface output into a small speaker for transmission and then, at the other end, a circuit to receive the tones and attenuate them to a level suitable for feeding into the interface at the other end. Now if anyone out there has tried this, or is prepared to try it out for us I would be most grateful to know if it can be done. If you have any details details please send them in and I will try to assemble a small project for one of the magazines. Thanks Keith, what will you think of next?

Board Boob

There was a slight mistake in last month's Mercofil (sic), what you didn't notice! The paragraph headed 'Micro Coup' actually belongs to Microdigital and not Petsoft. My apologies to anyone who may have been misled.

ETI

computing today

WHAT TO LOOK FOR IN THE NOVEMBER ISSUE. ON SALE 12TH OCTOBER

TURING OVER A NEW LEAF

The famous English mathematician Alan Turing, apart from developing the early ACE computer at the National Physical Laboratories had previously produced a theoretical machine. Called, not surprisingly, a Turing Machine it is a mathematical model of a computer. In this article by Giles Gummer the theory of these machines is explained and a simulation program is presented for the Nascom.

TRS–80 FOR YOU?

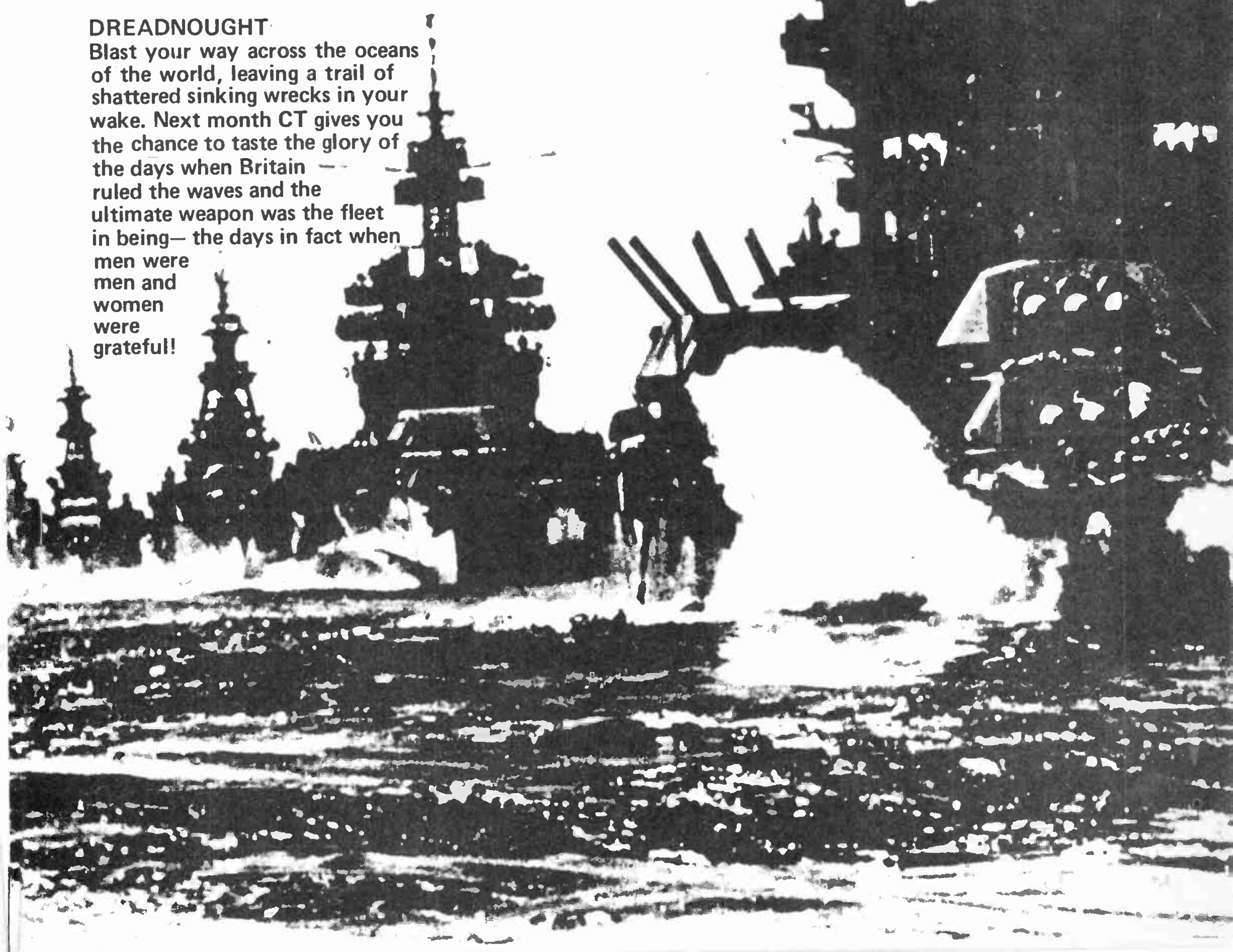
Apart from presenting the popular series on microprocessors each month Ian Sinclair has found time to take a close and critical look at the TRS-80. For anyone considering buying one of these machines this article is not to be missed as it provides a rare insight into a typical beginners problems.

TYPECASTING TRITON

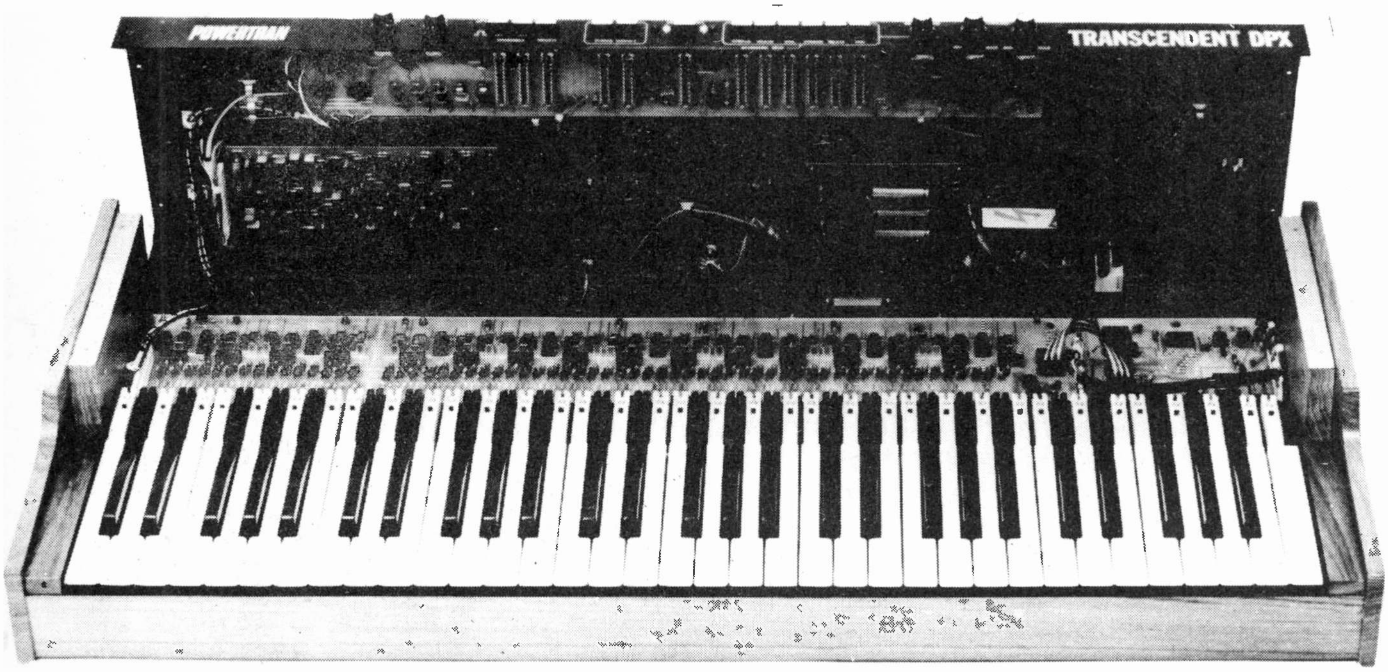
If you want a cheap, low-cost printer for your Triton we present a program and interface unit to allow you to use a GPO style teleprinter. The program also includes a mini letter editor as well as all the necessary code conversions. Print your way in style with this one.

DREADNOUGHT

Blast your way across the oceans of the world, leaving a trail of shattered sinking wrecks in your wake. Next month CT gives you the chance to taste the glory of the days when Britain ruled the waves and the ultimate weapon was the fleet in being— the days in fact when men were men and women were grateful!



STRING THING



String Thing finally bows out of ETI this month (it won't be the same without it!) with details of the dynamics section and power supply. Tim Orr (String Thing's dad) has also been giving some thought to how you put all the bits together and test the system.

The loudness of a note played on a piano is proportional to how hard the key is pressed. If the key is played rapidly then a loud note is produced. As a rule of thumb, the volume of the note should be proportional to the velocity of the key depression. By measuring key velocities it is possible to produce a piece of hardware that will generate notes with volume controlled by the initial keyboard force. Such a system is said to be touch sensitive and allows the player another parameter with which to add expression to the music.

Logic Sequence

When a note is pressed it produces a voltage which goes from −5V through 0V to +5V. The duration of the 0V period is inversely proportional to the key velocity and by measuring this period it is possible to generate an amplitude voltage for that note. The logic must perform the following sequence of events:

1 Scan the keyboard to determine if any of the keys are being pressed.
2 When a key is being pressed, i.e. sending out a 0V signal, time the duration of this period and store it in a memory.
3 When the key is fully depressed i.e. sending out a +5V signal, produce a signal (CIN) which goes high. CIN is used to enable the dynamic signal so that it will only generate a note when a key has been fully depressed.
4 When the key is released, the memory for that note is reset.
All this is done in a time multiplexed system, so that each note is interrogated, (once every millisecond, spending 16 microseconds on each note), in sequence.

The key pressed time varies from about 4 milliseconds for fast playing to between 100 and 200 milliseconds for soft playing. As each key is interrogated every millisecond then fairly accurate timing can be performed.

Controlling It

The input signal from the keyboard (MPI) is connected to two fast comparators, (IC1). The combination of the two outputs tells the logic whether MPI is +5V, 0V or −5V. This logic, (IC2, 3, 4, 5, 6, 7), then generates various control signals in response to the status of MPI. These include $\overline{\text{CIN}}$, CIN, OEN, KST', OEL, and MRW.

CIN goes high whenever a note is detected as being fully pressed. This signal is used as a carry for the adder IC11. It is used to generate a 'key-pressed' signal for the hold off vibrato circuit and its inverse $\overline{\text{CIN}}$ is used to enable the output of the DAC.
OEN is a signal that inhibits the demultiplexing network. It is a short pulse that starts just before and finishes slightly after the address changes state. The demultiplexer uses 4051 devices which exhibit some undesirable effects when the address is changed. By using OEN to inhibit them, these effects are greatly reduced. KST' is the key status signal that is sent to the memory.
OEL is used to enable the tristate outputs of the latch IC12. Both IC12 and the RAM (IC13) output data onto a common bus and so a tristate control mechanism is needed. MRW controls the memory $R/\overline{W}$ mode.

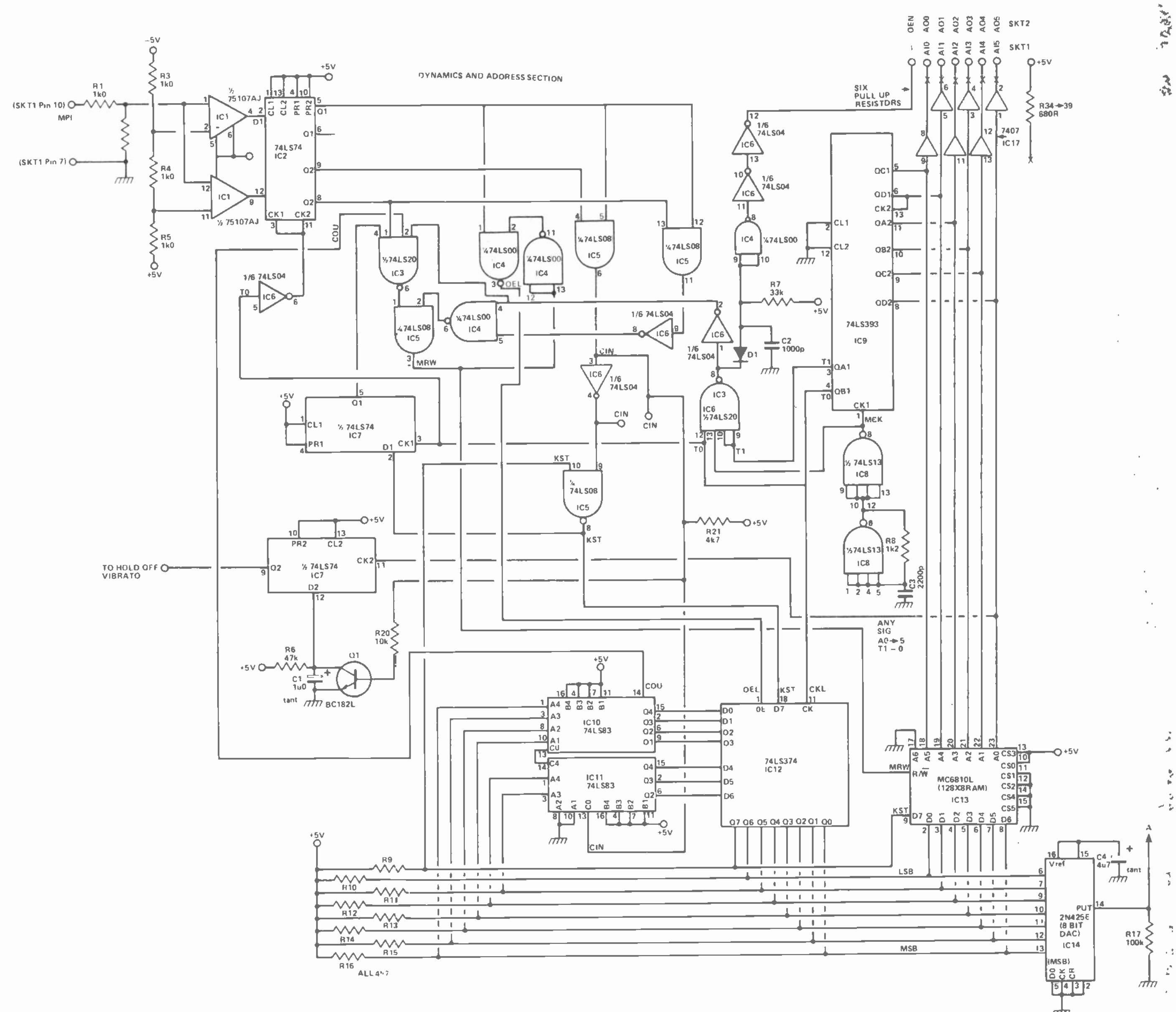


Fig. 1. Circuit diagram of the dynamics and address section.

HOW IT WORKS

When a note is pressed the sequence of events is as follows: the contents of the memory always start off with a maximum count, i.e. all ones. When MPI is determined to be 0V, the data at the address location that represents the note in question is taken out of the RAM and put into IC10, 11. These then subtract 4 from the data and then rewrite it back into the same memory address. When the multiplexing process next returns to the same key, if MPI is still 0V, the same process happens. Thus the contents of this location in memory are rapidly reduced towards all zeros. (When all zeros is reached the subtraction process halts).

When MPI is at +5V (key depressed) the subtraction process is stopped and what remains in the memory is a number proportional to the time taken for the key to be depressed. The data is constantly connected to the DAC (IC14) and so the DAC output shows all the data on the bus, including count down processes. When no keys are pressed the data is all ones and the DAC output is high. However, when keys are pressed, the down count appears as downward going pulses on the DAC output. These have to be selectively removed and this is done using a chopper switch driven by $\overline{CIN}$.

When CIN is low, the chopper switch Q2 is off and the DAC output is unaffected. When $\overline{CIN}$ is high, the DAC output is shortened to 0V and no output signal (MPO) is produced. So an MPO signal is only produced when $\overline{CIN}$ (key-pressed) is low. IC15 is used to buffer and amplify the DAC output and IC16 to further amplify and bend the transfer function making the touch sensitivity more natural. Q3 and Q4 buffer the input of IC16 providing a low impedence driver producing up to +10V of MPO signal. A small part of CIN is also mixed into the MPO signal via R26. This ensures that however lightly a key is played, a small volume note will always be produced. The dynamic operation is disabled by injecting a large DC voltage via R25 into the circuit. This always ensures a large MPO signal irrespective of the DAC output signal.

A key pressed signal is generated by using CIN to clock a retriggerable monostable made out of Q1, C1, R6, R20 and IC7. This produces a low output whenever a key is pressed and is used to initiate the hold off vibrato and squelch functions.

The address generator is a Schmitt trigger oscillator (IC8) and an eight stage binary counter (IC9). This generates the six bit address code and two internal timing waveforms. The addresses are connected to other circuits via preformed DIL connectors, this greatly reducing the wiring.

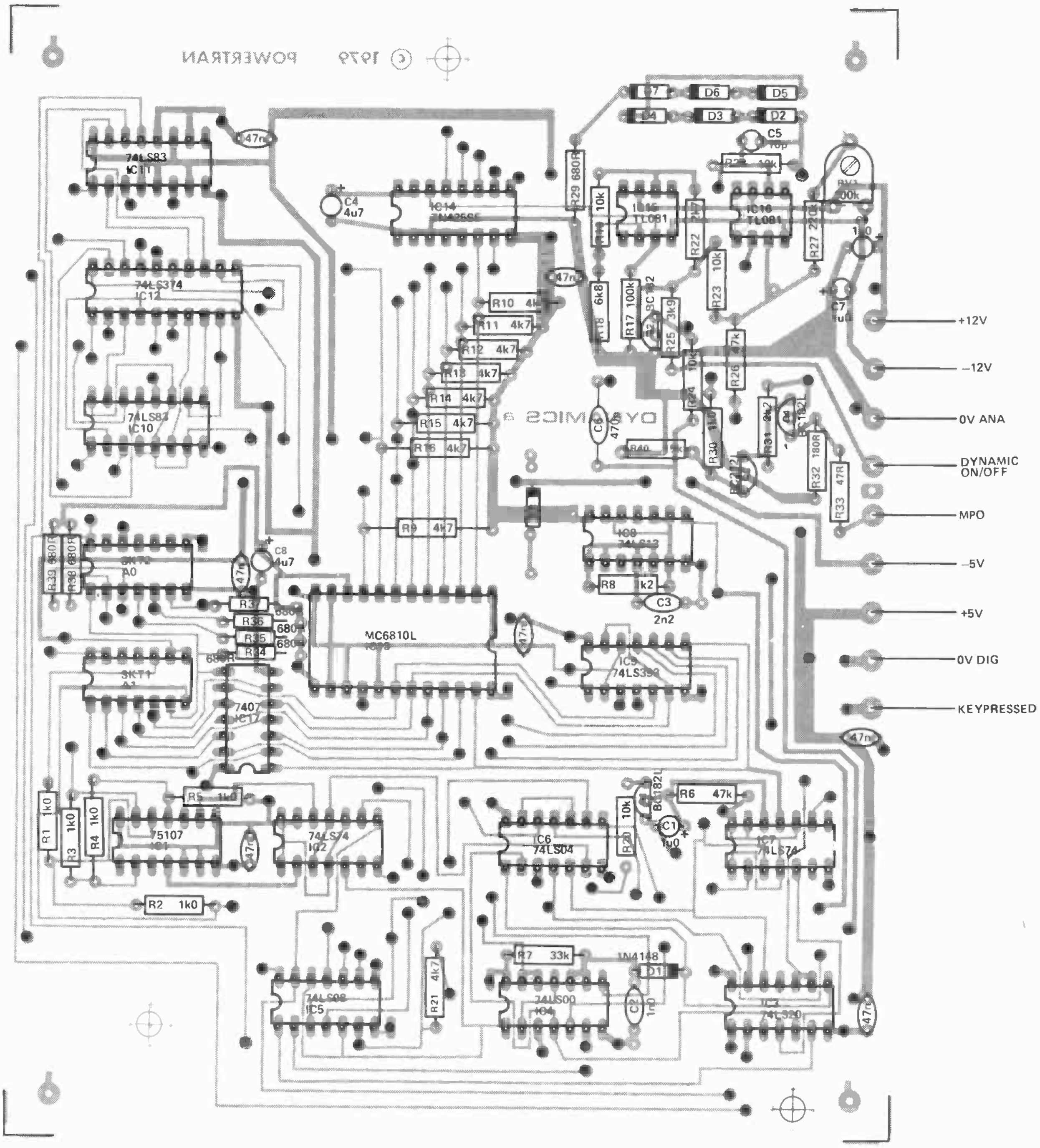


Fig. 2. Component overlay of the dynamics board.

BUYLINES

Powertran Electronics are supplying a complete kit of parts for this project at £365+15% VAT. Delivery by Securicor is £2.50 extra. Everything is included in the kit, down to the last nut and bolt. They even give you a plug.

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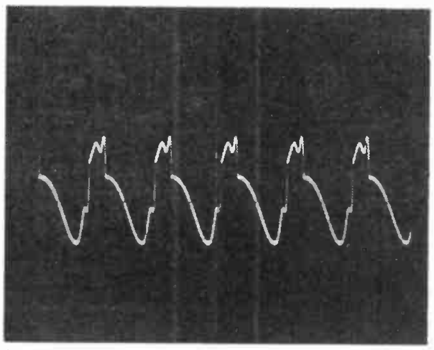
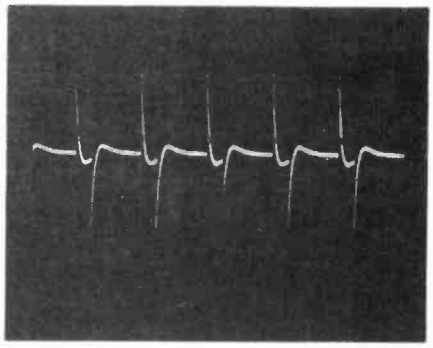




Output waveforms for honky tonk (left) and string (right).

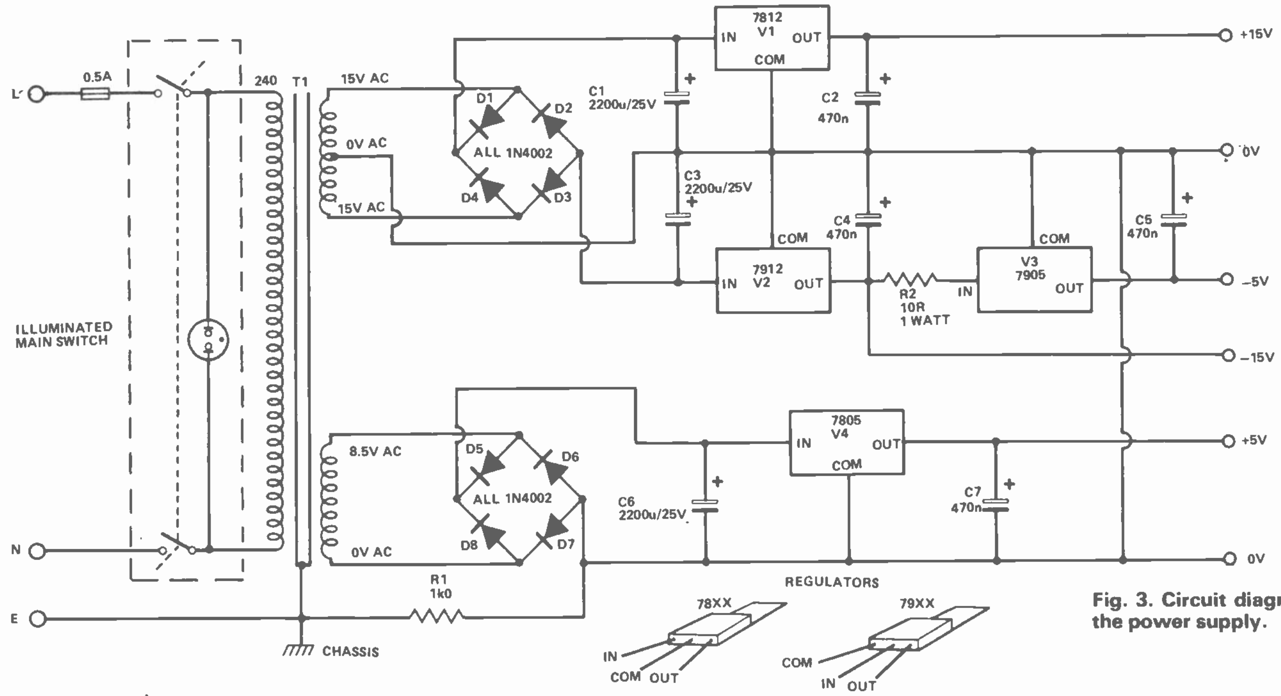


Fig. 3. Circuit diagram of the power supply.

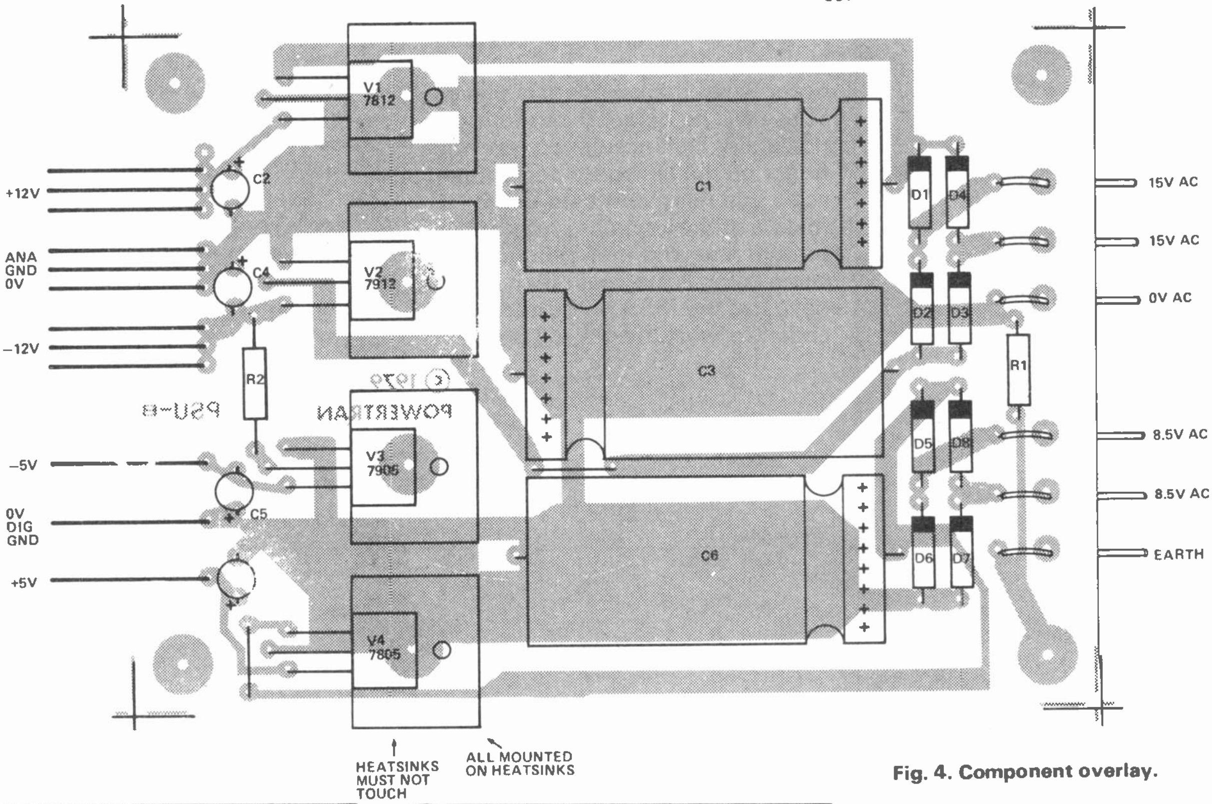
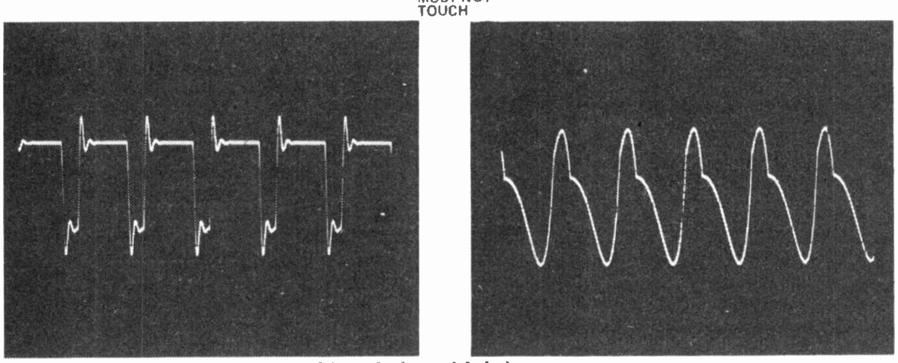


Fig. 4. Component overlay.



Output waveforms for brass (left) and piano (right).

HOW IT WORKS

POWER SUPPLY

Four power supply rails are used on this machine, ± 12 V and ± 5 V. The current consumption is relatively low and so ½ amp plastic voltage regulators mounted on small heatsinks are sufficient. To keep digital noise breakthrough via the ground lines to a minimum, the power supply has separate digital (DIG 0 V) and analogue (ANA 0 V) outputs. When assembling the power supply care must be taken to avoid letting heatsinks touch each other, as this will cause a short.

PARTS LIST

DYNAMICS BOARD

RESISTORS all 1/5%

R1-5, 30	1k0
R6, 26	47k
R7	33k
R8	1k2
R9-16, 21	4k7
R17	100k
R18	6k8
R19, 20, 23, 24, 28	4k7
R22	2k7
R25	3k9
R27	220k
R29, 34-39	680R
R31	2k2
R32	180R
R33	47R
R40	15k

POTENTIOMETER

RV1	100k horiz. preset

CAPACITORS

C1, 7, 9	1u0 35V tantalum
C2	1n0 polystyrene
C3	2n2 polystyrene
C4, 8	4u7 10V tantalum
C5	10p ceramic
C6	470p polystyrene

SEMICONDUCTORS

IC1	75107
IC2	74LS74
IC3	74LS20
IC4	74LS00
IC5	74LS08
IC6	74LS04
IC7	74LS74
IC8	74LS13
IC9	74LS393
IC10, 11	74LS83
IC12	74LS374
IC13	MC6810L
IC14	ZN425SE
IC15, 16	TL081
Q1, 2, 4	BC182L
Q3	BC212L
D1-8	1N4148

POWER SUPPLY

RESISTORS

R1	1k0 1/5W 5%
R2	10R 1W 5%

(R2 should not be more than 15mm long)

CAPACITORS

C1, 3, 6	2200u 25V electrolytic axial
C2, 4, 5, 7	470n 25V tantalum

SEMICONDUCTORS

D1-8	1N4002
V1	7812 voltage regulator
V2	7912 voltage regulator
V3	7905 voltage regulator
V4	7805 voltage regulator

MISCELLANEOUS

0.5A quick-blow 20mm fuse and holder, illuminated DPDT mains switch, 0-8.5V AC and 15--0-15V AC transformer, TV-5 Redpoint heatsinks for voltage regulators (4 off), PCB, hardware.

Assembly And Testing

Assemble the power supply and power it up. Test that the output voltages are within their correct values. Use a 1k resistor as a temporary load. The 12V rails have a ±0.5 V tolerance, the 5 V rails a ±0.25 V tolerance. Power up the dynamics board and the keyboard scan. Check the power rails are still OK. If you have a scope you can look at the MPO, MPI, Cin signals. Next power up the note generator boards. Check the power rails. Test to see that the top octave generator is running and that the dividers are working. It will be possible to see that the individual notes are working. Take care to plug the two DIL connectors in the correct way. Also note that the connector that goes to the keyboard scan is mechanically clamped (with a sticky clip) to that PCB. If it isn't then it may fall out.

If any of the address codes are faulty or missing then errors will occur when the keyboard is played. These will be binary repetitions of notes. For instance, if you run your finger up the keyboard and you get a scale that rises, and then in the middle of the keyboard returns to the bottom note and then produces the same rising scale again then you have lost the MSB of the address code. Connect the voicing board.

Check the power rails. Test to see that the voices are working. There are two presets to adjust.

The brass quality preset (PR2) should be adjusted so that when a brass sound is played there is a wide sweep of the filter.This setting is subjective and can be left to the user to select the required sound.

The mute preset (PR1) should initially be turned fully clockwise. Play a string chord and rotate PR1 anticlockwise until the output starts to be affected by the muting electronics. Then back off the preset slightly. The muting is not really needed except for chorus/ensemble effects. In this mode the signal to noise ratio is about 50 to 55 dB but this is not subjectively acceptable. With the mute in operation, 70 dB may be expected.

Lastly, connect the chorus/ensemble unit. Check the power rails. The preset alignment details were given in part one of the article. Test that the chorus effects are working and that the mute is functioning correctly.

For those who like experimenting, add a spring line reverberation unit to the system. It will widen the sound structures and also make the piano voice more realistic with its reverberent echo. ETI

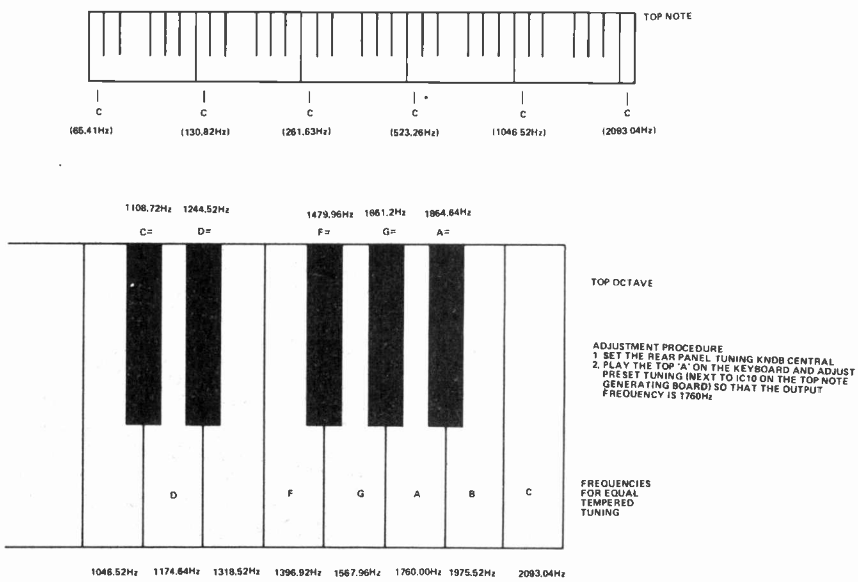


Fig. 5. Keyboard tuning procedure.

RAVEN ON...

Is it a bird: Is it a plane: No, it's David Raven of Metac Electronics, bringing you news of a future with speaking dictionaries and cheap VCRs.

CHANGES IN THE TECHNOLOGICAL world occur fast and it is often not realised what type of Society this has created. Regular readers of magazines like ETI are probably aware of the different world they see from the one seen through the eyes of people who are not up to date with the changes occuring in the electronics industry. The classic example of the void that exists was demonstrated by an entire government who last year discovered microprocessors. We now regularly hear politicians, trade union leaders and housewives discussing the inevitable changes which will take place all down to the ''silicon chip'' (that magic word). Like some modern cure-all, it provides the answers to low productivity, stagnant growth and more leisure time, or so we are told by the recently initiated. ETI readers, and anyone else who has cast an eye in the direction of a current electronics magazine during the last 7 to 10 years will have known what was happening. The effect on the way people respond to change inevitably affects companies and it is interesting to note the changes in our own industry on the firms that have responded easily to quite new products and those that have fallen by the wayside.

Examples of established companies that are growing from strength to strength with every change are not difficult to find. Electrocomponents Group better known to us as RS Components (ex Radio Spares), also including Doram and Electroplan, are probably the most successful component distributors in the UK and perhaps Europe. They seem to have handled the change from supplying radio spares in a big way. Other classic examples of traditional companies that ride the waves are Marconi Instruments and the bespoke manufacturers of Multimeters, Avo Ltd. Firms like the manufacturers of Scotch Tape, 3M, are still out there producing cassettes for mini-computers and even more amazing are companies like the Thompson organisation that straddle newspaper printiong and drilling for oil in the North Sea. Sadly there are others that do not make it and it all depends on how individuals can handle the rapid changes in technology.

The Wind of Change

Nearer home for me are retailers like Audiotronics, better known as Lasky's who have been fighting for survival for sometime, after a recent take over by chairman Geoffrey Rose who came in to bail the group out after a disastrous £1.7 million loss by their subsidiary Lasky's France. The rate of change in the Hi-Fi and associated electronic consumer products must have affected this company and, although they have now turned the corner back to profitability, time will only tell how successful they have been. In direct contrast companies. like Dixons have blossomed with profits of £10.7 million. There is no quick answer as to why some firms are able to survive technological change and others are not. However, I strongly suspect that the day a company director, manager, engineer or technician stops reading and keeping himself well informed is the day that company or person starts the technological slide down hill.

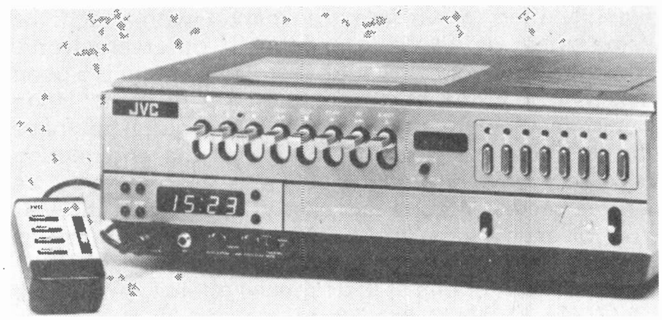


Fig 1. Video recorder in use

Video Recorders

All human things are subject to decay, — so said poet John Dryden (who was probably thinking of the phosphor glow on the telly screen) but he didn't know about video recorders. Now the image of Benny on Cross Roads can be restored at a whim and extracts from Stars on Sunday can be spliced with Deep Throat to obtain some pretty bizarre visual effects.

Current copies of the new video magazines have been promising us for some time a revolution in this industry and I have no doubt that it is happening, albeit slower than was at first imagined.

Chasing Nipon

American import figures of home entertainment electronics makes interesting reading since they reflect UK buying patterns in the near future. Colour TV imports have dramatically reduced by 1.4 million units as against video cassette recorder imports rising to nearly half a million sets last year and no doubt this figure will be greatly increased for 1979. There is still no domestic manufacturer of VCR's in the USA and, with the big exception of Philips, the UK is in the same situation. Taiwan and South Korea are ranked second and third largest exporters to the States of home entertainment electronics with Japan still firmly in the lead.

Prices of video cassette recorders are predicted to remain at their present quite high levels for some time with inflation causing effective price reductions over the next few years. These predictions are probably based on the way colour TV's have remained fairly price stable. I am a little sceptical about this, since the only reason for the price stability of TV's in the UK has been the tightly administrated patents protecting the PAL 625 line system. These patents are owned by Telefunken of Germany and are enforced in the UK by EMI. However, this situation can last for only the next year or so when the final patents run out. Restrictions on the size of receiver which may be exported from the Far East to the UK will be over and it remains to be seen what will happen. Taking in to account the drop in sales to the USA and the opening up of a previously protected market I can imagine plane loads of Japanese and other Far Eastern manufacturers descending on London with a force not encountered since those dark days just a few years ago when they removed our motorcycle industry.

Having caused sheer panic among TV manufacturers I feel sure video cassette recorders must also continue to fall in price. The main cause will be the manufacturers themselves who continue to outdate models with new technological changes that result in sales leads for them but leaving last year's model unsold unless the price is reduced. This competition will increase as more manufacturers move into the market with much the same effect as we have seen with other electronic consumer products. Although technically there is a good deal more to VCR's when compared to a TV game, Hong Kong manufacturers must not be ruled out. They have the technical expertise to produce all the engineering necessary for VCR's and it is only a matter of time before we will be seeing quite low cost VCR's here in the UK. You will of course be among the first to know about this since ETI will almost certainly be out there crashing the price as usual for one of their special offers.

Language Barrier

For some reason there is a popular misconception that you do not need to speak foreign languages if you are English. It seems that every time I go abroad all the English-speaking natives have left for England. So the introduction of an electronic pocket translation computer is good news for me.

The first to appear are being made in the states by the Lexicon Corporation. These small hand held units measure about 6 inches wide and 3.75 inches high and by plugging in various different modules you can alter the languages to those which are required.

It is all made possible by the availability of two integrated circuits: the single chip 3870 8 bit microcomputer from Mostek and a 64 kilobyte read-only memory also from Mostek. The microcomputer intercepts what is punched into a 33-key dual-function keyboard, controls the characters displayed and searches for words stored in memory. Some 1,500 words and phrases are stored in a read-only memory (ROM) in a language for every day use. Lexicon produce modules which will translate English into Spanish, French, Italian, German, Portuguese, and vice versa. It is also intended to increase the language available to include Hebrew, Japanese, Chinese and Russian.

Speaking Translator

Not to be out done Texas Instruments are first on the scene with their language translater that can talk. TI have produced a single chip speech synthesizer and four 128-kilobit lowspeed read-only memory chips which together with a plug-in ROM module gives the translator a 1,000 word vocabulary. Of the 1,000 words 500 can be displayed and pronounced, the rest are displayed only. The translator was unveiled at the 1979 International Consumer Electronics Show in Chicago and will retail in the States for about £125.00 with language modules costing £25 each.

This new area for hand held calculators is intriguing and one wonders what effect it will have when pocket translators take the place of dictionaries? It may become quite unnecessary to learn spelling which will be a relief to many young school leavers of today.

Fig 2. Language translator.

Grammar — Could do Better

However, not all the problems are yet solved as was pointed out in a recent article published in the magazine Business Traveller. The writer describes his experiences when he visited restuarants in New York's foreign language areas and it makes hilarious reading. He makes the point that the machines are literal and cannot express the nuances that make language communication an art and not a science. They are not able to distinguish between for example "like" the verb and "like" the conjunction. Grammar just goes out of the window except for a limited number of programmed common phrases. To be absolutely fair to these early models, they are a major breakthrough into a new area for consumer electronics.

It may well be the very early footsteps to a complete revolution in verbal communications between peoples of different nationalities and could result in better understanding between nations. We only have to point to the early four function calculators and basic video game to realise how fast this technology can change. Discussions are already well advanced on producing a European TV network using satellites positioned to beam programmes from other countries. It may well soon be possible to immediately translate these to different languages at the time programmes are transmitted resulting in truly international communications. ETI

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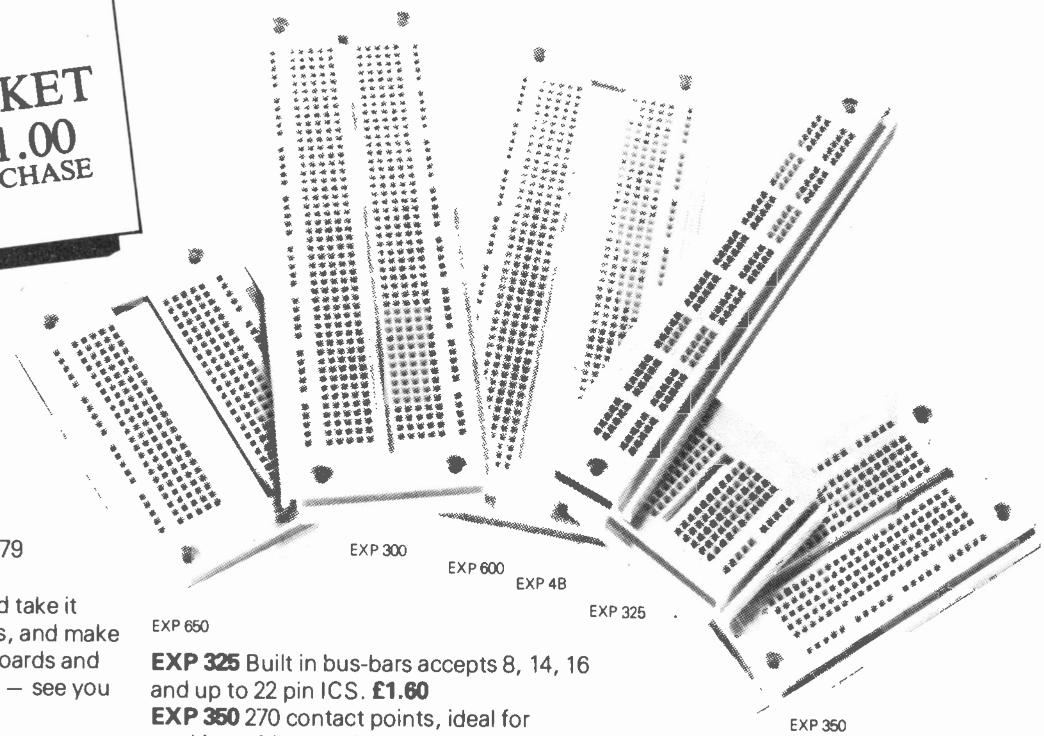

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DESIGNER'S NOTEBOOK

In this month's 'Notebook', project editor Ray Marston writes about Robots and LEDs

THE ETI DESIGN TEAM produces projects for both Eelctronics Today International and its sister journal, Hobby Electronics. At the time of writing, we're working on a small Robot, for publication in 'Hobby'. Part 1 of the HEBOT article will appear in the November issue of HE. The electronics of HEBOT are interesting. We in the design team are all particularly proud of HEBOT. You'll see why in the next few paragraphs.

The most difficult and challenging part of any Robot project is the mechanics. A strong and highly mobile chassis is required. It must have a powerful and efficient drive mechanism that will not be clogged by dirt and fluff, yet must be reasonably inexpensive.

The reason for our great pride in HEBOT is that, working in close co-operation with Remcon Electronics Ltd, we have not only evolved such a chassis, but have arranged for a fully engineered version of this basic unit, which has been christened ROBOT 1, to be produced commercially and made available at a reasonable price to the experimenter.

So, if you've ever fancied having a go at robot design or construction, you now have a chance to easily turn your dreams into reality.

The 'Robot 1' Chassis

The Robot 1 chassis is made of heavy gauge aluminium. It is hexagonal in form, and measures 10 inches across the flats. It is driven by two independent microdrive units, each comprising a fully-enclosed precision five ohm motor and a 225:1 reduction gearbox giving direct output drive to a three-inch diameter sponge-rubber tyred wheel. The tyres are approximately one inch in width, thus giving a low ground pressure and excellent traction on all surfaces from glass to carpet. The two micro-drive units are mounted on the centre line of the chassis, thus enabling the chassis to turn on its own axis when the units are driven in opposing directions. Forward and rear stability is obtained via ball castor units.

The chassis assembly comes complete with the two micro-drive units and a transparent plastic cover. The cover is 6.5 inches high, and enables 170 square inches of PCBs to be accommodated.

Performance? The chassis can travel at a maximum speed of nine inches per second, and can climb gradients of 1.1. The micro-drive units each consume 100 to 150 mA from a 4V8 supply, thus giving a comfortable three to four hours continuous running time from a pair of 500 mA/Hr Ni-Cad units.

Cost: about £35 plus VAT for a complete chassis unit and clear plastic cover. If you want more details, write to Remcon Electronics Ltd, 1 Church Road, Bexleyheath, Kent. But make sure you enclose a large stamped and addressed envelope, otherwise you won't get a reply.

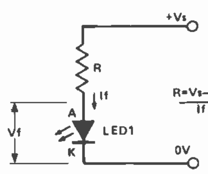
COLOUR	RED	ORANGE	YELLOW	GREEN
VF (TYPICAL)	1.8V	2.0V	2.1V	2.2V

Fig. 1. Typical forward voltage of standard LEDs (I_f=20mA).

More Robots

If you are really keen on Robots, you'll enjoy reading a new book called 'How to Build a Computer-Controlled Robot' by Tod Loofbourrow. It is probably the best 'build-a-Robot' book yet published. It describes a device called MIKE, which tops the scales at about 200 pounds.

MIKE uses slightly obsolescent technology, but is interesting because he uses an on-board micro-processor



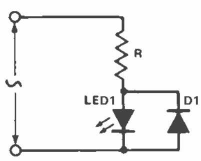


Fig. 2 (above left). Find the resistance you need for a specific current from your supply voltage with this circuit. Fig. 3 (above right) shows how to use an LED as an indicator in an AC circuit.

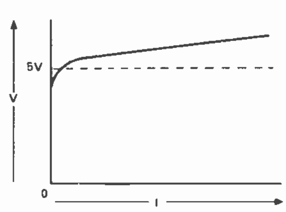


Fig. 4 (left). A reverse biased LED will behave like a zener.

unit (a Kim-1) to process sensor and other data and control motor movements. He uses ultra-sonics to detect obstacles and can, amongst other things, recognise certain spoken words. All very interesting, particularly if you are into software.

The MIKE book is published by the Hayden Book Company, of America, and is being imported into this country by NIC, 27 Sidney Road, London N22 4LT. It costs about £6. If you want more details, give NIC a ring on 01-889 9736.

Basic LED Charactersitics

Something that we all know about the LED is that it glows a pretty colour if we shove a bit of current through it. LEDs are presently available in four colours, red, orange, yellow and green. Blue LEDs will also be avaialble in the near future. A voltage is developed across the LED when it is passing a forward current. Figure 1 shows typical forward voltage of different coloured standard LEDs at forward currents of 20 mA.

When you use an LED, you have to wire some form of current-limiting device in series with it. Usually, a resistor can be used for current limiting. Figure 2 shows how to work out the value of resistance to give a particular current from a specific supply voltage: in practice, 'R' can be connected in either the anode or cathode side of the LED. The higher the operating current, the brighter the LED will glow. Most LEDs will operate safely up to absolute maximum currents of 30 to 40 mA.

You can use an LED as an indicator in an AC circuit by wiring a diode in inverse parallel with it, as shown in Figure 3, to prevent the LED being reverse biased. For a given brightness, the value of 'R' should be halved relative to that of a DC circuit.

In an LED is reverse biased, it will avalanche of 'zener' at a fairly low voltage, as shown in Figure 4. Most LEDs have maximum reverse-voltage ratings in the range three to five volts. These low ratings present a trap for the unwary user, so take heed.

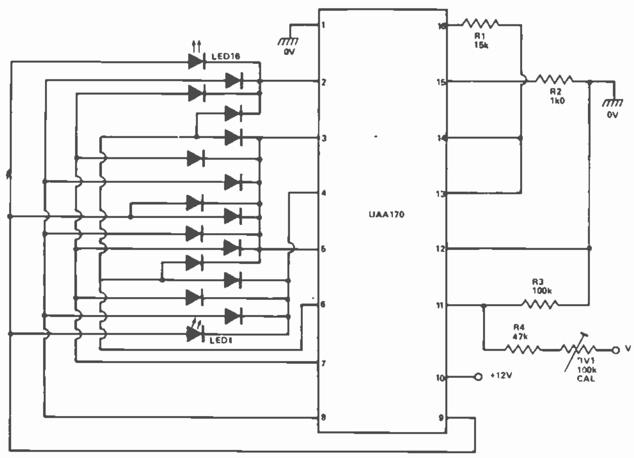


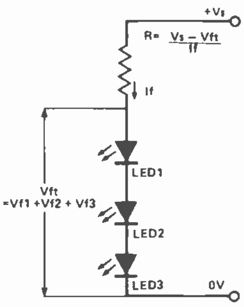
Fig. 5. Circuit diagram of a 0-10V 16 LED voltmeter using a UAA170.

LED Pitfalls

The first practical problem that you'll encounter when using an LED is that of identifying its polarity. Most LEDs have their cathode identified by a notch or flat on the package, or by a short lead. This practice is not universal, however, so the only sure way to identify an LED is to test it in the basic circuit of Figure 2. try the LED both ways round. when it glows, the cathode is the most negative of the two terminals. It is always good practice to test an LED before soldering it into circuit.

The second pitfall concerns the use of those 'cheapo' LEDs that come in Bargain Packs. These are usually advertised as 'second grade' or 'out of spec' devices, but just how out-of-spec they are can sometimes be quite mind blowing. You'll often find that half of the devices in a pack have forward voltages in the range five to eight volts, which makes them virtually useless in many applications.

If you ever need to drive a number of LEDs from a single currently available 'dot' or 'bar' LED-display driver ICs, always check its spec to see if it is sensitive to LED characteristics. The Siemens UAA170 15-LED 'dot' driver, for example, will only function correctly if all LED forward voltages are matched to within 0.5 volts, and can thus be used with first grade LEDs only. Figure 5 shows the circuit of a 0 to 10 volt 16-LED voltmeter using this IC.



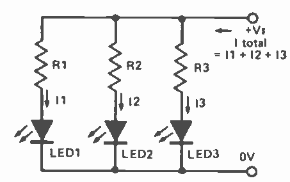


Fig. 6 (left). LEDs wired in series driven via a single current-limiting resistor. Fig. 7 (right). This circuit can drive an unlimited number of LEDs at the expense of current.

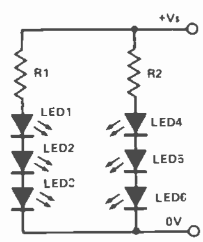
Driven To It

If you ever need to drive a number of LEDs from a single source, take notice of the Figure 6 to 9 circuits. Figure 6 shows how a number of LEDs can be wired in series and driven via a single current-limiting resistor. Note that the supply voltage used here must be significantly greater than the sum of the individual LED forward voltages. This circuit thus draws minimal total current, but is limited in the number of LEDs that it can drive.

The Figure 7 circuit, on the other hand, can drive an unlimited number of LEDs, but is very wasteful of current. The total current drawn is equal to the sum of the individual LED currents.

Figure 8 combines the Figure 6 and 7 circuits to give the best of both worlds. The circuit can drive an unlimited number of LEDs, at maximum current economy.

Figure 9 illustrates one of those 'traps for the unwary', or 'what NOT to do' circuits. This circuit will not function correctly, because inevitable differences in the forward voltage characteristics of the LEDs will usually cause one LED to 'hog' most of the available current, leaving little or none for the remaining two. ▶



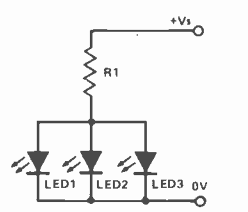


Fig. 8 (left). This is a combination of the Fig 6 and 7 circuits. Fig. 9 (right). How not to do it. One LED hogs the current.

LEDs And The CD4017B

The highly popular CD4017B decade counter with 10 decoded outputs is widely used for driving LED displays in chaser or sequencer applications. A certain amount of confusion seems to exist, however, concerning the 'correct' method of connecting the LEDs to the decoded outputs.

The decoded outputs of this CMOS device provide inherent current-limiting under short-circuit conditions. The manufacturers do not quote a maximum short-circuit current value, but practical experience indicates that currents of 10-15 mA are commonly available from the 'B' version of the 4017. A maximum device dissipation per output transistor figure of 100 mW is quoted on some data sheets, indicating that a volt drop up to about seven volts can safely be developed across a 4017 output stage under maximum-current conditions.

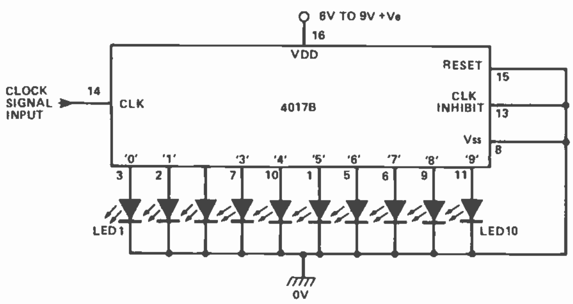


Fig. 10. An LED chaser circuit.

Thus, the LED chaser circuit of Figure 10, which has each LED connected directly between an output and ground, can safely be used up to maximum supply values of 9 volts. At voltages greater than 9 volts, the circuit of Figure 11, which has a resistor wired in series with each LED, should be used. Note that the main purpose of these resistors is that of reducing the power dissipation of the 4017B.

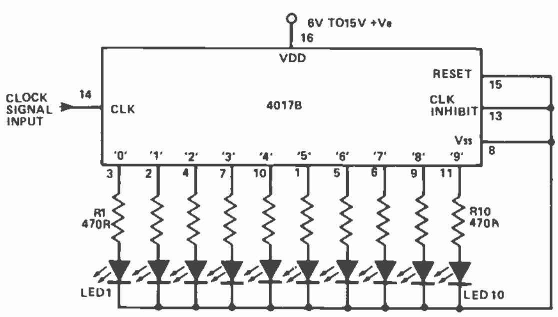


Fig. 11. For supplies greater than 9V, this circuit should be used instead of Fig. 10.

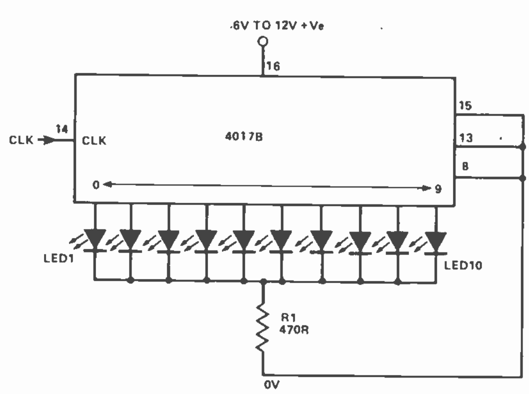


Fig. 12a. This circuit can be used with supplies up to 12 volts.

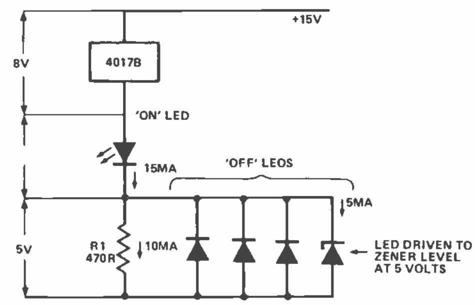


Fig. 12b. When one LED is on, the anodes of all the others are effectively grounded.

A variant that is sometimes used is shown in Figure 12a, and can be used with reasonable confidence at supply levels up to 12 volts maximum. Figure 12b shows a possible equivalent of this circuit when it is powered from a 15 volt supply, and illustrates the defect of the design. The action of the 4017 is such that when a given LED is ON, the anodes of all other LEDs are effectively grounded. R1 thus causes the OFF LEDs to be reverse biased. Because of the low reverse-voltage ratings of LEDs, it will often be found that one of the OFF LEDs will Zener at about five volts, giving the results shown in the diagram an possibly causing a destructive power overload in one of the 4017B output stages. Figure 12 thus represents a classic 'trap for the unwary' type of LED circuit. ETI

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10 PROJECT SPECIAL

Ten (10), yes ten projects for you — everything from a flash trigger, for all the budding Patrick Lichfields out there, to a versatile 1 minute to 20 hours timer. There's something for everyone — a rain alarm to warn you when it's welly time and a hum filter to give your hi-fi for Christmas.

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MICROSENSE

PART 4

A very simple example of interfacing to an MPU via a port is the type of hand control used in TV games for 'bat position'. This is a simple potentiometer and as such cannot be understood by a port or any other TTL circuitry. To interface a potentiometer to an MPU we can use a simple monostable such as a 555 timer or a 74123. With this type of IC a trigger signal causes an output signal to change state, after a time this output will revert to its original state, the time being set by an external capacitor and resistor network. If part of the resistor network contains a variable resistor such as a potentiometer than changes in the position of the potentiometer will change its resistance and will thus change the delay time of the monostable.

Let us take an example of such a circuit where at one end of the travel of the potentiometer the output changes state for 100 mS and at the other end the delay is 200 mS, thus we have a variation of 200 mS. The trigger of the circuit is connected to a port output bit and the delay output is connected to a port input. The MPU can thus trigger the monostable and then delay for a fixed time to make up the first 100 mS. If the MPU now performs program loop which reads the port input bit until the monostable output reverts to its original state we get—

```
START.      Set Trigger
            Delay 99 mS
            Set Count to zero.
LOOP.       Read input bit.
            If changed go to END.
            Add 1 to count.
            Delay reset of 1 mS
            Go to LOOP.
END.        At this point count contains 0-99 which
            represents a setting of the potentiometer.
```

The count at the end can be used as a variable in a program which can thus know the current position of the potentiometer and even its rate of change.

The potentiometer can obviously be changed for any other form of variable resistor (thermistor, LDR, pressure transducer) or in a similar manner with variable capacitance, voltage or current. Thus your MPU can sense variable inputs with an interface which costs about £1, several such circuits could be interfaced to an MPU to produce a very complex monitoring system.

Output Interfacing

Similar circuits in reverse can be used to allow an MPU to output a variable voltage and thus perform such tasks as heat or speed control or something as simple as playing tunes. The more usual output requirement is as a switched output, either as a pulse train or as a single ON/OFF switch. The pulsed outpug can be used to input to TTL type circuitry such as a counter chain for use in siuch things as IC testing. Here the CLOCK, RESET and LOAD signals can be simulated by the MPU which can also test the outputs from the counters or other ICs and thus check out a PCB or a single IC much faster than a human being.

Any form of ON/OFF conmtrol which can be driven from TTL type ICs can be driven from an MPU PORT. Examples are relays, SCRs, lamps, bells, solenoids, displays, knobs and whistles, with appropriate interfacing and/or buffering as required.

Summary

With this type of MPU interfacing plus the interface to humans in the form of a keyboard and a VDU or displays, the MPU can perhaps be seen to be similar to a PCB full of TTL type ICs. The main advantage of the MPU over the TTL is that the functions of the MPU can be quickly and easily modified to perform different tasks or the same tasks in a different sequence simply by changing the program controlling it.

Take our earlier example of a TTL checker, a totally automatic IC checker made from TTL would be almost impossible to build. With an MPU, two 8 bit I/O ports and a 16 pin socket most IC types can be checked by—

```
ENTER IC TYPE ? 7400.
7400 FAULTY AT PINS 8, 9, 10. NEXT—
ENTER IC TYPE ? 7447
7447 FAULTY AT PINS 4, 10, 14 NEXT— etc.
```

This is a very simple example of the use of an MPU by industry or by the amateur constructor. Of course, five minutes after doing the above the same MPU and PORT could be used to play TV games or dispense petrol.

Glossary of Terms

ABSOLUTE ADDRESS:
A fixed microprocessor address. The ACTUAL ADDRESS of line two of the SCRUMPI 3 VDU starts at OE20, its address RELATIVE to the start of the VDU is +x'20'.

ACCESS TIME:
Time taken for one complete access of a peripheral to the main MPU chip. The time taken to address a RAM chip, the RAM chip to respond and put the data at that address onto the output pins and for the MPU to read this data into the main chip is one complete ACCESS CYCLE, a typical ACCESS TIME for this cycle might be 1000 nS or microsecond.

ACCUMULATOR:
A register or latch internal to the MPU where data is stored temporarily before being sent to another location internal or external to the MPU chip.

ADDRESS:
The number which represents one unique location external to the MPU chip where data can be read or stored. The MPU handles this address in Binary format but it is usually referred to in Hexadecimal format.

ADDRESS BUS:
The set of output pins from the MPU chip and the associated circuitry linking them to other devices for the purpose of addressing those chips or parts of them.

ALPHANUMERIC:
A character set which mixes ALPHAbetic characters, NUMERIC characters and usually punctuation characters. The Alphabetic characters may be upper and/or lower case or even in a Japanese or Arabic script.

ALU:
The Arithmetic and Logic Unit internal to the MPU chip. This register handles all arithmetic and logical operations carried out as part of an MPU instruction.

ASCII:
American Standard Code for Information Interchange. A standard which is used to define the meaning of some bit patterns when expressed as an ALPHANUMERIC character set. SCRUMPI 3 uses the 64 character ASCII set as VDU characters..

ASSEMBLER:
A simple programming language which allows the programmer to define labels and fixed values and to then use these labels with a mnemonic instruction set to produce a machine code program.

ASYNCHRONOUS:
Refers to an external interface which can be started and stopped by the MPU or other equipment. The opposite is SYNCHRONOUS which means that the data is randomly available.

BAUD RATE:
The number of bits transmitted per second in a serial data transmission system. The number of bits per second may also include control bits as well as data bits.

BCD:
Binary Coded Decimal. A numbering system where each decimal number is represented by a pattern of bits which represent a binary number.

BINARY:
A counting system where the value of any digit can only be 1 or 0. As with decimal the right hand digit denotes the number of units of the next value, etc. In Decimal the units can be 0-9 and in Binary 0-1.

BIT:
A single binary unit of data, which has a value of 0 or 1.

BREAKPOINT:
A point in a program where the program flow is interrupted for the purpose of testing the logic of the program up to that point. Usually a breakpoint will transfer control to a routine which will display test data.

BUG:
When your MPU doesn't do what you expect it to and you cannot find out what it is doing or why, then you have a BUG running around. It is not advisable to hunt this sort of BUG with a foot or insecticide, use BREAKPOINTs.

BYTE:
A unit of data which is usually the maximum amount of data that can be handled or transferred at any one time. With an 8 bit data bus the SC/MP has an 8 bit BYTE. Other computers and microprocessors have bytes of 4, 12, 16 or 24 bits.

CLOCK:
A strobe signal which activates a certain sequence of operations.

COMPILER:
A high level, English like programming language which converts the instructions into machine code for later execution. Examples of such programming languages are COBOL, FORTRAN and PL/1.

CPU:
Central Processing Unit which decodes instructions and controls other units accordingly.

CUTS:
Computer Users Tape System. A standard method of recording data in serial form on an audio cassette recorder. Data is recorded at 300 baud by recording 8 pulses at 2400 Hz for a MARK, or 4 pulses of 1200 Hz for a SPACE.

D.M.A.:
Direct Memory Access. Direct access to a block of memory by more than one system. For example; in Scrumpi 3 the V.D.U. RAM is usually continuously accessed by the V.D.U. counter circuits, or it can be D.M.A.'d by the microprocessor which temporarily disables these counter circuits.

DATA BUS:
The output pins of the MPU chip and associated circuitry used for the transmission of data from one point in the system to another.

DEBUG:
A method of fault finding in programs usually using data dumps and breakpoints. This would be handled in software by a DEBUG routine.

DIRECT:
A method of expressing an absolute address in an MPU instruction where the actual address would be specified in Hexadecimal in the instruction.

DUPLEX:
Simultaneous transfer of data in two directions.

EPROM:
Erasable Programmable Read Only Memory. A type of memory chip which can hold data stored in it without the need for a power supply. Once programmed the data can only be erased by exposing the physical chip to intense UV radiation. Older references to EPROM may refer to the advent of Electrically Programmable ROMs as opposed to the Mask Programmable ROMs where the data is introduced during manufacture, neither of these types of ROM are erasable (except with a large hammer).

EAROM:
Electrically Alterable ROM. Similar to the EPROM, the EAROM can be erased by a sort of reversed programming with a high voltage. The EAROM is thus like a RAM which will not lose its data if power is removed.

FIRMWARE:
Data stored in a non-destructive form such as hard-wired or in a ROM.

FLAG:
An output pin which can be used to signal binary status to an external device. Think of it as the 'Flag' on a Taxi denoting whether the taxi is playing for hire or 'Hired'.

FLOPPY DISK:
A medium for recording data on a plastic disk. A floppy disk is a disk of magnetic coated plastic about 8" in diameter, data is recorded around the disk as in a gramophone record except that there is not one continuous groove. Data is read or written by a magnetic R/W head which is carried across a radius of the disk to one of 35 'Tracks' by a small motor. By preselecting the position of the motor a certain amount of DIRECT ACCESS of data is achieved.

MINI FLOPPY:
HANDSHAKE:
As above but a smaller disk is used.
A system of transferring data from one device to another. Device A will signal that it has data ready, device B will accept that data and signal that it has it to device A which is now released to collect more data. In the meantime device B will set an indicator which will show that it is BUSY with the last data until this ▶

data has been processed. The action of setting and checking these various indicators is referred to as HANDSHAKING.

HARD COPY:
Data in a permanent and tangible form such as printed, punched or even handwritten.

HARDWARE:
The physical components of a computer or microprocessor system.

HEXADECIMAL:
A counting system similar to BCD but allowing representation of numbers from 10-15 by the letters A-F.

IMMEDIATE ADDRESSING:
An addressing mode where the data for an instruction is the next sequential byte in the instruction stream.

INDEXED ADDRESSING:
An addressing system where the address of the data is expressed as relative to the address stored in an index or pointer register. To obtain the absolute address the offset address is added to the pointer address. this system is useful in processing tables or matrices of data.

INSTRUCTION:
A byte of data (or bytes) which are decoded by the CPU and ALU to cause the MPU to perform specific tasks with data.

INTERFACE:
The Hardware or Software required to be able to communicate with, sense or control external equipment.

JUMP:
Transfer of program logic flow by bypassing a number of instructions. The Jump can be forward over a positive number of bytes or backwards by expressing a negative number of bytes. The Jump can be conditional upon the status of the accumulator or other registers.

KARNT:
There is no such word.

MACHINE CODE:
A programming language in which the program is written in the Hexadecimal equivalent of the MPU instruction code.

MICROCYCLE:
One internal MPU operation, several microcycles make up an instruction.

MNEMONIC:
A method of expressing complicated words, names or phrases usually by using the first letter or letters of each major syllable of the original.

MODEM:
Modulator/DEModulator. An interface between an MPU and a Frequency shifting serial transmission system. A CUTS interface could be considered a MODEM as it uses two main frequencies to record on an audio recorder. The word MODEM usually refers to the piece of equipment which interfaces in this manner to a telephone line.

PAGE:
The unit of the largest are of memory which can be addressed by the available MPU address bus. SCRUMPI 3 has a 12 bit address bus which can thus be used to access a 4096 byte page of memory. The SC/MP chip can handle up to 16 pages of 4K bytes giving a maximum access of 64K bytes of memory.

POINTER REGISTER:
A register which contains the absolute address of an item of data in memory. Data can be accessed at this address or relative to it via the pointer register. The value of the pointer register can be updated to access a different block of data where the data can be one or several bytes.

PORT:
A form of 8 bit interface which allows data to be interchanged between the MPU data bus and any other similar bus. The interface is in the form of up to 8 signal levels in parallel being switched into or out of the basic MPU system to external logic circuits.

PROGRAM:
A sequence of instructions that will execute a predetermined sequence of operations.

PROGRAM COUNTER:
A special form of pointer register which points at the address where the MPU will find the next instruction to be executed. Normally this address is incremented by the value 1 each time but JUMPs or sub-routine accesses will cause the original value to be updated or exchanged.

PROM:
Programmable Read Only Memory. A ROM memory device which can be programmed by the user rather than by the manufacturer.

PROGRAMMER:
Either a person who writes programs, or a machine or interface which will allow the programming of PROMs.

PUSH:
Storing a byte of data on the data STACK. See STACK.

PULL:
Retrieving a byte of data from the data STACK. See STACK.

RAM:
Random Access Memory. As ROMs can be randomly accessed this is a misnomer, and the device should be called a RWM for Read/Write Memory can be used for storing data of a temporary type for fast, direct access retrival. RAMs are a volatile memory form, that is, they lose all data stored in them in the event of a power failure.

ROM:
Read Only Memory. An area of memory which will not respond to a WRITE command. The ROM is usually a non-volatile form of memory control of an MPU.

SCRATCH PAD:
An area of RAM used for short term storage of data during a process.

SIMPLEX:
One way transmission of data.

SOFTWARE:
A program which can be in the form of ROM, Floppy disk data, CUTS data or hard-copy (FIRMWARE) or in the form of a machine code or high-level language in RAM.

STACK:
A SCRATCH PAD system where data is stored in a First In Last Out (FILO OR LIFO) form. Think of a STACK as a cigarette or chocolate machine where a stack or packets is displayed. A PULL operation will remove an item from the bottom of the stack and gravity will thus cause the rest of the stack to drop by one location. For a PUSH operation you would need to lift the stack by one location and then insert one packet into the stack. The MPU keeps a STACK in a similar manner, the current stack address is changed by one and then the new data PUSHed into the new location. In most systems it is standard to decrement the value of the stack pointer for a PUSH as this then means that the newest item on the stack has the lowest address and the first item on the stack has the highest address.

SYNTAX:
The grammar of a programming language.

TRI-STATE:
Normally a logic integrated circuit output can be in a logic 0 state (0v) or a logic 1 state (+5v). TRI-STATE is a system where the output can be high impedance to the extent of being almost open circuit. Imagine two three position switches where the 'poles' of the switches are connected together and where each switch has an open circuit, ground and +5 volts position. With both switches in the ground position the logic level at the 'poles' is 0 (ground), similarly with both in the +5v position the output is logic 1 (+5v). However, if either switch is put into the opposite position then the result is a short circuit. The third position allows each switch to affect the common 'pole' bus without a possible short circuit.

UART:
Universal Asynchronous Receiver/Transmitter. An integrated circuit designed to handle serial/parallel/serial conversion and transmission of data.

VDU:
Visual Display Unit. A method of displaying data to human operators. The usually accepted output in the form of a cathode ray tube such as a TV set which is why alternative names are CRT (Cathode Ray Tube), or the American TVT (TV Typewriter). Data is usually displayed as several rows of alphanumeric characters.

WORD:
Another name for a BYTE of data.

WRITE:
To transfer data from the MPU chip to another memory or peripheral device.

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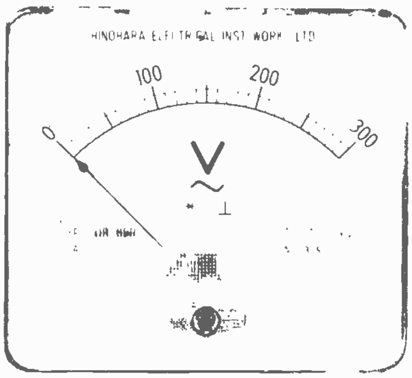

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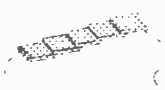

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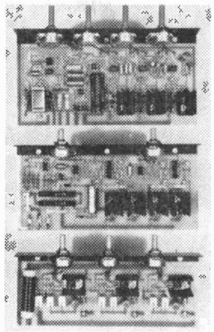

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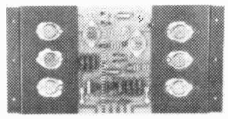

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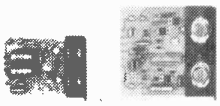

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9-0-9	100	13	**1.95**	.60
0.9, 0.9	330 330	235	**1.80**	.60
0-8-9, 0-8-9	500 500	207	**2.40**	.65
0-8-9, 0-8-9	1A 1A	208	**3.50**	.65
0-15, 0-15	200 200	236	**1.80**	.60
0-20, 0-20	300 300	214	**2.40**	.80
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8	4	108	**7.10**	1.10
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20	10	115	**13.50**	1.40
30	15	187	**16.50**	1.40
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1.0	79	**3.25**	.80
2.0	3	**5.25**	.95
3.0	20	**5.95**	1.10
4.0	21	**6.25**	1.10
5.0	51	**9.25**	1.10
6.0	117	**10.75**	1.10
8.0	88	**14.00**	1.40
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Sec: 0-19-25-33-40-50V

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1.0	103	**4.25**	.95
2.0	104	**6.95**	1.10
3.0	105	**8.25**	1.10
4.0	106	**10.50**	1.20
6.0	107	**14.75**	1.40
8.0	118	**19.85**	1.60
10.0	119	**23.75**	2.10

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1.0	126	**5.25**	95
2.0	127	**7.20**	1.10
3.0	125	**10.75**	1.20
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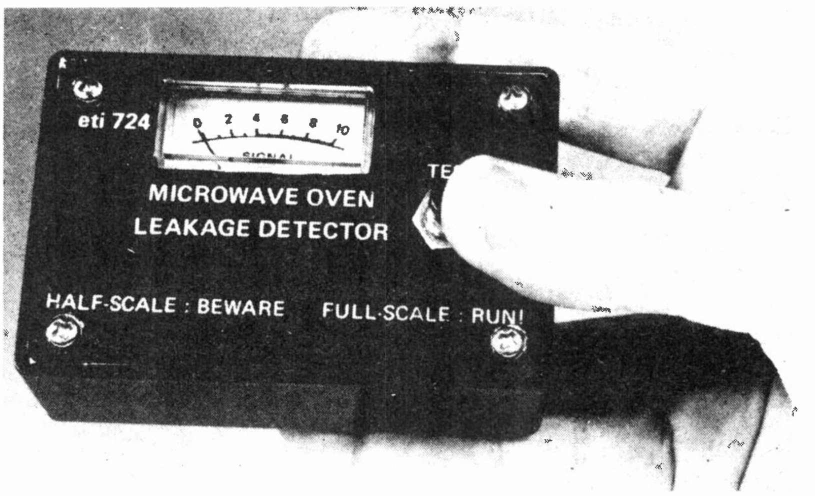
MICROWAVE OVEN LEAK DETECTOR

While microwave ovens are generally well-designed and safe to use, the human factor (even Murphy's Law) can thwart the manufacturer's efforts and possible unsafe levels of microwave energy may be radiated without warning. Simple and inexpensive to build, this project will indicate if your oven is safe . . . or not.

THE MICROWAVE oven is one of the most recent examples of advanced technology finding application in the home. Many thousand such devices are sold for domestic use in Australia alone each year, while commercial units have long been found in restaurants and snack-bars.

The microwave cooking method, while unlikely to usurp conventional cooking methods, has distinct advantages. It is usually quicker, two to five times quicker in fact. Because it heats the foods directly, but does not heat the bowl or container, so the food can be left enclosed. The process is often cleaner and less utensil-consuming as a result. Because the energy penetrates below the surface of a lump of food and does not rely so completely on conduction, it can be used for rapid defrosting of foods. (See ''How a microwave oven works'').

Unfortunately, the microwave energy is quite dangerous. It must be carefully contained within the cooking chamber. The window is usually sealed to the radiation by a fine metal grille similar to heavy duty fly-screen. The door fits flush and firm, and the instructions warn against allowing any distortion of the door. All ovens have safety circuits preventing the power being applied with the door open. Some ovens have as many as five interlocks against accidental activation without correct door closure. They do not, unfortunately, incorporate an alarm which warns if a leak occurs, This can happen if the door is slightly bent by being closed on a lump of stray food or if damaged during a domestic fracas.



The device is housed in a 'zippy' box, everything being attached to the front panel, held in place by the four screws. Our prototypes were calibrated through the kind assistance of the Electrical Engineering Department of Sydney University.

In view of these things it seems wise to have some additional method of checking for leakage.

Leak Detectors

The output is an analogue. This is set to read full-scale deflection (FSD) for a signal of approximately 5 mW/cm^2 in the 'test' mode. Hence, as little as 10% of the danger level can be read.

When the test button is released, the sensitivity increases by about an order of magnitude. In this condition the unit acts like a signal strength meter, and should show some deflection with the normal residual leakage of an oven. This confirms that it is working. We estimate that it should cost £10-£12, PCB included, as a kit. If you have upwards of £300 worth of oven, ten quid is not a bad investment to insure the family jewels . . .

Construction

Unless you are very experienced with high frequency work already it is important to use the PCB. The antenna is printed onto the board and so, is inherently tuned sufficiently closely when the correct board is used. It is also convenient as the meter and button are soldered directly on the copper side and the whole assembly is self-contained.

No box at all is actually necessary, but if you choose to use one, ensure that it is not metallic except for the front panel. There are no flying leads, etc, so if need be, one could leave the whole circuit just as is, with no ▶

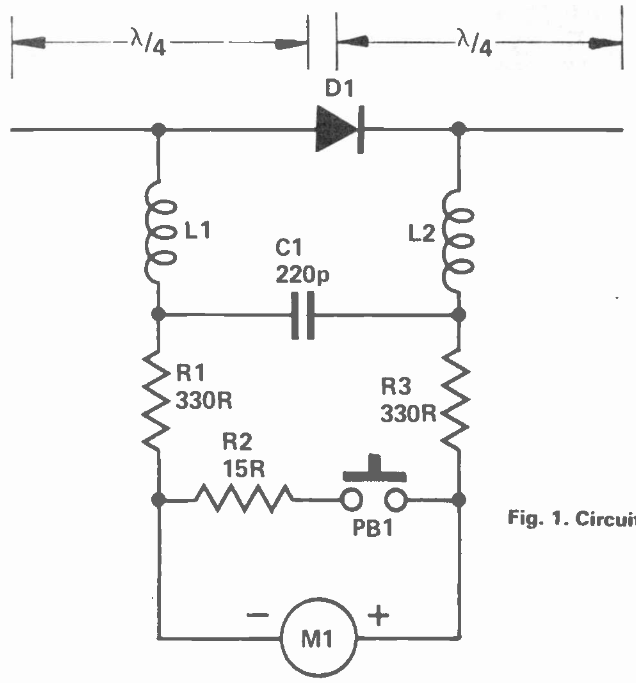


Fig. 1. Circuit diagram.

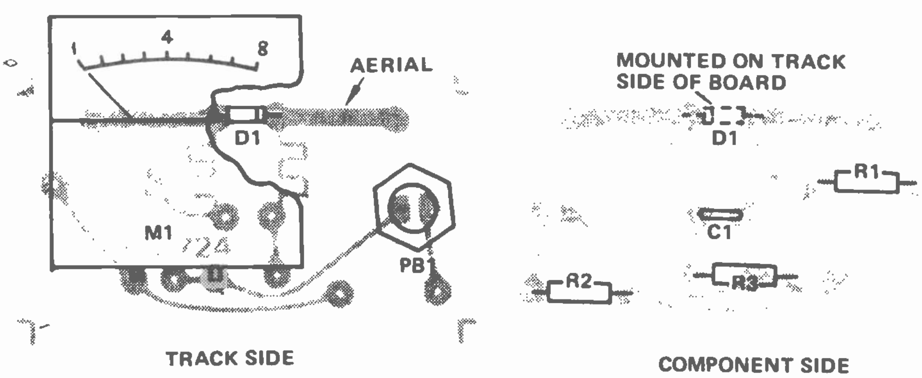


Fig. 2. Component overlay, showing both sides of the PCB.

box.

We used a 25mm x 50mm x 90mm jiffy box which was just big enough inside.

Ensure that the diode and meter are soldered in the right way round. Also try to solder the diode neatly, as shown in the overlay. It should be soldered onto the copper side directly, flat against the board in the centre of the dipole. Use of the board and close adherence to our design will ensure that your unit is close to prototype sensitivity and will thus read true.

Using It

The meter is moved around the door rim with the oven operating, meter facing away, button depressed, the back parallel to the door and spaced approximately 40mm from the surface.

When testing, it should be moved over the oven in each polarisation, just to be sure. To check if it is working, simply repeat the procedure without depressing the test button. Some erratic flicker of the needle should be evident, indicating correct operation. It can be left on top of the oven when not specifically being used, so that some drastic leak will cause deflection should that occur.

How a Microwave Oven Works

There are several separate sections to a microwave oven. Firstly, there is a Magnetron, which is the heart of the system. This is a thermionic device incorporating a resonant cavity. It is an oscillator and will deliver power at super high frequencies (microwave ovens operate on 2.45 GHz). The oven has a power supply

HOW IT WORKS

Operation is very simple. The device is completely passive and requires no batteries. It uses the radiated energy from the oven to deflect a meter directly.

The PCB dipole, when exposed to microwave radiation of about 2.5 GHz, develops an AC voltage across D1. When the diode is positively biased the diode conducts, shorting the dipole. When reverse biased it isolates, thus leaving a net voltage on the diode. This DC component is filtered by L1, L2 and C1.

The amplitude of the DC component varies somewhat with the type of radiation from the oven — CW or pulsed, depending upon the supply rectification and filtering used with the magnetron. It will also vary with distance, of course. R1, R2 and R3 define the sensitivity, the values chosen being suitable to produce FSD for 5 mW/cm² CW at the board plane with PB1 closed.

Some variation should be expected from unit to unit. This should not normally be of any concern, however, as a healthy oven will emit at least one order of magnitude less than the 5 mW level, and so the readout is unambiguous even when the unit is not the exact 5 cm from the oven surface.

PARTS LIST

RESISTORS	all ¼W 5%
R1, 3	330R
R2	15R
CAPACITOR	
C1	220p
SEMICONDUCTOR	
D1	HP 5082-2800 or similar.

MISCELLANEOUS
Push-to-make switch,
250uA fsd meter.
L1, 2 — see text.

BUYLINES

All the components used (except D1) should be readily available from your favourite component supplier. D1 is a standard diode used in microwave applications. If in difficulty get in touch with your nearest HP stockist.

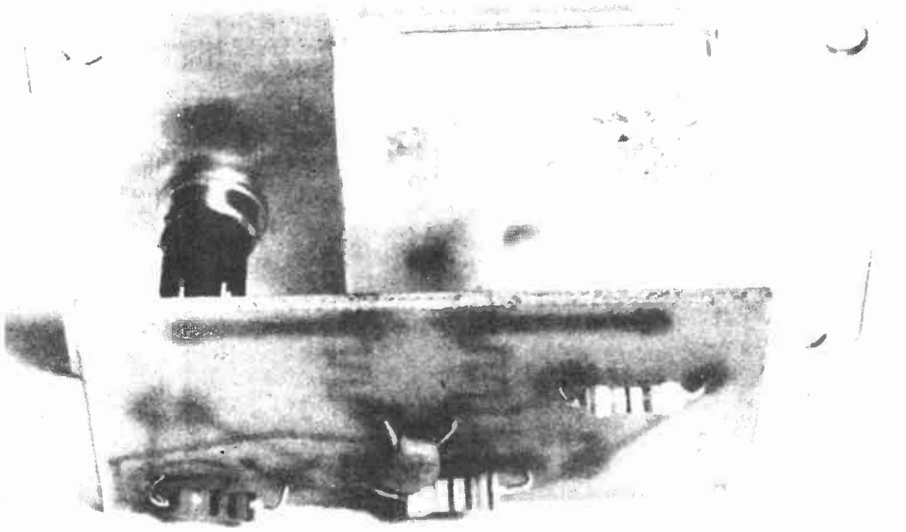
incorporating a number of safety interlocks preventing activation in unsafe circumstances.

There is a cooling system for the electronics, usually a fan. The cooking chamber has metal walls and some system of ventilation to remove steam, etc. The one fan is often used to cool the electronics as well as ventilate the cooking chamber. A duct (waveguide) transfers the microwave energy to the chamber from the magnetron. Some form of disperser spreads the energy and prevents standing waves within the chamber. This is either a rotating platform moving the food or a set of vanes in the chamber ceiling reflecting the beam about. (This is often driven by the fan motor or even the stream of cooling-ventilating air).

Finally, a control panel allows varying degrees of automatic control of the RF power. This always includes a timer and a door interlock.

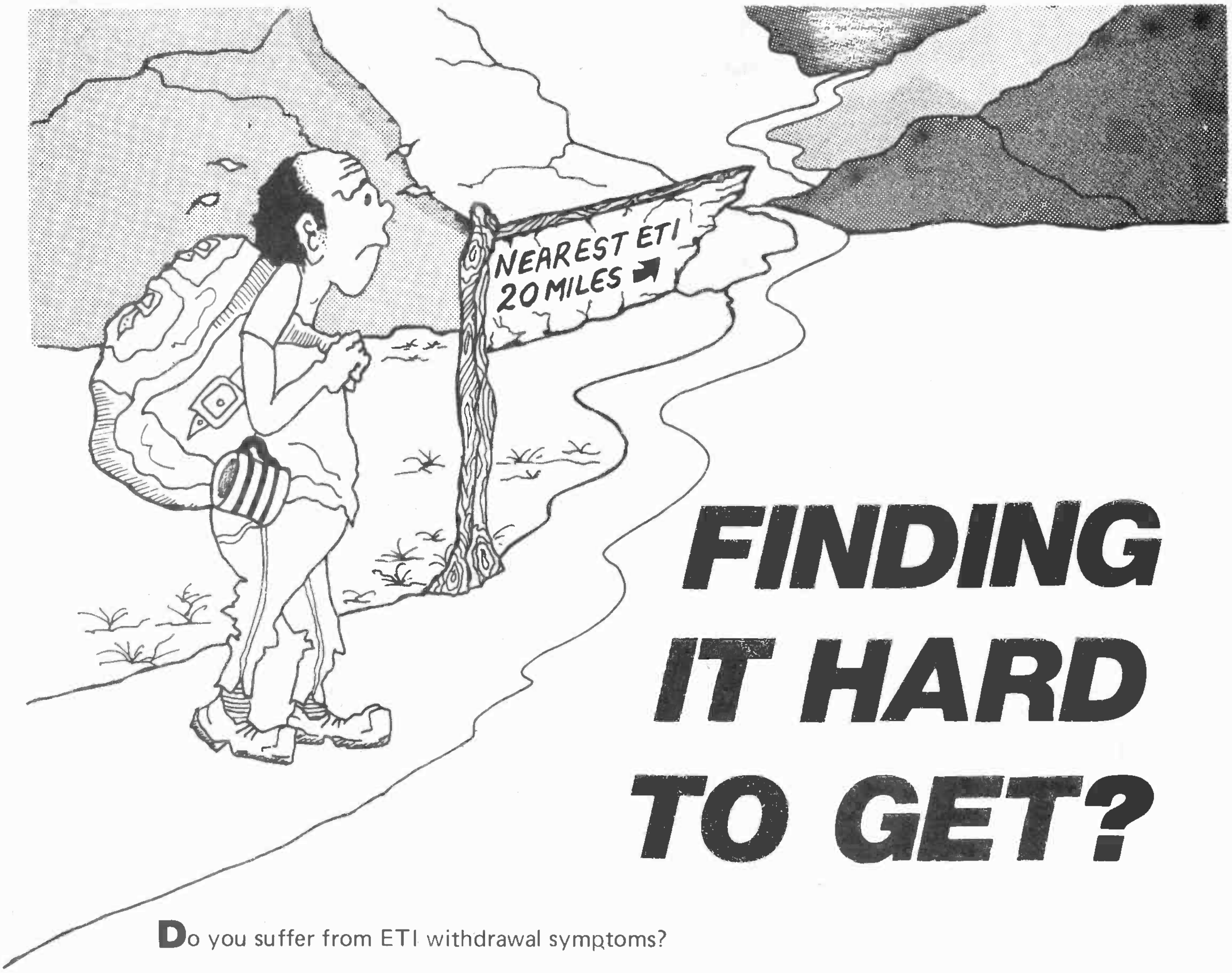
Water is the primary microwave absorbing agent in food. Dry food and glass or plastic containers are substantially unheated by the radiation. The energy can penetrate to a depth of about 20mm effectively, though this varies markedly with the food.

Domestic ovens consume about 1200 watts altogether, of which about half appears as microwave power in the food chamber. This, considering the mode of absorption, is considerably more efficient than an ordinary oven which is why the cooking speed is so rapid.



Internal view of the microwave oven leak detector shows the simplicity of construction.

ETI



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OP AMPS AND INTEGRATORS

Although we're dominantly digital these days, there are some applications where the trusty op amp is cheaper and easier — differentiating and integrating circuits, for instance. A. S. Lipson reveals all . . . .

DIGITAL COMPUTERS, folks, are not always fastest or cheapest. No, don't faint. No kidding — those amazing digital circuits we keep hearing about do not always get the job done first! They're fine, of course, as long as we stick to straightforward arithmetic, but unfortunately, there are occasions when we want to do other things (no, not that sort of thing . . .), such as integration or differentiation. Circuits performing these functions are not only of use in computers, however; they are of great use to those of us who are just simple mortals, as well. For instance, in function generators, a square wave may be changed to a triangular wave merely by integrating.

Now, while digital circuits can perform these functions, they do tend to get a bit bulky and expensive. It's very much easier to use analogue circuits. As it happens, we have very simple networks that make passable integrators and differentiators for very little money. They're capacitor-resistor series circuits, and their operation is quite easy to understand.

Differentiators

We can make quite a serviceable differentiator circuit from the series combination of resistor and capacitor shown in Fig. 1. Now from our original definition of capacitance, the current flowing through a capacitor is given by;

$$I_C = \frac{d\,V_C}{dt}$$

But, in the case where we are driving a load with very high input impedance, I_{OUT} will be negligible, and I_R will be very close to I_C. We can say, without too much inaccuracy, that $I_R = I_C$. I_R, however, is given by Ohm's law, $I_R = V_{OUT}/R$. Thus $V_{OUT} = RI_R$. Since I_R is the same as I_C, however, this gives;

$$V_{OUT} = RI_C = RC\frac{dV_C}{dt}$$

and so the output voltage is effectively the voltage across the capacitor, differentiated and then multiplied by a scale factor RC. If we don't want this scale factor, we can just arrange matters so that RC = 1.

The main problem with this circuit, of course, is that it

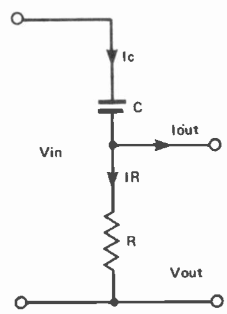


Fig. 1. Basic differentiator.

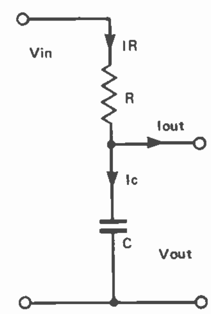


Fig. 2. Basic integrator.

is, indeed, the voltage across the capacitor, and not that across the input, which is differentiated. However, as long as we don't let the output voltage get too large, V_C will be very close to V_{IN}, and this error will not matter too much.

Integrators

The basic integrator circuit is very similar to that of the differentiator — the resistor and capacitor just swap positions (Fig. 2). Now we can find the circuit's action in the same way as we did before;

$$I_C = C\frac{dV_{OUT}}{dt}.$$

Integrating both sides of the equation;

$$\int I_C dt = CV_{OUT}.$$

But I_C is the same as I_R, provided we are driving a load with high enough input impedance. From Ohm's law, we have $I_R = V_R/R$, and thus;

$$1/R \int V_R dt = CV_{OUT}.$$

Dividing both sides by C;

$$V_{OUT} = 1/RC \int V_R dt.$$

Again, the voltage being integrated is the voltage across only one of the components — the resistor — and not that across the entire circuit. However, as long as we again arrange that V_{OUT}, that is, V_C, never gets *too* large, V_R is very close to V_{IN}, and we have a fair approximation to an integrating circuit with a gain of 1/RC. ▶

Bigger and Better

So far, the circuits we have looked at have had two main disadvantages; they are accurate only when driving circuits which have very high input impedances, and their output voltages cannot be allowed to become very large, or the difference between the input voltage and the voltage actually being acted on becomes too large to be ignored. (This in turn puts resistrictions on the allowable values of RC time constants and thus the components themselves, but we won't go into that.) How can these problems be solved? Did the man at the back mention op-amps? Dead right, friend. To see how they might be useful, however, let's do a quick bit of revision on them. (Those familiar with op-amps skip the next section.)

Op-Amps

Op-amps are famed for three major properties. The first of these is a very high input impedance, the second is a very low output impedance and the third is a gain so high that it may be approximated to infinity without too much innaccuracy for most purposes. It is this last property which leads to the 'virtual earth', a very useful concept in analysis of op-amp circuits.

The voltage gain of an amplifier is, by definition, the ratio of its output voltage to its input voltage. If the gain is m, then the output voltage V_{OUT} is mV_{IN}, or, if we are using the inverting input of an amplifier, $-mV_{IN}$. However, as we have stated, the gain of an op-amp is close to infinity. Thus, its output voltage is infinity times its input voltage, or, putting it another way, the input voltage is equal to the output voltage divided by infinity. Since the output voltage must be finite, the input voltage, or, more accurately, the difference in voltage between the inverting and non-inverting inputs, of an op-amp, must be zero. (Yes, I know it looks as though I've cheated somewhere, but I can assure you that it works.) Since this difference in voltage is zero, it follows that if we ground one input of an op-amp, the other input automatically goes to zero potential. This is not to say that it automatically gets shorted to earth — there is still a very high resistance between the two points — it just means that no voltage will be present; there is a 'virtual earth'. This concept, as has been stated, is a very useful one. Now we can apply it to our integrator and differentiator circuits.

The New Improved . . .

We saw in the last section that an op-amp has a very high input impedance and a very low output impedance. It was a very high input impedance, you will remember, that we needed for our basic circuits to drive, so suppose we put some sort of unity gain voltage amplifier on the outputs. It wouldn't affect the signal in any way, but it would mean that we could drive circuits with lower input impedances.

Well, using an op-amp, a unity gain voltage amplifier has a circuit something like that shown in Fig. 3. It's easy enough to understand; the output is shorted to the inverting input and so the voltage present at each is identical. However, the difference in voltage between the two inputs must be zero and so the same voltage is present at the input to the amplifier as is at the output. In practice, this means that the output voltage follows the input voltage. Amplifiers like this are often used as 'buffers' — allowing high output impedance circuits to drive low input impedance ones.

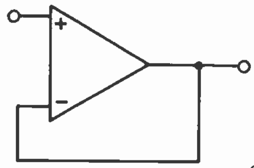


Fig. 3. Unity gain voltage amplifier.

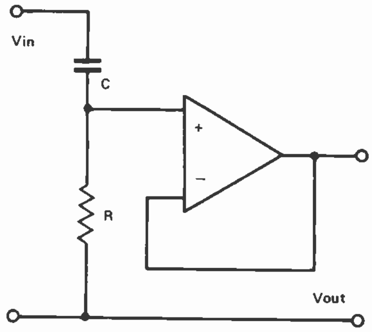
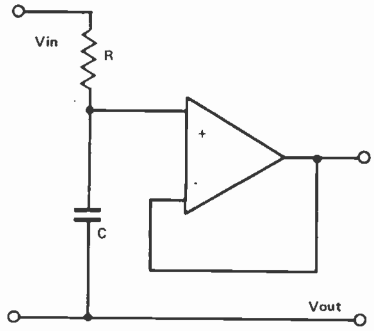


Fig. 4 a Differentiator with buffer.



b Integrator with buffer.

If we put one of these buffer amplifiers on the output of each of our circuits, we have the circuits shown in Fig. 4, and we have, indeed, solved one of our major problems; the circuits no longer need to drive into high impedances. The other problem is still present, however. Is it possible to improve our circuits again? Well, yes. (See, it was worth reading this far.)

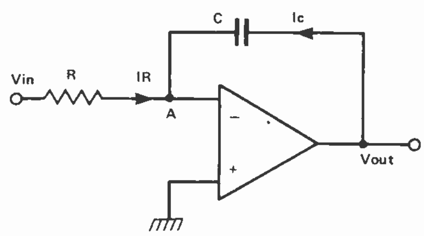
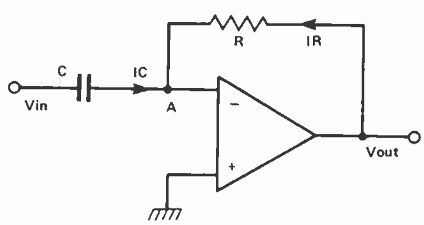


Fig. 5a (above) Integrator circuit using an op-amp and b (below) differentiator circuit using an op-amp.



At Last . . .

We'll look at the integrator first. The circuit is shown in Fig. 5a, and, unlike our last idea, does not use an op-amp tacked onto the end, but as an integral part of the circuit. (Yes, that's right, it's an integrated integrator . . . sorry, I just couldn't resist that. . .) It's action is as follows:

Since the input impedance of the op-amp is very high, it follows that the current actually flowing into it is very small, and hence, $I_R = -I_C$, to a first approximation, in order to keep the currents flowing into point A sum to zero. (Kirchhoff's first law — the algebraic sum of all the currents flowing into a point of a network is zero. This is the same as saying current in = current out.)

However, Ohm's law tells us that the current flowing through the resistor is given by the voltage across it, divided by the resistance. Now, the voltage at A is zero (virtual earth), so the current through the resistor is V_{IN}/R. The current through the capacitor is given by

$$I_C = C\frac{dV_{OUT}}{dt}$$

Hence, we have, since current through the resistor equals current through capacitor;

$$V_{IN}/R = -C\frac{dV_{OUT}}{dt}$$

$$\text{and so } V_{IN}/RC = -\frac{dV_{OUT}}{dt}$$

Integrating both sides of the equation, we obtain;

$$\frac{V_{IN}}{RC}dt = -V_{OUT} \text{ or } V_{OUT} = -1/RC\int V_{IN}dt.$$

Since R and C are constants, and can thus be moved out of the integration sign.

Hence we have effectively a circuit which integrates input voltage with respect to time, and which has, once again, a gain given by $-1/RC$. The integrating action may be seen if we apply a square wave to the input. We obtain a triangular wave as output, and one which compares very favourably with that obtained from our original circuit. (Fig. 6.)

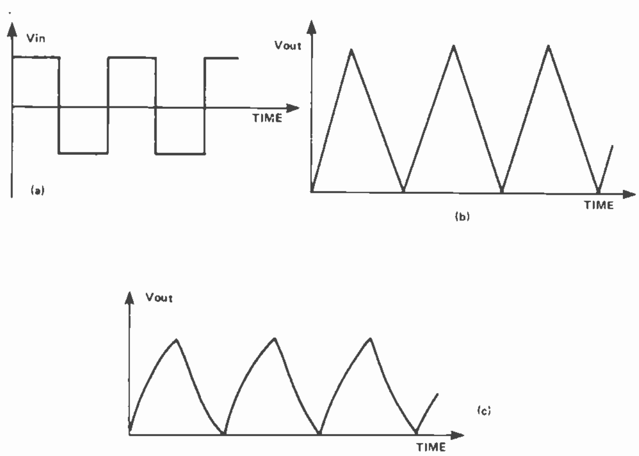


Fig. 6a Input square wave signal B output from op-amp circuit c output from original circuit.

Differentiator Mark 3

The action of the differentiator circuit (Fig. 5b) can be explained similarly. Again, current through the resistor is equal to that through the capacitor, because of the very high input impedance of the op-amp.

$$I_C = -I_R$$

But I_R is given by $(V_{OUT}-V_A)/R$ and V_A is zero (virtual earth again). Similarly, I_C is given by CdV_{IN}/dt. Therefore;

$$V_{OUT}/R = -C\frac{dV_{IN}}{dt}$$

multiplying both sides of the equation by R, we get;

$$V_{OUT} = -RC\frac{dV_{IN}}{dt}$$

And we have a differentiating circuit, the gain of which is given by $-RC$. We can see the differentiating action if we apply a square wave to the circuit as in Fig. 7.

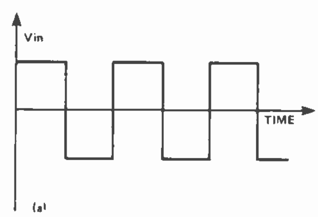
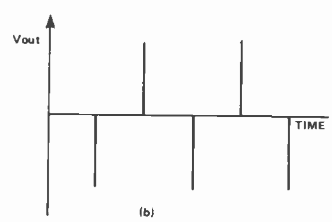


Fig. 7a (above) Input square wave signal and b (below) output from op-amp circuit.



Howzat!

With these two circuits we have overcome the difficulties experienced with our original RC combination series circuits. The voltage being acted on is the input voltage actually and, thanks to the low output impedance of the op-amp, we can use these circuits to drive many more circuits. The output voltage, which we were forced to restrict in our original circuits, for fear of affecting the action of the circuits, is now restricted only by the supply voltage to the op-amps.

The outputs of these circuits are, of course, inverted, as is shown by the minus signs in our equations. This is because of practical difficulties incurred when a non-inverting circuit is used, and can easily be solved by tacking a unity gain inverting voltage amplifier onto the output — surely a small price to pay for all the advantages that these circuits give us over the originals.

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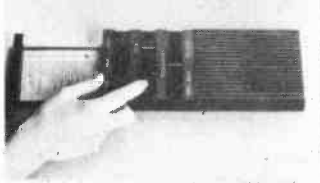

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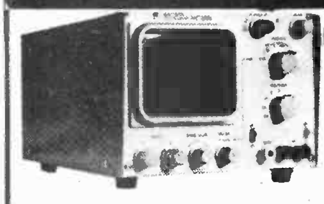

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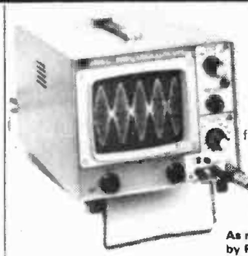

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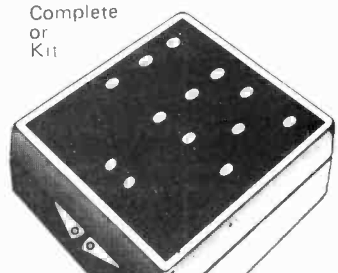

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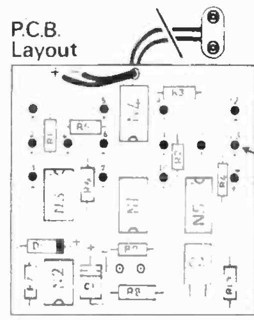

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tech tips

8 PAGE SPECIAL

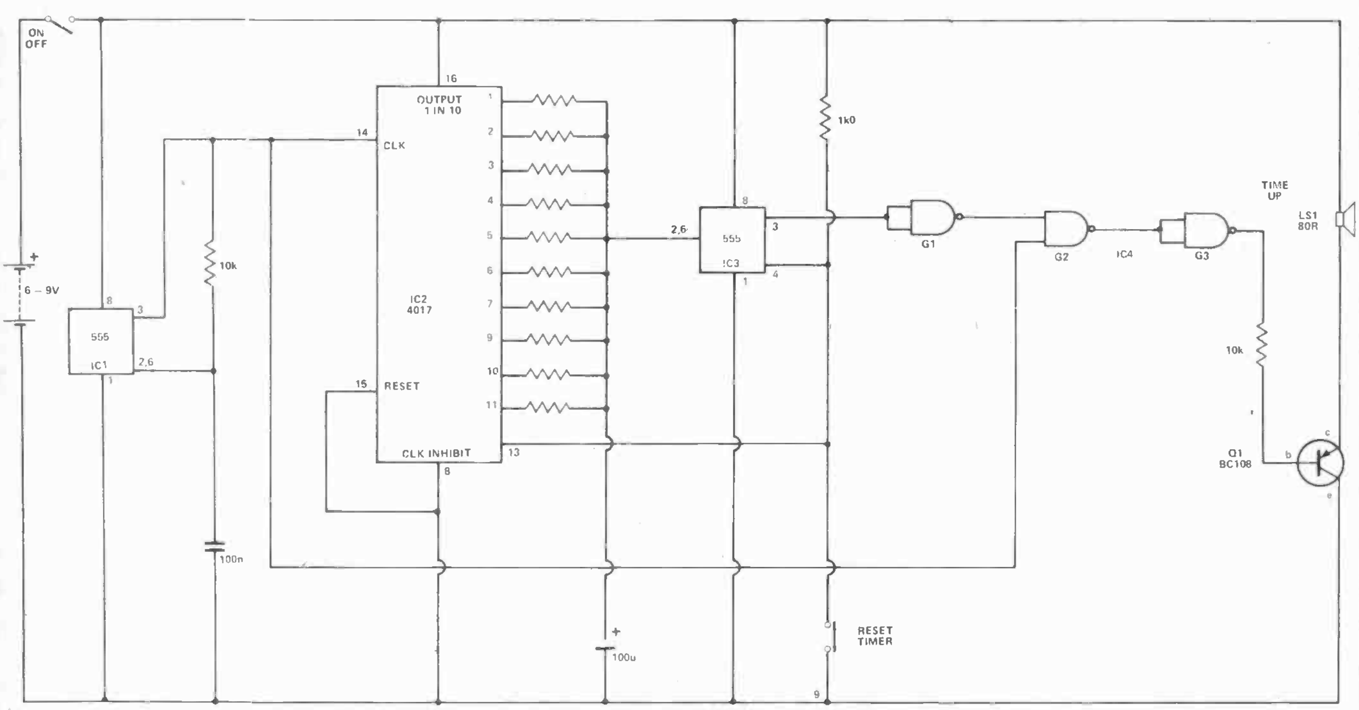
Random Delay Timer

S. D. Lang

This circuit is designed to add to the excitement of many board games. Players must make their moves within a random unknown time. The delays can be adjusted and the circuit uses only four ICs and a few passive components.

The 555 (IC1) provides a clock frequency for the 4017 and the 'time up' tone frequency. Normally the 4017 clock is inhibited as the clock inhibit pin 13 is high. However, when the 'reset timer' button is pushed, pin 13 is grounded and counting starts. The high output moves wildly between the outputs until the switch is released. Only one output will then be high, which one being entirely a matter of chance. The resistor connected to this high output determines the charging time of the capacitor. For the 100 u capacitor shown, 10 k should be allowed for each second of delay. When the capacitor has sufficiently charged up, IC3 switches off. This is inverted by G1 and appears high. The tone from IC1 is gated by this high signal to drive the loudspeaker via Q1.

Pressing the switch at any time clears the monostable and selects a random delay resistor. The delay resistors can be of any value selected by you. G1-3 are any NAND gates from a single 4011/7400. If the battery voltage is greater than 6 V a 4011 must be used.



tech tips

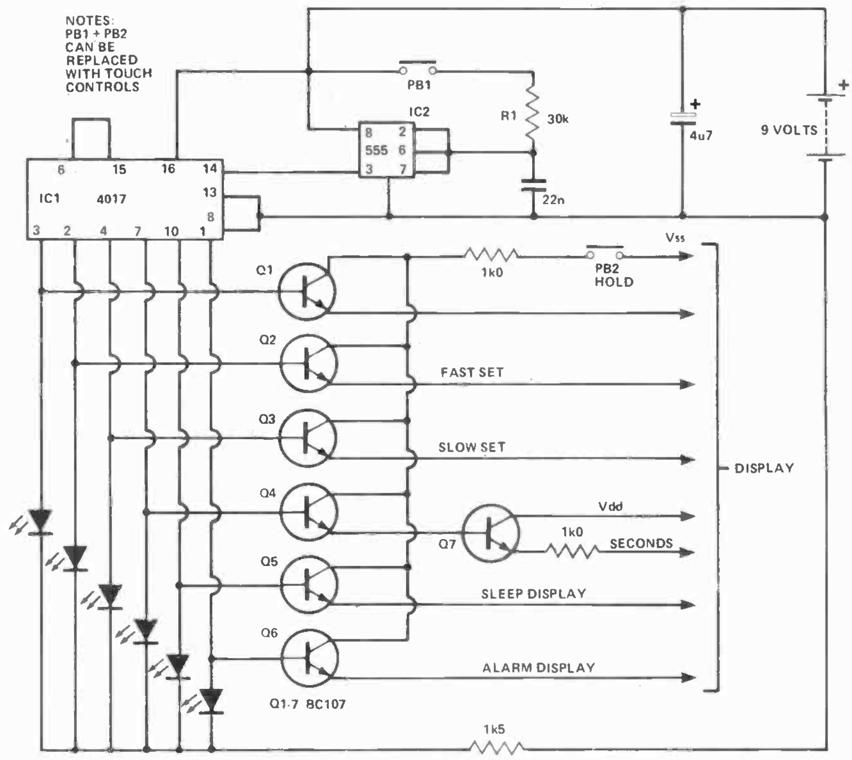
Readers' Circuits

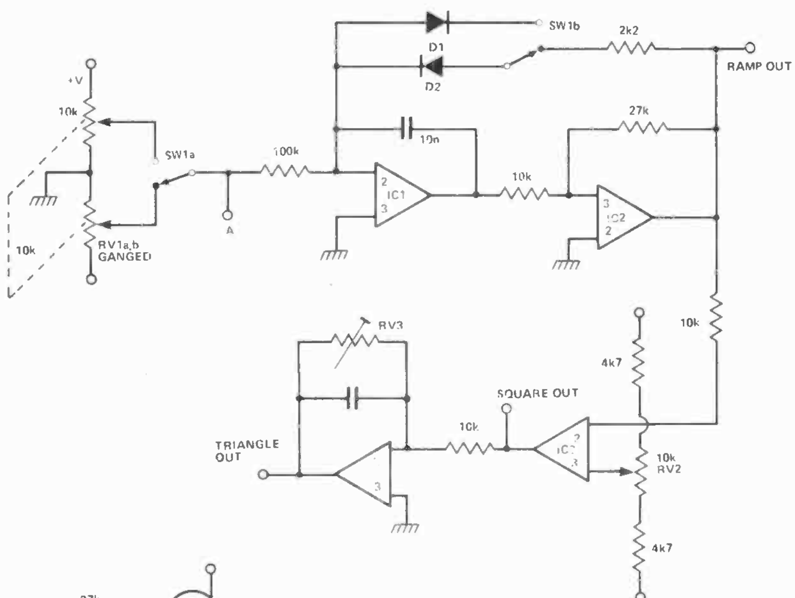
Clock Switching Unit

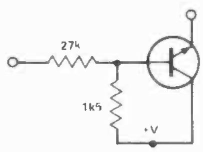
A. Claughan

On normal clock modules such as the National MA1002 or the Liton LT701 six bulky and untidy looking pushbuttons have to be used. This circuit cuts these six to two.

The output of IC2 is connected to the clock input of IC1. On reception of the first pulse, the first output goes high. Each time the output goes high, a corresponding LED is switched on and the base of the adjoining transistor goes positive. When the correct LED is switched on, pushbutton two is pressed. This switches on the transistor, completing the corresponding function. The rate at which the LEDs light up is adjusted by changing the value of R1. The seventh output of the IC is used as a pause so that the clock can run normally. The eighth output is connected directly to the reset input on IC1. This causes the IC to automatically reset on the eighth pulse. The 9 V supply is obtained by regulating one of the clock inputs.







Function Generator

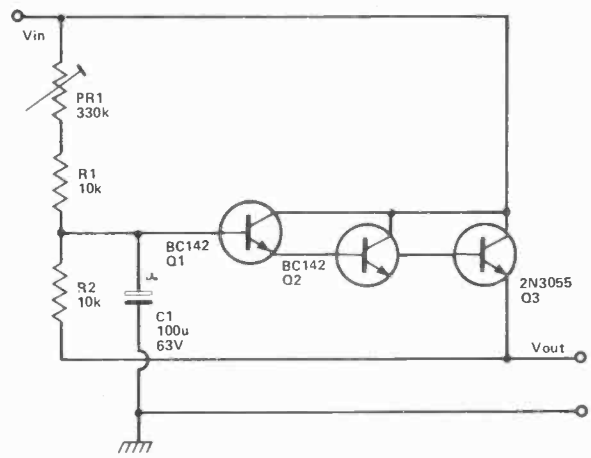
J. S. Paterson

IC1 is an integrator which, along with IC2, etc, forms a voltage controlled ramp oscillator, the frequency of which is set by RV1. S1 and diodes D1, 2 control the direction of the ramp. The output of IC2 is taken to IC3, which is a comparator providing a square output at pin 6. RV2 provides control of symmetry. Lastly, this square wave is fed to an integrator, which gives a triangular waveform. If the control voltage is applied via the circuit in Fig. 2 the frequency will vary logarithmically with voltage — useful for synthesizers.

With RV1 slider grounded, a ramp can be fed into the circuit at point A, so the oscillator will sweep through its range — useful for testing filters, etc.

Active Decoupling Circuit

J. P. Macaulay



What do you do if faced with the problem of running say a tuner which requires 30 V / 100 mA from a power supply of say 55 V?

This circuit is designed to drop a predetermined voltage and supply a reasonably large current to its load. The voltage drop between the emitter and collector of Q3 is directly proportional to the setting of PR1. In effect, Q1,2,3 can be considered as a single transistor with high current gain.

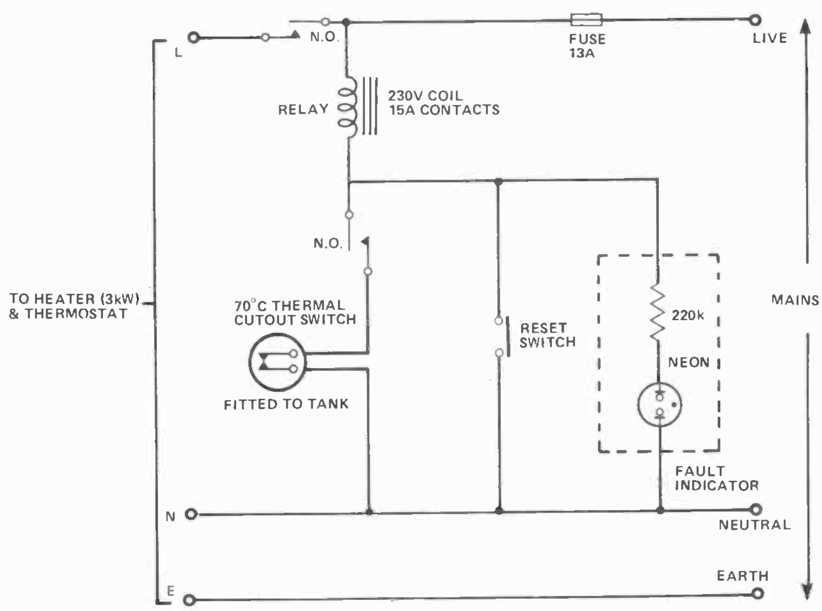
C1, between the base of Q1 and earth, performs a vital function, because its filtering action is amplified by the circuit and thus smooths the output voltage. If we assume that each of the transistors has a gain of 30, the circuit will possess an overall gain of 2700 times and an apparent capacitance will appear across Q3's emitter and earth of 0.27 F.

The circuit with an input voltage of up to 60 volts, but this must be taken as an absolute maximum due to the breakdown voltages of the devices used. When using fairly low voltage drops, up to say 10 V the maximum current that the circuit can supply will be limited to the size of heatsink employed.

Several amps can be supplied as long as the resultant heat can be safely dissipated. With the component values shown, the circuit can be adjusted by PR1 between 3-30 V.

Immersion Heater Protector

K. Cooper



The circuit was designed to cut the power to an immersion heater should the thermostat fail. This stops the water boiling over and all the subsequent damage. The cutout is fitted to a warm part of the tank (not too hot, or it will trip in normal use). Thus, if the water starts to boil, the cutout trips, cutting all power and lighting the neon.

The unit must be fitted in a well insulated box and care should be taken with the wiring to the cutout, which can be fixed and insulated with epoxy resin.

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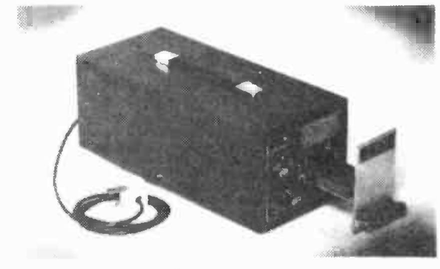

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COMPUTER BOARDS

The following is an extract from our leaflet ref. 'MP4', which is available free on request (a 9" x 6" SAE helps, but is not essential). See Microprocessor section to the right for board prices.

For many people the wide choice of micro-processors now available presents a difficult choice. To understand any particular microprocessor in depth a development system is almost essential, however in the past to understand more than one several separate development systems have had to be purchased.

The reason that separate systems, one for each processor, have been necessary is due to the fact that individual microprocessors have their own individual features: in one case to access memory a separate read strobe and write strobe is required, in another a 'read/write' line is used in combination with a combined strobe called 'valid memory address and phi-2'. With some processors, the same address bus can be used for both memory and 'input/output ports', under the control of a 'memory request' or an 'input/output request' control line.

Naturally, if a development system takes advantage of any of the particular unique features of any particular microprocessor, this makes it more difficult to graft some other unrelated microprocessor onto the same bus at a later date.

A Universal Micro System provides a basic bus structure on which any one micro-processor can be connected. The system uses a CPU (Central Processor Unit) card which is separate from the rest of the system, and this allows the same memory and interfaces to be retained when a different MPU is used.

The basic system bus consists of data and address buses together with read and write strobes. By locating the data input (Keyboard) and output (VDU) in the memory space then such chips as the 8080/Z80 family, which normally use input/output ports, can now be used without any fundamental change to the bus (and as a bonus, users of these MPU's have all the ports entirely free for their own purposes).

The range of p.c.b.'s includes boards to implement a memory-mapped VDU, cassette interface, keyboard interface, PROM programmer, and a number of RAM and ROM cards. All the cards are of International Size 114 x 203 mm (4½" x 8") except for the larger power PSU. A power supply card. This latter card is sized so that it can be bolted to the side of a standard 4" chassis module which is then compatible with the other cards. The cards have a standard 43-way edge connector, with one position used for polarisation.

We do not propose to defend the (relatively) small number of bus connexions (42), against such standards as the 'S100' 100-position bus. The S-100 bus, as it originated in America, is bigger and better. It is also more expensive. In the same way, a Ford 'Granada' is bigger and better than a Ford 'Cortina', but it doesn't mean a Cortina isn't good value for money, who knows — it may even be better value!

The International Size card is the recommended size for most '3U' 19" rack systems. These racks are made by Vero, Critchley, etc., and a variety of modules and blank cards are obtainable to aid individuals in customising their own system. (A convenient trade source of suitable hardware is the firm 'R.S. Components', but we would be happy to supply in case of difficulty.)

It is appropriate to mention that this range of cards is not meant to compete with any of the excellent computer kits which can be obtained. The purchaser of these types of kits simply acts as an unpaid (or at least underpaid) assembly worker. If the standard components are put together correctly the computer works, if they're not it doesn't. In the end each and every one is virtually identical.

The range of boards in the Universal Micro System are entirely different. You choose your microprocessor, memory, interfaces, etc., what addresses will be used, you choose whether or not to use our software, somebody else's, or indeed your own. (Don't be too alarmed if your level of experience does not permit you to take this sort of decision with confidence — we are always here to offer guidance if asked, we'll even tell you if the system is unsuitable for your needs, in the unlikely event that it is.)

As mentioned on the last page, a brave attempt has been made to begin the design of a Universal Micro System, to provide a sufficiently flexible arrangement to permit the system to grow over the years, and not to become obsolete overnight. To permit this flexibility, wherever possible 'patch areas' have been provided on the boards. A 'patch area' is an undedicated dual-in-line pattern which can accommodate an extra integrated circuit for your own use. Often these can be used to add some extra memory, or some extra address decoding. An extra supply voltage can be developed using an integrated circuit regulator, or gates can be added to allow separate 'Memory Request' and 'Input/Output Request' control lines on a memory card which does not already have this facility.

Of course we know that there are many people who would faint clean away at the thought of cutting printed circuit tracks, adding extra integrated circuits and bits of wire in the way described above, but it is not for these people that this sort of system has been designed. We would like to think of this system as basis on which you can build your own personal design, perhaps as an alternative to the use of 'Veroboard' or etching your own pcb's.

(Further sections give an outline of each card in turn. Although we have in mind all sorts of exotic future developments (e.g. high resolution graphics, floppy disc controllers, dynamic high-density RAM cards, programmable VDU formats, colour displays, Light pens, sound generators etc.) we prefer to keep quiet about them until they actually exist. All of the cards described actually exist, and at the time of writing (September 1979) most are in stock. (We plan it so they are all in stock, but people will insist on buying them, without caring what havoc they wreak in our stock control!))

CMOS

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

4000	15p	4042	75p	4089	£1.50	4419	£2.68	4531	£1.45
4001	17p	4043	94p	4093	63p	4422	£5.00	4532	£1.27
4002	17p	4044	90p	4094	£1.90	4431	TBA	4534	£5.13
4006	£1.05	4045	£1.45	4095	£1.05	4433	£11.32	4536	£3.69
4007	18p	4046	£1.28	4096	£1.05	4435	£7.93	4537L	£13.23
4008	87p	4047	87p	4097	£3.72	4440L	£11.58	4538	£1.25
4009	50p	4048	58p	4098	£1.10	4450	£2.67	4539	91p
4010	50p	4049	48p	4099	£1.45	4451	£2.67	4541	£1.14
4011	18p	4050	48p	40061	N/S	4452	TBA	4543	£1.59
4012	18p	4051	72p	40100	£2.50	4461	£2.18	4549	£3.69
4013	42p	4052	72p	40101	£1.61	4462	£2.42	4552	£10.55
4014	86p	4053	72p	40102	£2.12	4490FP	£6.54	4553	£3.87
4015	89p	4054	£1.10	40103	£2.12	4490VP	£3.48	4554	£1.19
4016	45p	4055	£1.28	40104	£1.09	4500	£6.95	4555	78p
4017	89p	4056	£1.34	40105	£1.06	4501	17p	4556	78p
4018	89p	4057	£25.70	40106	61p	4502	91p	4557	£3.86
4019	48p	4059	£4.80	40107	68p	4503	69p	4558	£1.14
4020	99p	4060	£1.15	40108	£5.36	4505	£5.71	4559	£3.69
4021	91p	4061	£15.67	40109	£1.02	4506	51p	4560	£1.84
4022	86p	4062T	£10.00	40181	£3.39	4507	55p	4561	65p
4023	20p	4063	£1.09	40182	£1.40	4508	£2.48	4562	£5.33
4024	66p	4064	N/S	40192	£1.40	4510	99p	4566	£1.59
4025	19p	4065	N/S	40193	£1.40	4511	£1.38	4568	£2.38
4026	£1.80	4066	57p	40194	£1.18	4512	81p	4569	£2.57
4027	45p	4067	£3.80	40257	£1.48	4514	£2.65	4572	25p
4028	81p	4068	22p	4160	£1.08	4515	£2.99	4580	£5.74
4029	99p	4069	20p	4161	£1.08	4516	£1.08	4581	£2.62
4030	58p	4070	23p	4162	£1.08	4517	£3.82	4582	98p
4031	£2.05	4071	21p	4163	£1.08	4518	£1.02	4583	76p
4032	£1.00	4072	21p	4174	£1.08	4519	51p	4584	43p
4033	£1.45	4073	21p	4175	99p	4520	£1.08	4585	£1.01
4034	£1.96	4075	23p	4194	£1.08	4521	£1.88	4595	£1.20
4035	£1.11	4076	85p	4408	£6.59	4522	£1.08	4597	£2.32
4036	£2.45	4077	23p	4409	£6.59	4524	N/S	4598	£2.65
4037	£1.00	4078	21p	4410	£5.73	4526	£1.08	4599	£6.95
4038	£1.08	4081	20p	4411	£9.58	4527	£1.52	4700	£1.75
4039	£2.45	4082	21p	4412VP	£9.43	4528	99p		
4040	£1.05	4085	74p	4415V	£7.50	4529	£1.14		
4041	80p	4086	73p	4415F	N/S	4530	85p		

74C

74C00	24p	74C83	£1.29	74C164	£1.04	74C905	£7.26	74C926	£4.84
74C02	24p	74C85	£1.29	74C165	£1.04	74C906	54p	74C927	£4.84
74C04	24p	74C86	64p	74C173	90p	74C907	54p	74C928	£4.84
74C08	24p	74C89	£4.38	74C174	£1.51	74C908	96p	74C929	£11.93
74C10	24p	74C90	85p	74C175	90p	74C909	£1.63	74C948	TBA
74C14	£1.41	74C93	85p	74C192	£1.10	74C910	£6.78	80C95	54p
74C20	24p	74C95	£1.04	74C193	£1.10	74C911	£7.13	80C96	61p
74C30	24p	74C107	£1.22	74C195	£1.04	74C912	£7.13	80C97	54p
74C32	24p	74C150	£4.12	74C200	£6.78	74C914	£1.41	80C98	61p
74C42	92p	74C151	£2.46	74C221	£1.36	74C915	£1.10	82C19	£4.13
74C48	£1.38	74C154	£3.67	74C373	£1.73	74C918	£1.06	88C29	£1.93
74C73	54p	74C157	£2.20	74C374	£1.73	74C921	£11.83	88C30	£1.93
74C74	56p	74C160	£1.10	74C901	54p	74C922	£3.66		
74C76	54p	74C161	£1.10	74C902	54p	74C923	£3.73		
		74C162	£1.10	74C903	54p	74C924	TBA		
		74C163	£1.10	74C904	54p	74C925	£4.84		

MODULATORS

UM111. E36 UHF Ch.36 Vision Modulator £2.50
UM1231 UHF Ch.36 Vision Modulator wide bandwidth (for computers etc.) £4.70
UM1263 FM Sound Sub-carrier Modulator £2.50

NEW SWITCH MODE PSUs

AC 5221S 5v/10A, remote sense £63.25
AC 8221S 5v/5A, +12v/1A, −12v/1A £78.90
AC 9221S as 8221 but also −5v/0.1A £84.30
Typically 70% efficient. Dims. 4"×8½"×2"

MICROPROCESSORS

COMPUTER BOARDS

114 x 203 mm fibreglass, with gold plated edge connector.

Buffered SC/MP CPU	£7.95
SC/MP Protoboard	£5.95
Z80 CPU card	£7.50
VDU 'A' } set	£7.50
VDU 'B' } of	£7.50
VDU 'G' } three	£7.95
EPROM Programmer (2708s)	£7.95
4k PROM board (5204s)	£5.95
8k PROM board (2708s)	£7.95
2k RAM board (2102s) 1K-2K	£7.95
8k RAM board (2114s) 1K-8K	£7.95
TAPE interface	£7.50
Keyboard interface	£7.50
PSU 5v. + 12v. ±12v board	£7.50
PSU 5v. −12v board	£4.95

Further details on request

Z80

Z80 CPU (2½MHz)	£9.90
Z80-CTC (2½MHz)	£5.95
Z80-P10 (2½MHz)	£6.60

(Add £1 for the 4MHz version of any of the above 3 chips.)

SC/MP II RAM I/O

SC/MP II (4MHz)	£8.82
INS 8154 RAM I/O	£7.75

6800

6800 MPU	£6.55
6802 MPU	£9.95
6810 (128 × 8 RAM)	£2.97
68A10 (128 × 8 RAM)	£3.75
6820, 6821 PIA	£3.96
6850 ACIA	£3.08
MC6880	£2.64

6502

6502	£12.00
6520 PIA	£6.22

CMOS

COSMAC 1802	£9.85
CDP 1864	£7.25

STATICS (Mostly 450nS)

2101—256 x 4	£2.25
21L02—1K x 1	£1.20
2111—256 x 4	£1.75
2112—256 x 4	£2.25
2114—1K x 4	£5.50
4118—1K x 8 (2708 Compatible)	£18.50

DYNAMICS

MK 4027 4K 250nS	£3.50
MK 4116 16K 250nS	£8.75
MK 4816 2K x 8	£30.52

UV ERASABLES

5204 ½K x 8	£7.50
2708 1K x 8	£7.50
2716 2K x 8 single 5v	£32.28
TMS 2716	£16.95
PROMWASHING each Prom	50p (+30p+VAT)

UV PROM ERASER

PROMBOX 12	£63.63

INTERFACE

81LS95/6/7/8	£1.25
75491 LED driver	50p
75492	92p
ZN425	£3.95
8T26	£2.64

MOSTEK VDU BOARD

VAB-2	£125.00

OHIO SUPERBOARD II

Assembled	£188.00

CRT Controller: Uarts

Thompson CSF SF.F96364E	£11.50
AY-5-1013 UART TR 1602	£4.00
AY-5-1013A	£4.70
AY-3-1014A	£5.60
AY-3-1015	£5.60

CHAR. GEN. KEYBOARD ENCODER

MCM 6571/4/5/6	£9.50
MCM 66760	£9.75
MK 5302	£15.29
RO-3-2513 (5v Uppercase)	£6.95
DM 8678 CAB/BWF	£14.27
AY-5-2376	£9.75

FIRMWARE

2K Tiny Basic for Z80 (2 x 2708)	£25
4K NIBL in 4 x 2708	£55
NIBL-MM in 4 x 2708	£55
ETIBUG 1 in 5204	£14.95
ETIBUG 2 in 5204	£14.95
KITBUG (1 x 5204)	£14.95
MIKBUG 60-7	£13.70
KITBUG MM (1 x 2708)	£19.95
SC/MP Utilities (1 x 2708)	£19.00

VOLTAGE REGULATORS

7805	75p
7905	£1.08
7812	97p
7912	£1.08
LM 323K	£5.61

QUARTZ

32.768KHz (Watch)	£3.23
60 KHz	£9.95
100.0 KHz	£3.62
200.0 KHz	£3.92
204.8 KHz	£3.92
262.144 KHz	£3.92
307.2 KHz	£3.92
312.5 KHz	£3.92
455.0 KHz	£4.95
1.000 MHz	£3.62
1.008 MHz	£3.92
1.280 MHz	£3.92
1.8432 MHz	£3.62
2.000 MHz	£3.62
2.097152 MHz	£3.23
2.4576 MHz	£3.62
2.500 MHz	£3.92
2.56250 MHz	£3.62
3.000 MHz	£3.62
3.2768 MHz	£3.23
3.579545 MHz	£1.95
4.000 MHz	£2.90
4.032 MHz	£3.23
4.096 MHz	£3.23
4.194304 MHz	£3.23
4.433619 MHz	£1.25
4.608 MHz	£3.23
4.800 MHz	£3.23
4.915 MHz	£3.23
5.000 MHz	£3.23
5.0688 MHz	£3.23
5.120 MHz	£3.23
5.185 MHz	£3.23
6.000 MHz	£3.23
6.144 MHz	£3.23
6.400 MHz	£3.23
6.55360 MHz	£3.23
7.000 MHz	£3.23
7.168 MHz	£3.23
7.680 MHz	£3.23
7.86432 MHz	£3.23
8.000 MHz	£3.23
8.388608 MHz	£3.23
8.867237 MHz	£3.23
9.375 MHz	£3.92
9.800 MHz	£3.92
10.000 MHz	£3.23
10.245 MHz	£3.23
10.700 MHz	£3.23
10.92 MHz	£3.92
11.000 MHz	£3.92
12.000 MHz	£3.92
14.0 MHz	£3.92
14.31818 MHz	£3.23
16.000 MHz	£3.92
18.000 MHz	£3.23
18.432 MHz	£3.23
20.000 MHz	£3.62
20.1134 MHz	£3.23
21.1134 MHz	£3.23
27.0MHz	£3.92
27.648 MHz	£3.92
38.6666 MHz	£3.23
48.000 MHz	£3.23
100.000 MHz	£3.23
116.000 MHz	£3.23

VEROBOARD

0.1" Pitch with copper strips

2½"×1" (pack of 5)	74p
2½"×3¾"	53p
2½"×5"	62p
2½"×17"	£1.86
3¾"×3¾"	62p
3¾"×5"	69p
3¾"×17"	£2.40
4.7"×17.9"	£3.14

0.1" Plainboard (no strips)

3¾"×2½"	38p
3¾"×5"	59p
3¾"×17.0"	£1.56
Terminal pins	£1.50/500
V-Q DIP board	£1.17
DIP breadboard	£2.91
Spot face cutter	93p
Pin insertion tool	£1.28

SOLDERCON PINS

100 50p 1000 £3.95

DIL SOCKETS

8/14/16 pin 10p/12p/13p
18/20/22 pin 18p/20p/25p
24/28/40 pin 30p/40p/50p

TIMER ICs

NE555/556 29p/49p

OP-AMPS
(All Mini dips)

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

4 DIGIT LED DISPLAY

Multiplexed, common cathode, prime quality.

NSB 3881 (0.3")	£4.25
NSB 5881 (0.5)	£5.75

LED DISPLAYS

DL-704E/707E	85p
DL-727E/728E	£2.00
DL-747E/750E	£1.80
FND 500/560	£1.20

LIQUID CRYSTAL DISPLAY

4×0.5" Digits 40 pin DIL £9.95

CLOCK CHIPS

AY-5-1224A	£2.60
MK 50253	£5.50
MK 50362/50366	£6.50
MC 14440/(LCD)	£11.50

SIX DECADE COUNTERS

MK 50395/6/7	£8.75
MK 50398/9	£6.20

DATA

Note: In this section all data books are subject to 0% VAT. For postage see 'Terms' at top of page.

c650 page COSMOS Databook (RCA)	£4.95
c31 page 'A Guide to SC/MP Programming' by Dr. Drury (Kemitron)	£3.75
c20 page 'A Guide to Kitbug' (Kemitron)	75p
c24 page NIBL Reference Guide (National)	£3.45
c6 page data for Mk 4118	25p
16-page data for INS 8154 (ISP-8A/650) (National)	50p
20-page data for SC/MP II (National)	50p
c100 page CDP 1802 MPU User Manual (RCA)	£4.50
c45 page Fixed Point Binary Arithmetic Routines for COSMAC	£4.50
c31 page Floating Point Arithmetic Routines for COSMAC (listings excluded)	£4.50
c43 page COSMAC MPU Product Guide (RCA)	75p
c15 page CDP 1802 Instruction Summary	25p
c70 page Understanding CMOS (RCA)	£1.50
SC/MP Microprocessor Assembly Language (National)	£6.90
1 page COSMOS Pocket Selection Guide (RCA)	25p
c21 page COSMOS Digital Integrated Circuits (RCA)	75p

SPECIAL: Z80 DATA PACK £14.95

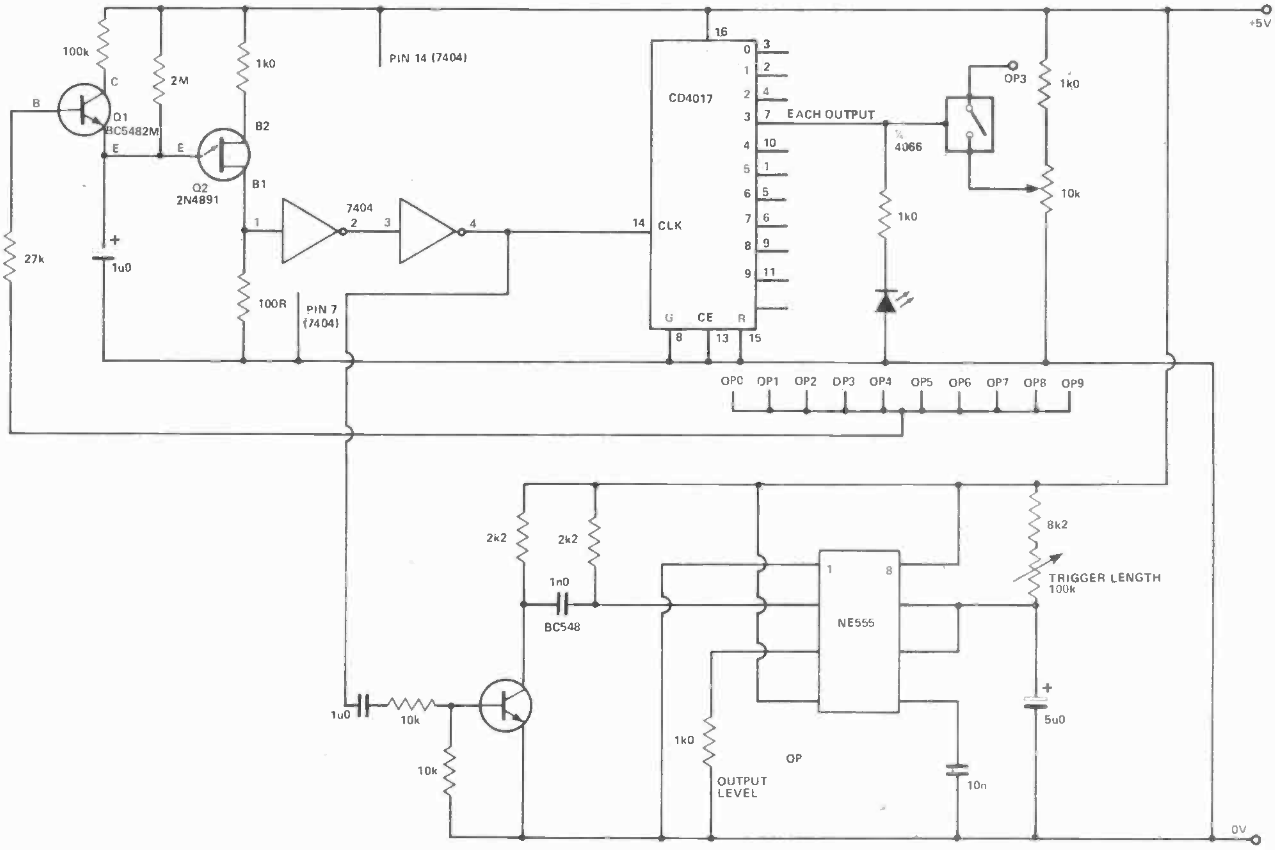
A set of the following 5 Z80 data manuals and all the related data we can find of interest to the Z80 user. Approximate weight 1.75kg

c90-page Z80 CPU Technical Manual
c10-page Z80-CTC Product Specification
c25-page Z80-P10 Technical Manual
c200-page Z80 Programming Manual
c25-page Z80 Micro Reference Manual

c100-page Starship Simulation by Roger Garrett (Dilithium)	£5.10
c50-page Finite State Fantasies (Cartoons putting programming on human level) (Matrix Press)	£2.00
c225-page Home Computers: 2^{10} Questions and Answers. Vol. 1: Hardware by Rich Didday (Dilithium)	£5.70
c175 page Home Computers: 2^{10} Questions and Answers. Vol. 2: Software by Rich Didday (Dilithium)	£4.95
c175 page Home Computers: Beginners Glossary and Guide by Miller and Sippl (Dilithium)	£4.95
c104 page Machine Language Programming for Beginners by Ron Santore (Dilithium)	£5.10
c225 page Understanding Computers by Paul Chirlian (Dilithium)	£6.50

74LS

74LS00	14p	74LS27	28p	74LS76	40p	74LS125	60p	74LS163	£1.18	74LS240	£2.36	74LS283	£1.92	74LS375	£1.60
74LS01	14p	74LS28	48p	74LS78	40p	74LS126	60p	74LS164	£1.14	74LS241	£2.32	74LS290	£1.28	74LS377	£2.12
74LS02	16p	74LS30	22p	74LS83	£1.15	74LS132	95p	74LS165	75p	74LS242	£2.32	74LS293	£1.28	74LS378	£1.84
74LS03	16p	74LS32	27p	74LS85	£1.18	74LS136	55p	74LS166	£2.26	74LS243	£2.32	74LS295	£1.85	74LS379	£2.15
74LS04	16p	74LS33	39p	74LS86	43p	74LS138	85p	74LS170	£2.88	74LS244	£1.70	74LS298	£1.68	74LS384	86p
74LS05	20p	74LS37	39p	74LS90	60p	74LS139	85p	74LS173	£1.05	74LS245	£2.70	74LS324	£2.40	74LS386	.86p
74LS08	22p	74LS38	39p	74LS91	£1.04	74LS145	£1.08	74LS174	£1.06	74LS247	£1.90	74LS325	£2.90	74LS390	£2.30
74LS09	22p	74LS40	28p	74LS92	89p	74LS147	£1.70	74LS175	£1.10	74LS248	£1.90	74LS326	£2.94	74LS393	£2.30
74LS10	20p	74LS42	98p	74LS93	89p	74LS148	£1.73	74LS181	£3.98	74LS249	£1.90	74LS327	£2.86	74LS395	£2.18
74LS11	22p	74LS47	90p	74LS95	£1.16	74LS151	96p	74LS183	£2.98	74LS251	£1.34	74LS347	£1.48	74LS396	£2.15
74LS12	23p	74LS48	£1.20	74LS96	£1.16	74LS153	76p	74LS190	£1.40	74LS253	£1.42	74LS348	£1.86	74LS398	£2.76
74LS13	38p	74LS49	£1.20	74LS107	44p	74LS154	£1.70	74LS191	£1.40	74LS257	£1.10	74LS352	£2.28	74LS399	£2.30
74LS14	75p	74LS51	24p	74LS109	55p	74LS155	96p	74LS192	£1.30	74LS258	£1.46	74LS353	£2.28	74LS445	£1.50
74LS15	30p	74LS54	28p	74LS112	55p	74LS156	96p	74LS193	£1.30	74LS259	£1.60	74LS365	65p	74LS447	£1.44
74LS20	20p	74LS55	30p	74LS113	50p	74LS157	76p	74LS194	£1.66	74LS261	£4.50	74LS366	65p	74LS490	£1.80
74LS21	22p	74LS63	£1.50	74LS114	50p	74LS158	96p	74LS195	£1.36	74LS266	52p	74LS367	65p	74LS668	£1.82
74LS26	48p	74LS73	46p	74LS122	70p	74LS160	£1.28	74LS196	£1.00	74LS273	£2.44	74LS368	66p	74LS669	£1.82
		74LS74	41p	74LS123	70p	74LS161	98p	74LS197	£1.40	74LS275	£2.50	74LS373	£1.80	74LS670	£2.48
		74LS75	48p	74LS124	£1.80	74LS162	£1.38	74LS221	96p	74LS279	66p	74LS374	£1.95		



Simple Rhythm Generator

J. J. Trinder

The circuit was designed to be used with a synthesiser to play simple repeating rhythms automatically. All that was required in this case was a trigger signal, although a pitch signal could be added easily by duplicating the switch and resistor networks on the 4017 outputs.

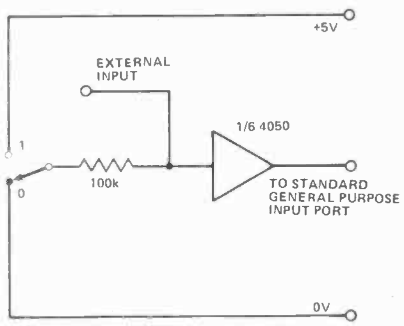
The clock drives the 4017, which sequentially takes its outputs high. These are used to turn on switches. The output voltage from each switch can be varied by adjusting the pot.

The outputs are added together and fed back to the base of Q1, thus varying the speed of the clock depending on the setting of the pot on the output selected. The clock is also used to trigger a monostable formed around an NE555. This circuit provides the gate pulse for the synthesiser. The gate length can be varied by adjusting the 100 k pot.

External Input For Micros

P. F. Tilsley

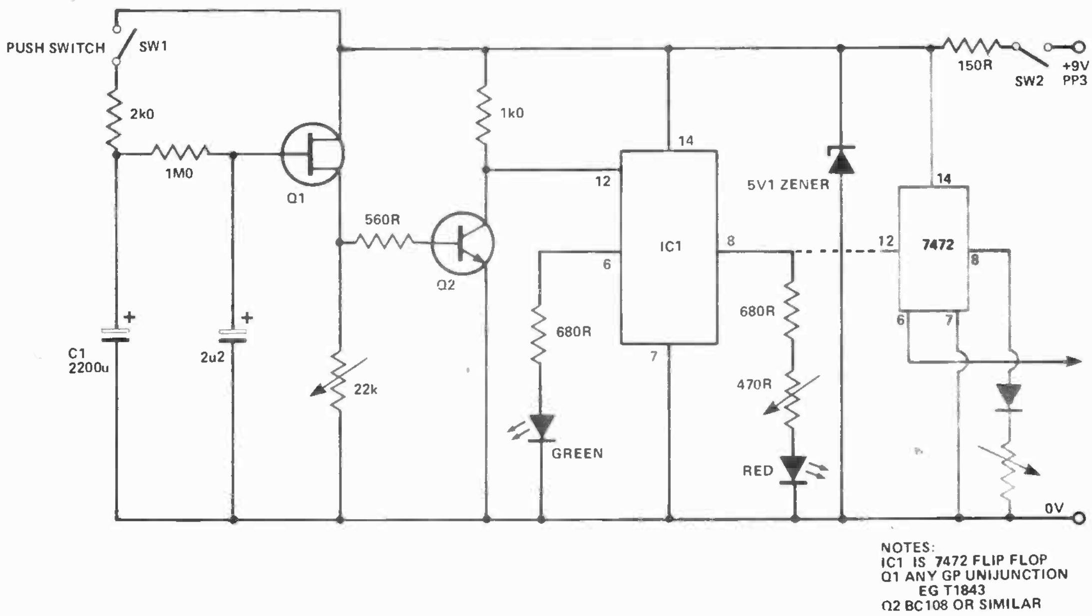
This simple circuit provides a micro with an 8 bit switch/external signal input port. The state of the switches controls the byte read by the micro, but any totem pole TTL signal applied to the external input socket over-rides the signal from the corresponding switch. The value of the resistor is not as critical. The circuit is shown for only one bit.



Heads Or Tails

Steven Snook

This circuit differs from previous Heads or Tails circuits in that when the switch is released the switch is released the LEDs will continue to flash at a continually decreasing speed, until eventually they stop and one or the other will remain on. When SW1 is depressed C1 charges via the 2k resistor, when SW1 is released C1 produces a gradually decreasing voltage into the emitter junction of Q1. This produces a slow drop in frequency of oscillation, the oscillation ceases when C1 is completely discharged. The output of the oscillator is fed into an inverter, Q2, then into the 7472 flip flop. The 470R preset must be adjusted to give equal chances of each LED. A novel, untested, modification would be to omit the red LED and drive another 7472, this would give four combinations instead of two.

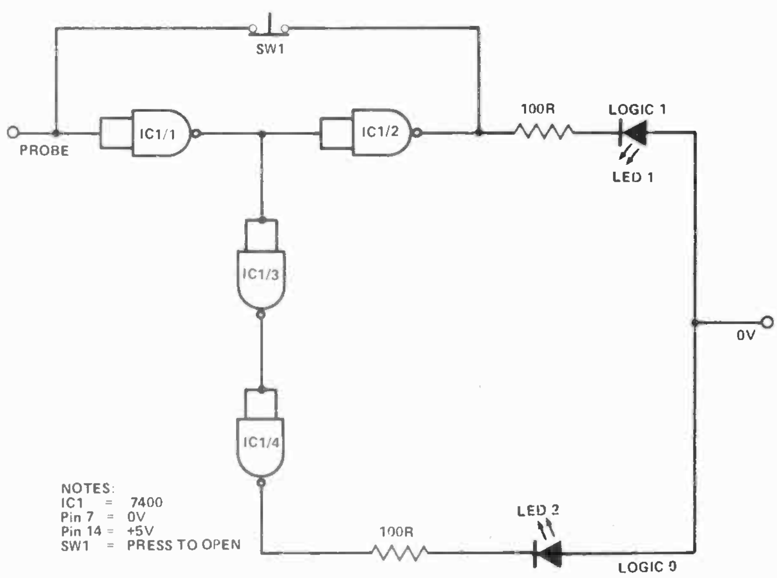


One Chip Logic Probe

K.D.Hedger

This circuit, although very cheap and with a low componant count, is very effective. When logic 1 is at the input of IC1/1 output goes low causing IC1/2 output to go to logic 1 lighting LED 1. Logic 0 at the input of IC1/1 causes the output to go high, IC1/3 goes low and IC1/4 goes to logic 1 lighting LED 2.

SW1 takes the output of the IC1/2 back to the input of IC1/1 so locking LED one on until the push to open switch is released.



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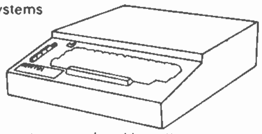

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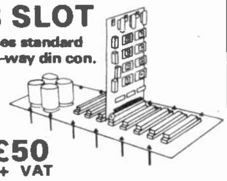

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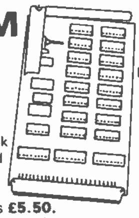

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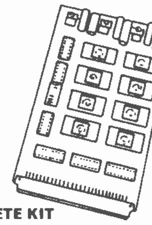

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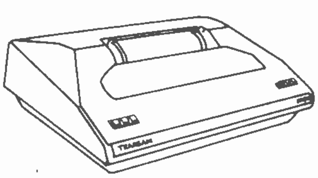

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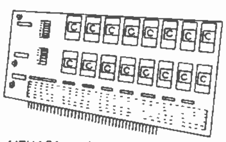

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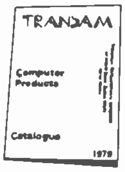

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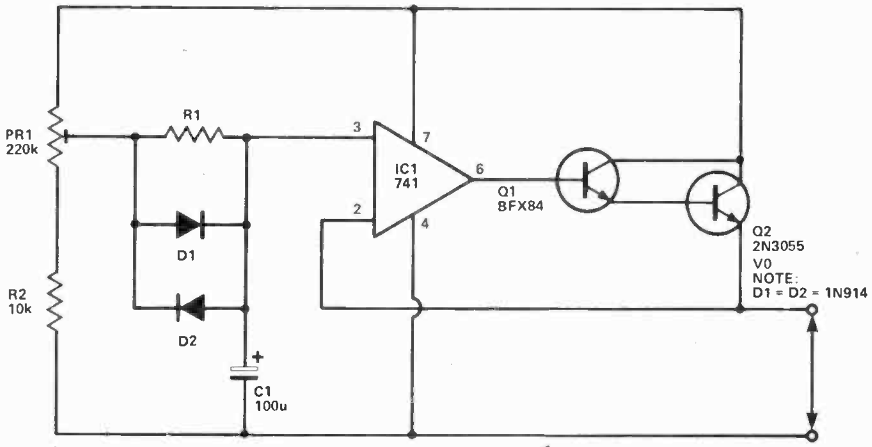


The circuit shown is essentially a gyrator which amplifies the effect of C1 to produce an equivalent capacitance at the output, many times the value of C1.

PR1 is used to set the output voltage to the required level whilst C1 charges through D1. Once the voltage across the diode drops to less than 0.6V C1 will continue to charge through R1 until the voltage across C1 is equal to that on the slider of PR1.

The equivalent capacitance at the output is equal to the product of the current gain of the circuit and the value in Farads of C1. If we assume that the input impedance at the non-inverting input of the 741 is 1M0 and the output impedance is 1R0 then this capacitance will be equal to 10^{-4} $FX10^{6}=100F$!

In practice the input impedance at low frequencies is many tens of megohms whilst the output impedance is a small fraction of an ohm, so the above figure is very conservative.

D2 is included to allow the output voltage to be quickly adjusted by allowing C1 to discharge to earth through R2. In practice however the output voltage will only respond rapidly to input voltage changes of more than 600mV.

Extra Memories On The T158

A. Fleming

Key code 82 is not used in the users' manual. However, if it is entered into the program (by pressing STO 82 and deleting STO) the registers used for storing data during arithmetical calculations can be used like the calculator's memories. That is, numbers can be stored, recalled, added, subtracted, divided or multiplied into these registers. This works on the T158 and may also work on the T159.

Any operation using one of these registers requires two program steps. The first one contains the keycode 82. The first digit of the second step defines the operation and its second digit defines the register. Table 1 shows how to work out the digits of the second step.

The calculator uses these registers for other operations. It is, therefore, necessary to know which ones the calculator will use. Each time the calculator has to remember a number during calculations, it goes into the next register in the sequence A,B,C . . . Table 2 shows the other functions which use these registers.

The blank boxes indicate registers which may contain numbers (which can be recalled using 82) but are now ignored in calculations.

First Digit	Second Digit
0 ≡ store (STO)	1 ≡ reg. A
1 ≡ recall (RCL)	2 ≡ reg. B
3 ≡ add into (SUM)	3 ≡ reg. C
4 ≡ multiply into (Prd)	4 ≡ reg. D
5 ≡ Subtract into (INV SUM)	5 ≡ reg. E
	6 ≡ reg. F
6,7,8 or 9 ≡ into (INV Prd)	7 ≡ reg. G
(Words in brackets indicate indicate the equivalent memory function)	8 ≡ reg. H

Examples

keycodes	function
82 38	add into reg. H
82 04	store D
82 66	divide into reg. F

Σ+	uses	G and H
x	"	1st L.A.R. *
INV x	"	1st & 2nd L.A.R. & H
OP 11	"	1st & 2nd L.A.R.
OP 12	"	1st, 2nd & 3rd L.A.R.
OP 13	"	1st, 2nd, 3rd & 4th L.A.R.
OP 14 & OP 15	"	1st, 2nd & 3rd L.A.R. & H
P → R	"	1st L.A.R. and G & H
INV P → R	"	2nd L.A.R. and G & H
DMS & INV DMS	"	1st & 2nd L.A.R. and H

*L.A.R. stands for "lowest available register(s)" i.e. the next registers after those being used for arithmetical calculations.

Example

The following is a section of a program:—

π + 6 x (RCLO + 1 + RCL 1 P → R =

Program execution	Registers and contents A	B	C	D	E	F	G	H
π + 6x	π	6						
(RCL 1 +	π	6	contents mem. 0					
1 + RCL 1	π		contents mem. 0 + 1					
P → R	π	6	contents mem. 0	Used			Used	Used
=								

tech tips

Readers' Circuits

Texan Roulette

J. Blandford.

This roulette program has been devised for a Texas TI57 programmable calculator. You choose the number on which you want to bet. The calculator then generates ten random numbers in the range 0 to 36. A lose deducts one chip from your initial pile of 100 (in memory 4) and a win adds 36. The winning number also flashes on the display.

After ten random numbers, the calculator stops. Pressing SBR4 displays the amount of chips left in your pile. Press R/S to reload the memories, enter a new number and press R/S to start again.

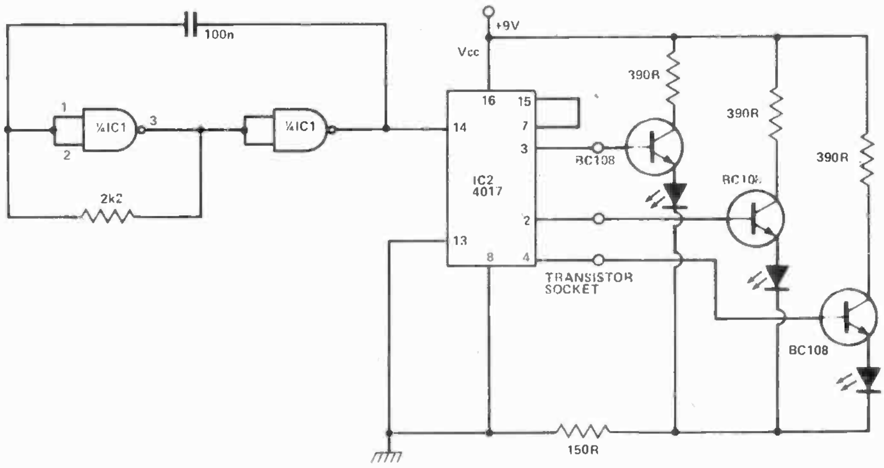
KEY	LOC	CODE
2nd Lab 1	00	86 – 1
2nd π	01	30
+	02	75
RCL 1	03	33 – 1
=	04	85
yx	05	35
8	06	08
–	07	65
2nd INT	08	49
=	09	85
STO 2	10	32 – 2
1	11	01
INV SUM 4	12	– 34 – 4
RCL 2	13	33 – 2
STO 1	14	32 – 1
x	15	55
3	16	03
7	17	07
=	18	85
2nd INT	19	49
2nd PAUSE	20	36
2nd x=+	21	66
GTO 2	22	51 – 2
2nd INV DSZ	23	– 56
R/S	24	81
GTO 1	25	51 – 1
2nd Lab 2	26	86 – 2
STO 5	27	32 – 2
RCL 4	28	33 – 4
+	29	75
3	30	03
6	31	06
=	32	85
STO 4	33	32 – 4
RCL 5	34	33 – 5
+	35	75
x	36	55
2nd Lab 4	37	86 – 4
RCL 4	38	33 – 4
R/S	39	81
CLR	40	15
1	41	01
0	42	00
STO 0	43	32 – 0
CLR	44	15
R/S	45	81
STO 7	46	32 – 7
CLR	47	15
GTO 1	48	51 – 1

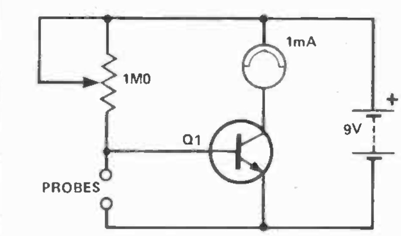
PRESS	DISPLAY
100 STO 4	100 stored for starting score
SBR 4	100 score
R/S	Enter number (0 – 36)
R/S	Start
	10 random numbers (0 – 36)
	each wrong number
	subtracts 1 chip from score
	right number flashes adds
CLR	36 to score
SBR 4	Displays score
R/S	Enter new number
R/S	Re start

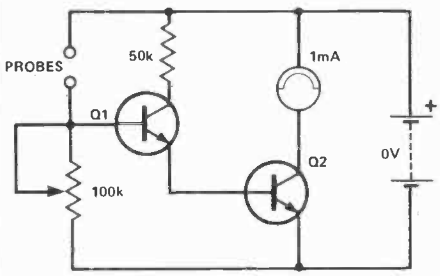
Improved CMOS Test Bed

G. Scott

Having made Mr Anderson's CMOS test bed (March ETI) I found that the LEDs were barely bright enough to be seen. In this circuit, with the addition of three, one transistor amplifiers, the LEDs are easily viewed and the current drain is only 14 mA.







NOTE:
Q1-2: BC108 OR SIMILAR

GSR Meter

D.Chivers

The galvanic skin response meter is probably the easiest both to construct and to use. Fig.1 uses a single BC108 – incidentally, the meter used was simply the 1mA range of a multimeter. While the circuit shown had the required sensitivity, it was not selective enough and under all sorts of stresses and strains the needle refused to budge from a set position. The darlington pair configuration of Fig.2 greatly increases sensitivity and the 100k pot will bring the reading down to a usable level – without this, the current passing through the meter would be about 30mA. This modified circuit proved to be amply selective.

For use as probes, silver foil taped onto the tips of the first and second fingers proved to work well, though for more permanent use steel gauze is recommended. Naturally the hand must be kept as steady as possible during experiments.

First experiments proved highly successful; the meter needle drifted at first and frequent use of the sensitivity control was required, but after a few minutes the needle stabilised.

Since the needle responds to stress within the body or mind, it is easy to make it move; talking, thinking hard or biting a finger all cause the needle to move up, making it go back down by removing the factor causing the stress. Moving the needle below its mean value was far more difficult especially while watching the meter and actually trying to relax – in fact to start with this actually caused tension. The easiest way to do this is to simply close the eyes and relax, while an observer takes note of the results. On opening the eyes the reading would jump up to what it had been before relaxation commenced.

This circuit will of course function as a lie detector but since stress is caused by any question the results are not too reliable and certainly of no significance.

An unexpected use for the circuit of Fig.1 is that of a transistor tester. If a fixed value resistor of about 2M25 is used in place of the pot the gain of the transistor may quickly be tested; FSD= approx. hfe 250. For NPN transistors, polarity of the meter and battery must be reversed.

Anti — Acoustic Feedback System For Group Or Disco

G.T.Edwards

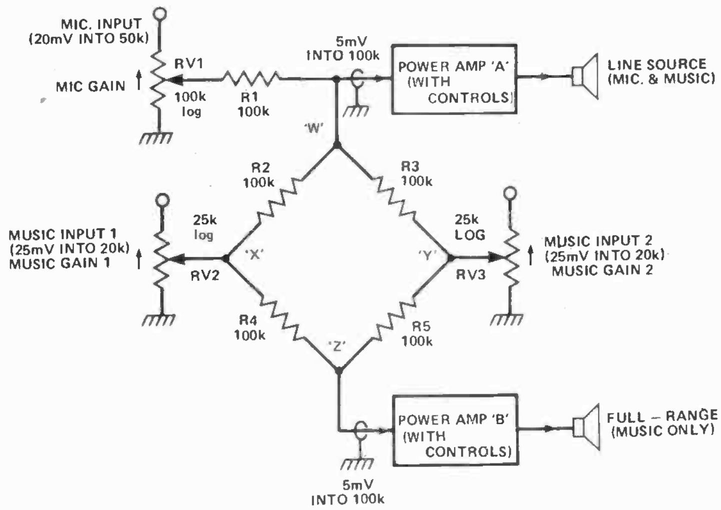
The directional properties of Line-Source Loudspeakers are best for minimising acoustic feedback ("Howl-Round"); unfortunately their bass response is usually inadequate for the full musical range. The ideal system would consist of a completely separated amplifier system for microphone inputs terminating in line-source loudspeakers, the "music" being amplified independently and fed at suitable power levels to less-directional full-range loudspeakers. However, as this is costly and increases transportation problems, a system was evolved in which a full-range non-directional loudspeaker would respond to "music" inputs only, a line-source being used at the same time responding to both "music" and "mic." inputs.

The principle has been proved in practice using the passive network shown in the diagram. As the microphone input is attenuated successively by three potential dividers before reaching the full-range loudspeaker system, the risk of feedback from this speaker is negligible. Typically there is at least 26 dB reduction in microphone signal voltage between the input to amplifier 'A' and the input to amplifier 'B'.

The circuit is easily adapted to other signal levels and impedances by modifying component values on a proportional basis; a more elaborate "active" system is possible using virtual-earth summing amplifier stages.

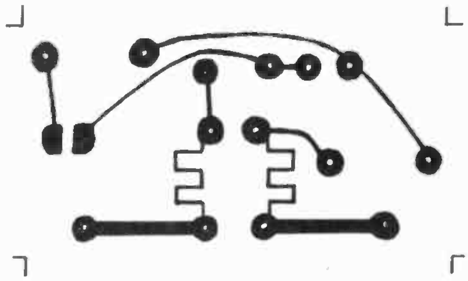
Simulated stereo is possible from monophonic programme material by connecting a capacitor (about 2n2) between point 'Z' and earth; another capacitor (about 1n0) being connected in series at 'W'.

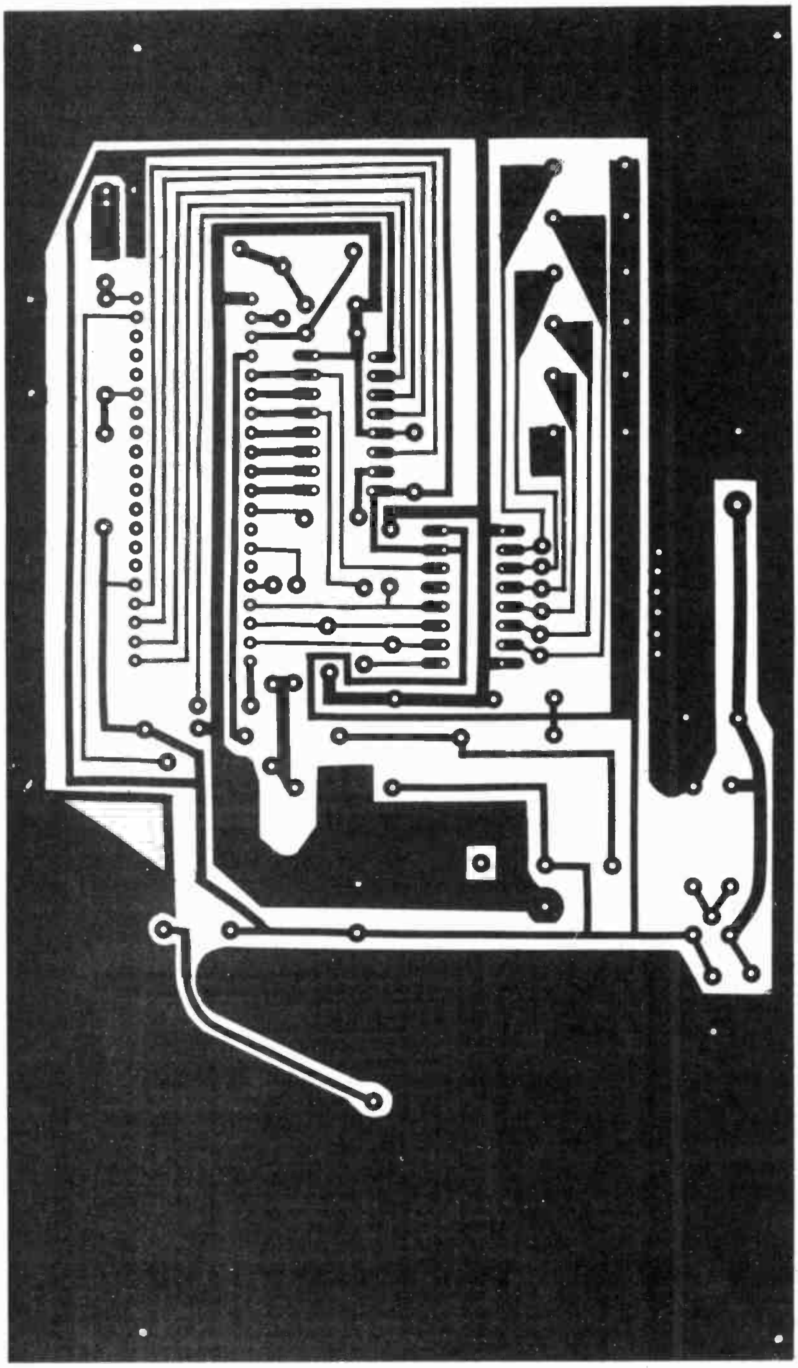
An inherent advantage of the system is that a "music" output is obtained even if one of the power amplifiers, or one of the loudspeakers, should go faulty during a performance.



PCB PATTERNS

Right: Microwave oven leakage detector PCB shown full size track side upward. Note that the aerial is formed by the lower track 'arms.' Below: Foil pattern for the TV Pinball Wizard. This board is copyright NIC models, and thus only available from them.

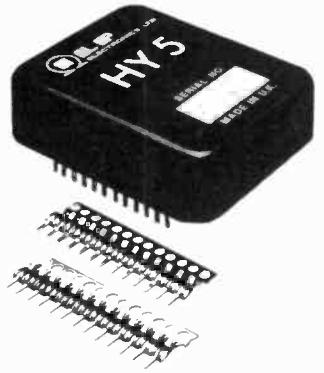


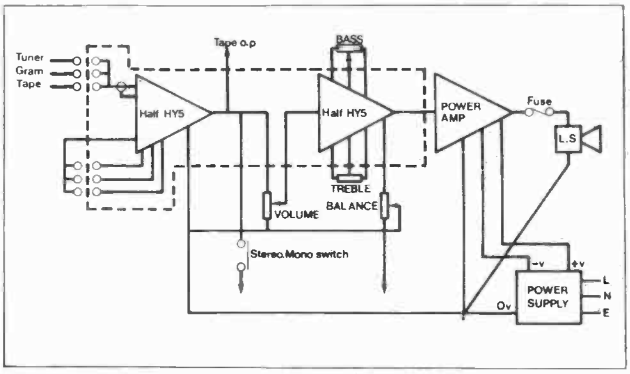


and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER

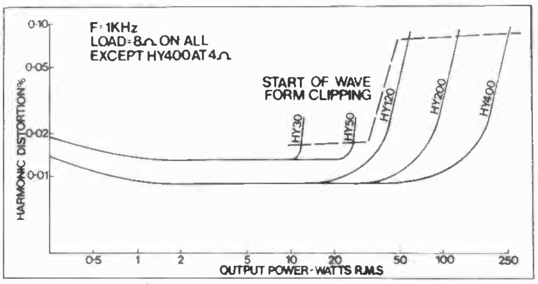




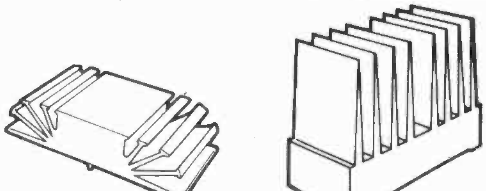
The HY5 pre-amp is compatible with all I.L.P. amplifiers and P.S.U.'s. It is contained within a single pack 50 x 40 x 15 mm. and provides multi-function equalisation for Magnetic/Ceramic/Tuner/Mic and Aux (Tape) inputs, all with high overload margins. Active tone control circuits; 500 mV out. Distortion at 1KHz–0.01%. Special strips are provided for connecting external pots and switching systems as required. Two HY5's connect easily in stereo. With easy to follow instructions.

£4.64 + 74p VAT

THE POWER AMPLIFIERS

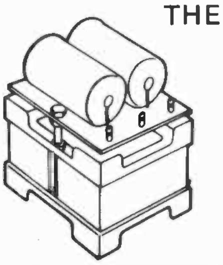


Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105x50x25	155	**£6.34** + 95p
HY50	30 W into 8 Ω	0.02%	90dB	-25 -0- +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0- +35	114x50x85	575	**£15.20** + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0- +45	114x50x85	575	**£18.44** + £2.77
HY400	240 W into 4 Ω	0.01%	100dB	-45 -0- +45	114x100x85	1.15Kg	**£27.68** + £4.15



Load impedance — all models 4 - 16 Ω
Input sensitivity — all models 500 mV
Input impedance — all models 1·00 K
Frequency response — all models 10Hz - 45KHz - 3dB

THE POWER SUPPLY UNITS



I.L.P. Power Supply Units are designed specifically for use with our power amplifiers and are in two basic forms — one with circuit panel mounted on conventionally styled transformer the other using toroidal transformer to halve weight and height.

PSU 36 for 1 or 2 HY30's **£8.10** + £1.22 VAT
PSU 50 for 1 or 2 HY50's **£8.10** + £1.27 VAT
PSU 70 with toroidal transformer for 1 or 2 HY120's **£13.61** + £2.04 VAT
PSU 90 with toroidal transformer for 1 HY200 **£13.61** + £2.04 VAT
PSU180 with toroidal transformer for 1 HY400 or 2 x HY200 **£23.02** + £3.45 VAT
PSU 30 ± 15V at 100mV to drive up to five HY5 pre-amps **£4.50** + 68p VAT

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I.L.P. ELECTRONICS LTD.
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Telephone (0227) 54778 Telex 905780

Tecknowledgey for sale.

The Mark III FM Tuner

DIY Hi-Fi will never seem the same again. Ambit's Mark III tuner system is electrically and visually superior to all others. Some options available, but the illustrated version with reference series modules: £149.00 + £22.35 VAT
With Hyperfi Series modules £185.00 + £27.75 VAT

ALL TUNER KITS £3 carriage

Features of the system:
* Precision construction & design of all parts
* Time/frequency display
* State of the art performance with facilities for updates, using modular plug in systems.
* Deviation level calibrator for recording
* All usual tuner features

Digital Dorchester All Band Broadcast Tuner: LW/MW/SW/SW/SW/FM stereo

A multiband superhet tuner, constructed using a single IC for RF/IF processing - but with all features you would expect of designs of far greater complexity. The FM section uses a three section (air gang) tuned FET tunerhead, with ceramic IF filters and interstation mute; AM employs a double balanced mixer input stage, with mechanical IF filters - plus a BFO and MOSFET product detector for CW/SSB reception. Styled in a matching unit to the Mark III FM only tuner, employing the same degree of care in mechanical design to enable easy construction. MW/LW reception via a ferrite rod antenna.

Electronics only (PCB and all components thereon)	£33.00 + £4.95 VAT
Complete with digital frequency readout/clock-timer hardware	£99.00 + £14.85 VAT
Complete with MA1023 clock/timer module with dial scale	£66.00 + £9.90 VAT

Hardware packages are available separately if you wish to house your own designs in a professional case structure. Please deduct the cost of electronics from complete prices.

LW/MW/FM LCD Digital Frequency Display - July PW feature

Update your old radio, or build this into a new design. Or use it as a servicing aid - this low power unit with LCD display reads direct frequency in kHz/MHz, or with usual AM/FM IF offsets for received frequency. Low power LCD means no RFI - 15-20mA at 9v even with the divide by 100 prescalar. FM resolution is 100kHz, AM 1kHz. Sensitivities better than 10mV
Complete kit £19.50 + £2.93 VAT, built and tested module £27.00 + £4.05VAT
Ambit stocks and distributes a wide range of frequency counter LSI for all types of DFM- part two of the catalogue contains details of the MSM5523/4/5/6 range, and the versatile MSL2318 divide by ten or hundred prescalar IC. The DFM1 combined counter for AM,FM SW and direct/clock/stopwatch/timers - details available, but SAE please !

PW SANDBANKS PI METAL LOCATOR

Maintaining our professional approach to home constructor kits, we offer the pulse induction 'Sandbanks'. Now with injection molded casing for greatly improved enviromental sealing. £37.00+£5.55vat

VHF MONITOR RX WITH PLESSEY IC

4/9 channel version of the PW design but using standard (fundx9) crystals, and TOYO 8 pole crystal filter with matching transformers. Coil sets from our standard range to cover bands from 40 to 200MHz. Complete module kit £31.25 +£4.68vat

MICROMARKET — OSTS overflow:

6800P	650p	8212	230p	2102	170p
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6850P	275p	8224	350p	2513	754p
6810	400p	8228	478p	4027	578p
6852	365p	8251	625p	2114	1000p
8080	630p	8255	540p	+15% VAT	

RADIO and AUDIO MODULES : Consistently the most advanced

FOR FM

EF5801-3-4 series: 6 stage varicap tuning, all with oscillator output

5801	Dual gate MOSFET RF stages, bipolar mixer	£17.45 + 2.61VAT
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5804	'Hyperfi' series, with internal PIN diode agc, and ultra wide range tuning system	£24.95 + 3.74VAT
EF5402	4 stage varicap tuner with TDA1062 and LO output. Uses FET/IC input. PIN agc	£10.75 + 1.61VAT

FOR 30-200MHz

The EF series are available on special order to cover bands (usually approx 20% of the centre frequency) in the range described. Details in our price list.

FOR FM IFs at 10.7MHz

7030	single 6 pole linear phase filter IF with HA1137	£10.95 + 1.64VAT
7130	two 6 pole linear phase filter IF with CA3189E	£16.25 + 2.44VAT
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Various types, guaranteed the world's biggest and best ranges

LARSHOLT FM TUNERSETS

7252	MOSFET front end combined with CA3089 IF	£26.50 +3.97VAT
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FM/AM tuning synthesiser, see details elsewhere in th is advertisement

COMPONENTS FOR RADIO/COMMUNICATIONS/AUDIO/TV etc.

As usual, Ambit brings you the latest and best, a small selection of which is shown in this advertisement. The Ambit catalogues contain information on most of the devices mentioned here - and an order for the new part three will ensure you stay up with latest developments. Data photocopying service described in pricelist info.

RADIO ICs for FM		vat
CA3089E	1.94	29
CA3189E	2.45	37
HA1137W	2.20	33
HA11225	2.20	33
SN76660N	0.75	11
RADIO ICs for AM/FM		
TDA1090	3.35	50
TDA1083	1.95	29
TDA1220	1.40	21
IF AMPLIFIERS		
KB4406	0.50	07
MC1350	1.20	18
see comms ics also		
COMMUNICATIONS		
KB4412	2.55	38
KB4413	2.75	41
SD6000	3.75	56

SL1600 series		
SL1610	1.60	24
SL1611	1.60	24
SL1612	1.60	24
SL1613	1.89	28
SL1620	2.17	33
SL1621	2.17	33
SL1623	2.44	37
SL 624	3.28	49
SL1625	2.17	33
SL1626	2.44	37
SL1630	1.62	24
SL1640	1.89	28
SL1641	1.89	28
SL6640	2.75	41
SL6690	3.20	48
MC3357	3.12	47
MC1496	1.25	19
NE544	1.70	25

Audio preamps		vat
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LM382N	1.65	25
KB4436	2.53	38
KB4438	2.22	33
TDA1028	3.50	53
TDA1029	3.50	53
TDA1074	3.75	56
Audio power		
TBA820M	0 75	11
TBA810AS	1.09	16
LM380N	1.00	15
ULN2283	1.00	15
TDA2002	1.95	29
HA1370	2.99	45
TDA2020	2.99	45

2SJ133/2SJ48 £10.00 + £1.50 pr. various high voltage drivers etc. from correctly matched Hitachi series transistors. (All 120v types)

FETs, MOSFETs, bipolars. and various others: see PL

OSTS: Remember all OSTS stocks are obtained from BS9000 approved sources - your assurance that all devices are very best first quality commercial types. Some LPSN TTL is presently in great demand, so please check by phone before ordering .

TTL:Standard AND LP Schottky

All prices listed in pence *

	'N'	'LSN'
7400	13	20
7401	13	20
7402	14	20
7403	14	20
7404	14	24
7405	18	26
7406	38	
7409	17	24
7410	15	24
7411	20	24
7412	17	
7413	30	
7414	51	
7415		24
7416	30	
7417	30	
7420	16	24
7421	29	24
7423	27	
7425	27	
7426		27
7427	27	29
7428	35	32
7430	17	24
7432	25	24
7437	40	24
7438	33	24
7440	17	24
7441	74	
7442	70	99
7443	115	
7444	112	
7445	94	
7446	94	
7447	82	89
7448	56	99
7449		99
7451	17	24
7453	17	
7454	17	24
7455	35	24
7460	17	
7463		124
7470	28	

	'N'	'LSN'
7472	28	
7473	32	38
7474	27	38
7475	38	40
7476	37	38
7478		38
7480	48	
7481	86	
7482	69	
7485	104	99
7486		40
7489	205	
7490	33	90
7491	76	110
7492	38	78
7493	32	99
7494	78	
7495a	65	99
7496	58	120
7497	185	
741XX series		
74107	32	38
74109	63	38
74110	54	54
74111	68	
74112		38
74113		38
74114		38
74116	198	
74118	83	
74120	115	
74121	25	
74122	46	
74123	46	
74124		137
74125	38	44
74126	57	44
74128	74	
74132	73	78
74136		40
74138		60
74139		60
74141	56	

	'N'	'LSN'
74142	265	
74143	312	
74144	312	
74145	65	97
74147	175	
74148	109	191
74150	99	
74151	64	84
74153	64	54
74154	96	
74155	54	110
74156	80	110
74157	67	55
74158		60
74159	210	
74160	82	130
74161		78
74162		130
74163	92	78
74164	104	130
74165	105	
74167	20	
74169		200
74170	230	200
74172	625	
74174	87	120
74175	87	110
74176	75	
74177	78	
74181	165	350
74183		210
74184	135	
74185	134	
74188	275	
74190		92
74192	105	180
74193	105	180
74194	105	
74196	99	110
74197		110
74198	150	
74199	160	
74247		90
74253		105

	'LSN'
74257	108
74260	153
74273	124
74283	120
74293	95
74365	49
74366	49
74367	43
74368	49
74373	77
74374	77
74377	124
74379	130
74393	140

VOLTAGE REGS:

7800 series 1Amp pos	95p
7900 series 1Amp neg	100p
78M series ½Amp pos	90p
78LCP 100mA	35p
78MGT2C variable	175p
79MGT2C variable	175p
723CN variable IC	65p
NE550	73p
L200 variable V and I	195p

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1 Amp in IEC chassis connector	4.83
6 Amp in IEC	5.83
5 Amp wirein	3.87

(Toroid cores in Cat no. 2)

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NE555 30p NE556 78p NE558 180p
LM3909 72p

95H90DC divide by 10/11 to 320MHz	780p
11C90DC divide by 10/11 to 650MHz	1400p
8629 divide by 100 to 175MHz min	420p
MSL2318 divide by 10/100 to 175MHz min	420p
ICM7216BIPI : 8 decade 10MHz DFM counter and full function timer, with direct drive for an LED display (mpx). Uses 10MHz xtal	1982p
ICM7217AIBI : 4 decade programmable counter with direct LED drive	950p
ICM7207 clock pulse generator	495p
ICM7208 : 7 decade counter display	1495p
ICM7106CP : LCD DVM (3½ digit)	955p
ICM7106CPK : evaluation kit for 7106	24.80
ICM7107CP : LED DVM (3½ digit)	955p
ICM7107CPK : LED DVM kit for 7107	20.65
OKI MSM5523/4 : LED/Fluorescent display driver IC for time/timer/stopwatch/ AM/FM received frequency display and direct counter (use MSL2318 prescalar) inc Crystal	1400p
MSM5525 : AM/FM frequency only couner, for fluorescent displays (6LT06) inc xtal	1100p
MSM5526 : as MSM5525 but for LCD	1100p
4 digit LCD for ICM7106 or MSM5526	1100p
10 LED (2½x5mm) bar graph driver PCB for LOG or LIN (specify). Kit ex leds	300p

IMPORTANT: ALL PRICES SHOWN EXCLUDE VAT - WHICH MUST BE ADDED AT 15% OVERALL.
PLEASE NOTE THE REDUCED CMOS/LPSN TTL RANGES DUE TO CURRENT SUPPLY SHORTAGE

CD4000

4000	17
4001	17
4002	17
4006	109
4007	18
4008	80
4009	58
4010	58
4011	17
4012	17
4013	55
4014	95
4016	52
4017	80
4018	80
4019	60
4020	93
4021	82
4022	90
4023	17
4024	76
4025	17
4026	180
4027	55
4028	72
4029	100
4030	58
4035	120
4040	83
4042	85
4043	85
4044	80
4046	130
4048	60
4049	55
4050	55
4051	65
4052	65
4053	65
4055	135
4059	563
4060	115
4063	109
4066	53
4068	25
4069	20
4070	20
4071	20
4072	20
4073	20
4075	20
4076	90

4522	149
4528	102
4529	141
4532	125
4538	150
4539	110
4543	174
4549	399
4554	153
4558	117
4560	218
4562	530
4566	159
4568	281
4569	303
4572	25
4584	63
4585	100

LINEARS

CA3130E	84
CA3130T	90
CA3140E	
CA3140T	72
LM301AH	67
LM301AN	30
LM339N	66
LM348N	186
LM3900N	60
709HC	64
709PC	36
710HC	65
710PC	59
723CN	65
741CH	66
741CN	27
747CN	70
748CN	36
NE531N	105

7 SEG DISPLAYS
HP5082 series.......

Red	7650	233p
	7653	233p
Yell	7660	233p
	7663	233p
Grn	7670	233p
	7673	233p
Fairchild FND 500/507		150p

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Varicap tuning diodes for AM/FM/TV :
1-9 v AM tuning (Cr 15:1) from TOKO–

KV1211	double matched	175p	26p vat
KV1210	triple matched	245p	37p vat
KV1215	triple snap-apart	245p	37p vat
MVAM115	single 15v	105p	16p vat
MVAM125	single 25v	105p	16p vat
MVAM2	double 25v	148p	22p vat
BB204/104	double FM	40p	6p vat
BA102	single AFC etc	30p	4p vat
BA121/ITT210	single afc	30p	4p vat
BB105B	single UHF	40p	6p vat
PIN DIODES, BANDSWITCH types			
BA479	PIN attenuator	35p	5p vat
TDA1061	Pi-form atten.	95p	14p vat
BA182	Bandswitch	21p	3p vat

All RF semiconductors stocked in depth. Please ask for quantity pricing details.

MPU controllable digital freq. synthesiser PCB. Preliminary:
Serial data controlled, with the standard swallow count system for maximum speed of operation. Multiple time constant filters, suitable for AM/FM and other communications/generator applications. Not for beginners. Full preliminary data package £1 + SAE. No phone enquirles answered on this system for the time being. Watch this space........ Projected cost of the controller PCB less than £30: comprises the two modulus counter, prog.div., phase detector, multiple TC loop filter/integrators.

TOP GRADE LEDS by AEG: PRICES ARE EXC. VAT (add 15%)

SIZE	Red	Green	Yello	Orang
5mm	14p	16p	15p	20p
3mm	13p	15p	18p	19p
2½x5	17p	20p	20p	24p

Quantity discounts for LEDs:
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FUTABA FLUORESCENT VACUUM DISPLAYS for CLOCKs etc

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TOKO COILS, FILTERs, CHOKES, etc for AM/FM/TV comms– (please add VAT @15%)

TYPE	Size: 5mm	7mm	10mm	
AM IF	55p	33p	30p	Various for ICs, transistor etc.
FM IF	55p	33p	33p	Various for ICs, transistor etc.
SW coils			33p	Two impedance series
OSC coils	55p	33p	33p	For LW/MW/SW
TV vif/sif			35p	

Various coils in the range 20kHz to 300MHz - see TOKO catalogue

CERAMIC and MECHANICAL FILTERS (inc MURATA TYPES)

CFT455B/ CFT455C 60p; CFX014 -180p; CFU455C - 85p
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MURATA CFU455H and CFU455F cermic block filters 1.95ea
MURATA CFM455 series ladder filters. D,E,F,G,H bandwidths available now (20,16,12,8,6 kHz) £8.35 ea (metal encapsulated)
SFD455B, SFD470B, SFD472B 85p ea
CFM2 series mechanical elements types A,B,C,D (4-10kHz bandwidth) - 65p ea. (As used in RCME feature)

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CFSE10.7/SFE10.7 - stereo FM IF ceramic filters (sim FM4 etc)	50p
CFSB10.7/SFE10.7MJ - mono bandwidth ceramic FM IF filters	50p
SFE10.7ML - ultra linear phase stereo ceramic IF filters	70p
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Current news: A PCB for the Mullard DC tone and volume control system is now available £3 + 0.45 VAT. HMOS PA modules for 60-100W - kit £14 +£2.10VAT, heatsink £4.10+0.61. FM radio control system crystals £3.75 pair inc VAT (Sept. on). MK50366N: static drive clock/timer IC £3.78 + 0.57 VAT. 12½kHz channel spacing 8 pole 10.7MHz XTAL filter by TOYO type H4402 £15.50 + £2.32VAT. A further updated pricelist is now available, and we would like to remind you that enquiries can only be answered if accompanied either by an official business letterhead, or an SAE. STOP PRESS: TOKO's new split-apart triple AM tuning diodes are in stock £2.45 + 37p VAT, (KV1215). S BL1 diode DBM 1-500MHz - £4.25+0.64p.

Terms: CWO please. Account facilities for commercial customers OA. Postage 25p per order. Minimum credit invoice for account customers £10.00. Please follow instructions on VAT, which is usually shown as a separate amount. Overseas customers welcome - please allow for postage etc according to desired shipping method. Access facilities for credit purchases.

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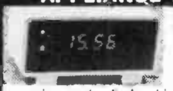

Switches any appliance up to 1KW on and off at preset times once per day. Kit contains: AY-5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, PCBs and full instructions.

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710	33p
747-14	48p
748-8	44p
CA3018	86p
CA3028A	90p
CA3046	70p
CA3054	120p
CA3080	75p
CA3130T	100p
CA3140E	45p
LF351N	65p
LF356N	85p
LM301AN	32p
LM308N	80p
LM318	200p
LM324	74p

LM339	60p
LM348	90p
LM377	185p
LM380N	75p
LM381N	140p
LM382N	140p
LM1310N	150p
LM3900N	55p
LM3909N	70p
MC1496P	85p
NE531	105p
NE555	25p
NE556	60p
NE566	140p
TBA641A	200p
TBA641B	200p
TBA800	75p
TBA810	110p
ZN414	100p
ZN1034	200p
TTL	
7400	11p
7401	11p
7402	11p
7403	11p
7404	13p
7405	13p
7406	26p
7407	26p
7408	13p
7409	13p
7410	13p
7411	16p
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7413	27p
7414	48p
7416	25p
7417	25p
7420	13p
7421	21p
7422	16p
7427	22p
7428	26p
7430	13p
7432	20p
7433	30p
7437	19p
7438	19p
7440	12p
7441	49p
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7444	64p
7445	60p
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7447	53p
7448	53p
7450	13p
7451	13p

7453	13p
7454	13p
7460	13p
7470	25p
7472	21p
7473	20p
7474	22p
7475	26p
7476	26p
7480	40p
7485	64p
7486	20p
7490	26p
7491	30p
7492	30p
7493	25p
7494	45p
7495	35p
7496	45p
7497	128p
74100	80p
74105	43p
74107	20p
74109	27p
74110	42p
74118	80p
74121	26p
74122	35p
74123	42p
74125	37p
74126	37p
74132	48p
74141	50p
74142	192p
74145	55p
74150	69p
74151	48p
74153	48p
74154	65p
74155	48p
74156	40p
74157	40p
75160	59p
74161	50p
74162	59p
74163	50p
74164	64p
74165	55p
74166	80p
74173	86p
74174	64p
74175	55p
74176	53p
74177	53p
74180	50p
74181	130p
74182	50p
74190	75p
74191	75p

74192	50p
75193	64p
74194	64p
74195	53p
74196	53p
74197	50p
74198	107p
74199	107p
CMOS	
4000	14p
4001	14p
4002	14p
4006	78p
4007	15p
4008	66p
4009	32p
4010	43p
4011	14p
4012	14p
4013	32p
4014	85p
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4070	14p
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4072	14p
4073	17p
4081	14p
4082	14p
4086	65p
4510	69p
4511	75p
4516	69p
4518	69p
4520	69p

4528	85p
TRANSISTORS	
AC126	20p
AC127	20p
AC128	20p
128/176 MP	40p
AC176	20p
AC187	21p
AC188	21p
AD149	60p
AD161	40p
AD162	40p
AF116	21p
AF117	24p
AF124	34p
AF139	35p
AF239	45p
BC107	10p
BC108	10p
BC109	10p
BC147	8p
BC148	10p
BC149	9p
BC157	10p
BC158	10p
BC159	10p
BC167	8p
BC169C	13p
BC177	15p
BC178	15p
BC179B	18p
BC182	10p
BC183	10p
BC184	10p
BC209	11p
BC212	11p
BC213	11p
BC214	14p
BC461	34p
BC477	23p
BC478	23p
BC479	23p
BC547	12p
BC548	12p
BC549	13p
BC557	13p
BC558	13p
BC559	15p
BCY70	16p
BCY71	19p
BCY72	18p
BD115	40p
BD131	38p
BD132	38p
BD135	35p
BD136	35p
BD137	35p
BD138	35p

BD139	35p
BD140	35p
BF180	24p
BF184	21p
BF185	25p
BF194	10p
BF195	10p
BF196	10p
BF197	10p
BF244B	19p
BF259	25p
BFR39	32p
BFR79	32p
BFX29	27p
BFX84	27p
BFX87	27p
BFX88	27p
BFY50	22p
BFY51	22p
BFY52	18p
BRY39	35p
BSX20	22p
BU205	140p
BU208	200p
MJ2955	110p
MJE340	40p
MJE2955	104p
MJE3055	69p
MPF102	32p
MPF103	40p
MPF104	40p
MPF105	40p
MPF106	46p
MPSA06	23p
MPSA56	23p
MPSU06	61p
OC35	86p
TIP29	35p
TIP29B	40p
TIP30	35p
TIP30B	40p
TIP31	35p
TIP32	35p
TIP33	40p
TIP33C	60p
TIP34A	65p
TIP35C	200p
TIP36A	220p
TIP41A	60p
TIP42A	60p
TIP2955	70p
TIP3055	55p
ZTX107	13p
ZTX108	13p
ZTX109	13p
ZTX300	16p
ZTX301	18p
ZTX302	20p
ZTX303	24p

ZTX304	27p
ZTX311	19p
ZTX341	22p
ZTX500	16p
ZTX501	16p
ZTX502	21p
ZTX503	17p
ZTX504	28p
2N696	35p
2N697	13p
2N698	30p
2N706	14p
2N914	34p
2N918	33p
2N1131	20p
2N1302	38p
2N1303	60p
2N1304	55p
2N1613	25p
2N2222A	21p
2N2369	17p
2N2484	30p
2N2646	50p
2N2904	25p
2N2905	23p
2N2906	17p
2N2907	23p
2N2926	11p
2N3053	22p
2N3054	50p
2N3055B	50p
2N3442	150p
2N3702	11p
2N3703	11p
2N3704	11p
2N3705	11p
2N3706	11p
2N3707	11p
2N3708	11p
2N3709	11p
2N3710	11p
2N3711	11p
2N3772	180p
2N3773	330p
2N3819	21p
2N3820	35p
2N3823	70p
2N3866	60p
2N3903	20p
2N3904	20p
2N3905	20p
2N3906	20p
2N4037	33p
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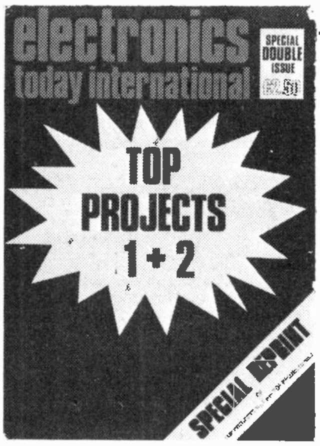

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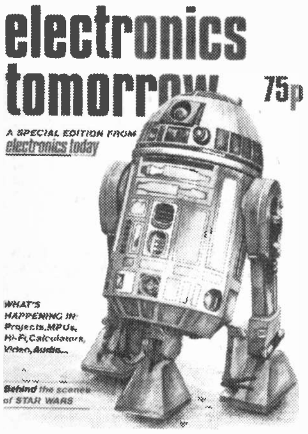

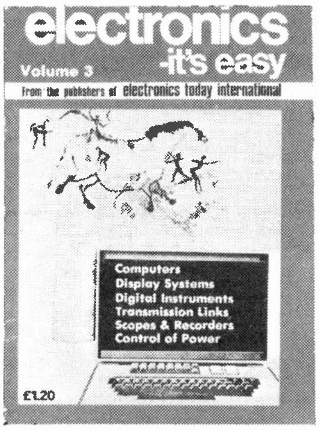

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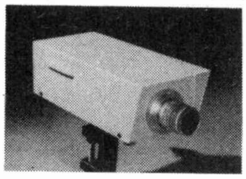

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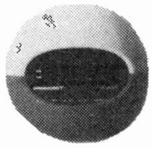

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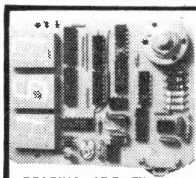

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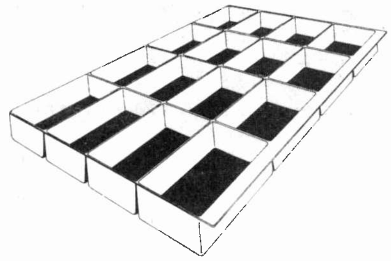

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Personal interviews will be held in London in October or November, 1979.

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Upgrade your system as your needs increase. Contains sockets for additional 16K or 32K RAM and a disk controller for up to 4-mini-disks. Software selectable dual cassettes can be used. Features a Centronics parallel port, real time clock, and a connector for an RS-232C interface or whatever. Requires Level-II Basic. 220/240V AC.

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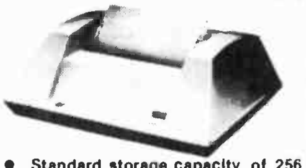

The DP 8000 prints the 96-character ASCII set in single or double width at 84 lines per minute. ● The unit operates bi-directionally to print a 9 x 7 matrix on multiple copy, pin-feed plain paper. ● This model accepts RS-232C or current loop serial data at baud rates switchable from 110 to 9600 and Parallel Bit data input at over 1000 characters per second. ● Standard storage capacity of 256 characters ● Other features include Out of Paper Detector, Top of Form Programming and Skip Over Perforation Control.

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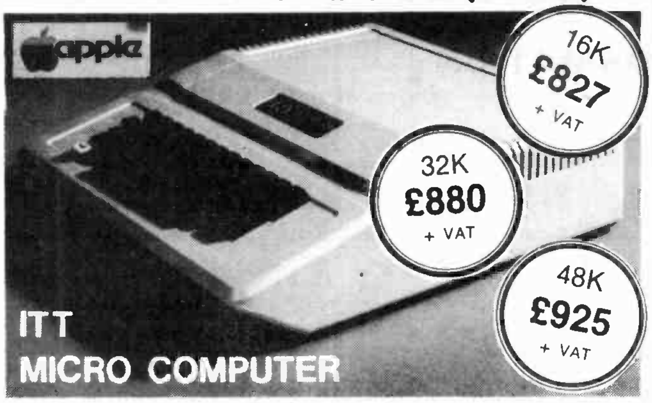

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video 100

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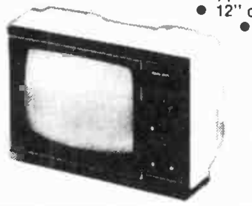

● Ideal for home, personal and business computer systems
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PET COSTS LESS AT COMP and it's a pedigree

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8K — Comes complete with integral cassette deck. Full manuals supplied. Powerful 8K Microsoft Basic in ROM. Masses of software available — **£499** + VAT

16K — Same as above but with new improved keyboard and cassette supplied as extra. Machine code monitor on board so you can program in 6502 machine code — **£590** + VAT

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At a price equivalent to learning one language, LEXICON offers you, English, Spanish, French, German, Italian and Greek. The LK3000 comes to you with the person to person module which contains 6 languages, de-luxe carrying case and a charger adaptor using its own power source which will give you 4 - 5 hours continuous use, and can easily be re-charged from the mains supply, wherever you may be in the world. Every additional module carries a concise and understandable instruction book. Your deluxe carrying case has room for two additional modules.

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AND DISSASSEMBLER
INCLUDED FREE

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- ★ Uses ultra-powerful 6502 microprocessor
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- ★ Professional 52 Key keyboard in 3 colours — software polled meaning that all debouncing and key decoding done in software

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

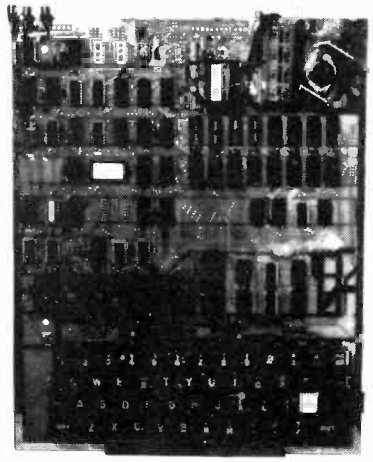
OPERATORS

+ - * / ↑ NOT.AND.OR. > < <> > = < = RANGE 10^{-32} to 10^{+32}

VARIABLES

A.B.C. ... Z and two letter variables

The above can all be subscripted when used in an array. String variables use above names plus $ e.g. A$



*8K Microsoft Basic means conversion to and from Pet, Apple and Sorcerer easy. Many compatible programs already in print.

SPECIAL CHARACTERS

@ Erases line being typed, then provides carriage return, line feed.

← Erases last character typed.

CR Carriage Return — must be at the end of each line.

: Separates statements on a line.

CONTROL/C Execution or printing of a list is interrupted at the end of a line. "BREAK IN LINE XXXX" is printed, indicating line number of next statement to be executed or printed.

CONTROL/O No outputs occur until return made to command mode. If an Input statement is encountered, either another CONTROL/O is typed, or an error occurs.

? Equivalent to PRINT

Simple Soldering due to clear and consise instructions compiled by **Dr. A.A. Berk**, BSc.PhD

NO EXTRAS NEEDED JUST HIT 'RETURN' AND GO.

Build, understand, and program your own computer for only a small outlay.

KIT ONLY **£219** + VAT
including RF Modulator & Power supply.
Absolutely no extras.

Available ready assembled and tested, ready to go for
£269 + VAT

FUNCTIONS

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

STRING FUNCTIONS

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

EXTRAS AVAILABLE SOON

COLOUR ADD-ON enables you to choose your foreground and background colour anywhere on the screen. Flash any character on the screen at will. Full documentation and parts in kit form.

AD-A-RAM EXTENDER CARD provides up to 32K Dynamic RAM Expansion, 8 Eprom sockets for 2708's or 2716's. Parallel Port (centronics compatible) and an RS232C serial port.

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1) **Business and Education**
2) **Fun and Games**

One lineprinter will be awarded to the winner of each category.

Send or bring along to the address shown below the following:

1) The program on cassette in the format used by the **COMPUKIT UK101**
2) Any documentation that you have for the program (source listing not necessary)
3) This coupon signed by you accepting the rules and conditions of the competition.

RULES:

1) Entries, including documentation, must be printed by computer or typed double spaced, with your name on every page.
2) Send or bring your entries to the address shown below.
3) Entries must be received by midnight on 29/2/80, any received after this time are void.

Winners will be notified by post before 31/3/80.

4) You warrant by your signature that all programs and documentation material included is entirely your own creation, and that no rights to it have been given or sold to any other party, and you agree to allow **COMPUKIT LTD.** to use, publish, distribute, modify, and edit it as it sees fit.
5) All entries become the property of **COMPUKIT LTD.** No entries will be returned nor any questions answered regarding individual entries.
6) Judging will be by a selected panel chosen by, and including representatives of COMPUKIT LTD. Judges may assign programs to any of the categories as they see fit. Decision of the judges is final.
7) Employees of **COMPUKIT LTD,** its dealers, distributors, advertising agencies and media are not eligible to enter.

Name ____________________

Address ____________________

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I agree to abide by the above mentioned rules.

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