

# **TRANSCENDENT 2000** SINGLE BOARD SYNTHESIZER

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

# COMPLETE KIT ONLY £168.50 + VAT!

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





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

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The Transcendent DPX is a really versatile new 5 octave keybbard instrument. There are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound — fully polyphonic i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano or a honky tonk piano or even a mixture of the two Alternatively you can play strings over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass at the lower end (the keyboard is electronically split after the first two octaves) or vice versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard to sensitive! The harder you press down a key the louder it sounds — just like an accoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrato comes in only after waiting a short time after the note is struck for even more realistic string sounds.



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

# COMPLETE KIT ONLY £299.00 + VAT!

To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects

As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing etc. etc.) and an interface socket (25 way D type) is provided for this purpose

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet

The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug — you need buy absolutely not more parts before plugging in and making great music! When finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200

POWERTRAN

ORDERING INFORMATION **AND MORE KITS ON PAGE 8** 

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



hole truth p20



start digging here p.78



guess what p.51

# EECTONICS TOUSY MARCH 1980 VOI 9. NO 3 INTERNATIONAL

# **FEATURES**

DIGEST	9	and now the good news
BLACK HOLES	20	Bottomless pits
1537	31	A new chip explained
DESIGNERS NOTEBOOK	41	Walking rings and other miracles
RAVEN ON	46	Inside information
AUDIOPHILE	51	The latest in sound news
TV SOUND	72	A few hints for the courageous
TRANSLATOR	84	A new words box
TECH TIPS	93	Readers ideas

# **PROJECTS**

SIGNAL TRACER	26	Better late than never
MUSCLE METER	56	Read any good biceps?
HEATER CONTROL	67	A posh thermostat
METAL LOCATOR	78	A discriminating locator
VOLTAGE CONTROLLED MIXER	87	Project 80 VCM

# **INFORMATION**

SPECIALS	17	The best of ETI
ETI APRIL	29	Crystal ball time
MARKETPLACE	39	Shopping with ease
HE APRIL	49	The hobby's future
BE AN ETI MAN!	53	Time to come and join us
ETIPRINT	75	Lay it all down
BOOKS	77	Words of wisdom

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# Britain's first comp

A <u>complete</u> personal computer for a third of the price of a bare board.

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Until now, building your own computer could easily cost around £300 – and still leave you with only a bare board for your trouble.

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television; everything!
And yet the ZX80 really is a complete,
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- FREE course in BASIC programming and user manual.

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The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter, and the Sinclair teach-yourself BASIC manual.

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- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.

- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
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# ...and the Sinclair teach-yourself BASIC manual.

If the features of the Sinclair interpreter listed alongside mean little to you-don't worry. They're all explained in the specially-written 96-page book free with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming-from first principles to complex programs. (Available separately-purchase price refunded if you buy a ZX80 later.)

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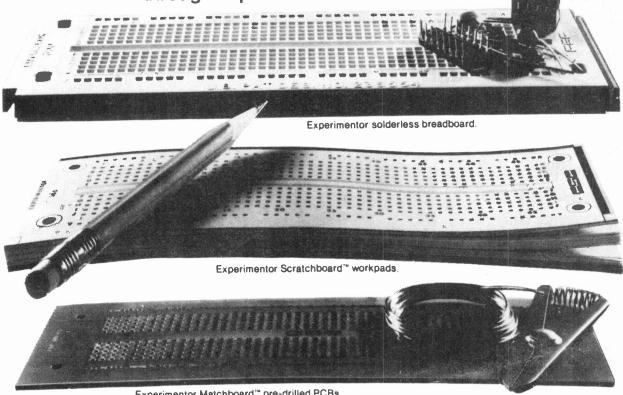
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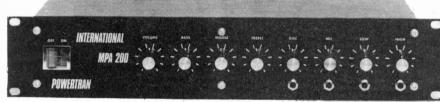
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Kit includes fully finished metalwork, fibreglass PCB controls, wire, etc. — Complete right down to the last nut and bolt!

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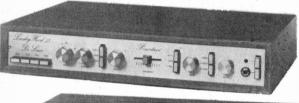
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The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.







# 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

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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.





# DIGEST



# **Radiation Hazard**

Have you any old ex-government equipment with luminous dials or pointers? (They may not now be luminous because of phosphor degeneration).

Mr. Manning of Birmingham University has informed us of a radiation hazard that may exist some ex-government from equipment.

He was moved to write to us after examining a revolution counter, containing two large moving coil meters with edgewise scales about 100 mm long,

6-14-18-22-26-30 and scaled marked 'Engine Speed Hundreds of RPM'.

The graduations and numbers are filled with radium activated luminous paint, applied very thickly. At 10 cms from the scales a Geiger counter registered 1000 counts per second. With alpha and bata radium ond. With alpha and beta radiation blocked, the count rate was still 100 cps. As Geiger counters are only one or two per cent efficient for gamma rays, the true rate may be several thousand per second. In that event the radioactive paint used is such a strong source (several millicuries) that one would require a licence to use it for teaching purposes.

If you have any ex-government equipment with luminous dials or pointers — better safe than sorry, have it properly disposed of if you think it may be a radiation hazard. Warning - don't burn the equipment; that will simply spread the radium through the air.

# For Starters

The Dema System is a compact electronic ignition unit introduced by Maywood Technical Developments. Priced at £49.50 including VAT and postage, the unit is aimed at both the private motorist and the fleet operator.

The system incorporates a variable pulse width circuit to determine when the voltage stored on capacitors should be swtiched by thyristor to the HT coil and spark plugs. It monitors the revs and varies the duration of the spark to achieve as near as possible complete initiation of combustion.

The system can be installed by unskilled staff in about half an hour without having to make any alterations to the vehicle.

The Dema System is available from Maywood Technical Developments Ltd, Peake House 232 High Street, Harlington, Hayes, Middlesex UB3 5DS.

# **Tantless**

It seems that there isn't a lot of tantalum ore about these days. Although it hasn't exactly been the first item on News at Ten, it means there's a shortage of tantalum powder, from which the capacitors are made. Supply and demand just isn't working in our favour. As demand keeps on rising, the known reserves are being exhausted. That inevitably means that tantalum capacitors are bound to increase in price rapidly over the next year or

# **Red Hot Radar**

Under Chairman Brezhnev Soviet defence spending has increased from half to almost double that of America.

Subcommittee Senate heard recently that the latest Soviet airborne tactical lookdown/shoot-down radars are believed to be superior to any system now used by American forces.

Russian missile guidance systems can now match their American counterparts. Russia is also annually devoting several times America's spending on research into high energy laser research.

TTLs by T	7/1250 200			SERIES	VEROBO	ARDS 0 1 0.1	5 TRANSISTOR		59 <b>36</b> p	TIP29C 56	p. 2N3054 <b>65</b> p	40361/2 <b>45</b> p	
7400 74800 7401 7402	80p 74278 29 12p 74279 110	Op 4020 Op 4021	100p 930 110p 930 110p 930	02 175 08 316	2.5×3.7 2.5×5"	5" 48p 4:	d) AC126 25 3p AC127/8 20	BFR4	10 25p 11 25p	11P30A 48 11P30C 60 11P31A 58	p 2N3055 48p p 2N3442 140p p 2N3553 240p	40364 120p 40408 70p 40409 85p	10A, 400V 200p 25A 400V 400p
7402 7403 7404 74S04	14p 74290 150 14p 74293 150	Op 4023 Op 4024	22p 93 50p 93 20p 93	11 <b>275</b> 12 <b>160</b>	3.75×3. 3.75×5′	75" 57p 64p 64	AC187/8 25 AF116 50	BFR8	30 <b>25p</b>	ПР31С 62 ПР32A 68 ПР32С 82	P 2N3565 30p P ZN3584 250p	40410 <b>85p</b> 40411 <b>300p</b> 40594 <b>87p</b>	ZENERS 2.7V-33V 400mW 9p
7405 7406 7407	18p 74365 10 32p 74366 10	Op 4026	50p 93 84p 93	16 <b>225</b>	9 4.75 x 17 Plot of 100 Scot face	.9" 290p — pins 50	AD161/2 45 AU107 200	BFX3 BFX8	34p 34/5 <b>40p</b>	ПРЗЗА 90 ПРЗЗС 114 ПРЗ4А 115	p 2N3702/3 12p p 2N3704/5 12p p 2N3706/7 14p	40595 106p 40673 75p 40841 90p	1W 15p
7408 7409 7410	17p 74368 10 19p 74390 20	Op 4029 Op 4030	100p 933 55p 936 200p 937	34 <b>360</b> 38 <b>200</b>	Vero Wirir	n tool 1.18 o Pen spools	Bp BC109 11 BC117 20 BC147'/8 8	BFW	18 <b>30</b> p.	TIP34C 160 TIP35A 225 TIP35C 290	p 2N3773 300p p 2N3819 250	40871/2 90p DIODES	PLASTIC 3A 400V 60p
7411 7412 7413	24p 74490 225 20p 74LS SERIES	5p 4033 4034	200p 937	74 200		370 7		BFY5	1/2 <b>30p</b> 6 <b>33p</b>	TIP36A 270 TIP36C 340 TIP41A 65	P 2N3820 50p P 2N3823 70p	BY127 12p BYX36-300 20p OA47 9p	3A 500V 65p 6A 400V 70p 6A 500V 88p
7413 7414 74C14 7416	50p 74LS02 16 90p 74LS03 1	8p 4036 8p 4037	295p   LI	NEAR I.Co /1-0212 600p /1-1313 668p	MM571 NE531 NE555	60 <b>620p</b> 150p 22p	BC169C 12 BC172 12 BC177/8 17	BRY9 BRY3 BSX1	9 45p 9/20 20p	TIP41C 78 TIP42A 70 TIP42C 82	2N3902 700p 2N3903/4 18p	OA81 15p OA85 15p OA90 9p	8A 400V 75p 8A 500V 95p 12A 400V 85p
7410 7417 7420 7421	27p 74LS05 25 17p 74LS08 25	4039 4040	195p A) 100p A)	/1-1320 <b>320p</b> /1-5050 <b>140p</b> /3-1270 <b>840p</b>	NE5618 NE5628	70p 425p	BC179 18 BC182/3 10 BC184 11	BU10	05 <b>190</b> p 08 <b>250</b> p	TIP54 180 TIP120 120 TIP122 130	2N4037 65p 2N4058/9 12p 2N4060 12p	OA91 9p OA95 9p OA200 9p	12A 500V 106p 16A 400V 110p 16A 500V 130p
7422 7423 7425	22p 74LS11 40 34p 74LS13 40	Ap 4043 Ap 4044	90p AY	/5-1224A <b>240p</b> /5-1315 <b>800p</b> /5-1317A <b>775p</b>	NE565 NE566 NE567	130p 155p 175p	BC187 30 BC212/3 11 BC214 12	BU20 BU20	5 <b>200</b> p . 8 <b>200</b> p	TIP142 180 TIP147 100 TIP2955 78	2N4123/4 27p 2N4125/6 27p	OA202 10p 1N914 4p 1N916 7p	T2800D 130p
7425 7426 7427 7428	30p 74LS14 72 40p 74LS15 48 34p 74LS20 20 17p 74LS21 40	4046 1 4047 1	10p CA 55p CA	3019 <b>80</b> p 3046 <b>70</b> p 3048 <b>225</b> p	NE571 RC4151 SAD102	425p 400p	BC237 15 BC327 16 BC337 16	E300 E308	50p 50p	ПР4055 70 ПS43 34 ПS93 30;	2N4401/3 27p 2N4427 90p	1N4148 4p 1N4001/2 5p 1N4003/4 6p	THYRISTORS
7430 7432 7433	17p 74LS27 38 30p 74LS30 20 40p 74LS32 27	4049 4050	49p CA 80n CA	3080E 72p 3086 48p 3089E 225p	5FF9636 5N7600 5N7601	4 £11 3N 175p	BC338 16 BC461 36 BC477 /8 30	MJ25 MJ29	55 <b>90p</b>	ZTX108 12; ZTX300 13; ZTX500 15;	2N5087 27p 2N5089 27p	1N4005 6p 1N4006/7 7p 1N5401/3 14p	1A 50V 40p 1A 400V 65p 3A 400V 90p
7437 7438 7440	35p 74LS42 70 35p 74LS47 90 17p 74LS51 24	4052 p 4053	80p CA 80p CA	3090AQ <b>375</b> p 3130E <b>90</b> p 3140E <b>50</b> p	5N7601 5N7602 5N7602	3ND 120p 3N 140p	BC516/7 50 BC5478 16 BC548C 9	MJE3 MJE2	40 <b>50</b> p 955 <b>100</b> p	ZTX502 18p ZTX504 30p 2N457A 250p	2N5179 90p 2N5191 83p	1N5404/7 19p 1S920 9p HEAT SINKS	8A 600V 140p 12A 400V 160p 16A 100V 160p
7441 7442A	70p 74LS55 30 60p 74LS73 50 12p 74LS74 36	4055 1 4056 1 4059 6	25p CA 35p CA	3160E 100p 3161E 140p 3162E 450p	SN7647 SP8515 TAA621	7 200p 750p 275p	BC549C 18 BC557B 16 BC559C 18	MPF1 MPF1	02 <b>45</b> p 03/4 <b>40</b> p	2N696 35p 2N697 25p 2N698 45p	2N5245 40p 2N5296 55p 2N5401 50p	For TO220 Voltage Regs, and Transistors 22p	16A 400V 180p 16A 600V 220p BT106 110p
7444 1 7445 1	12p 74LS75 40 00p 74LS76 45 93p 74LS83 110	p 4060 1 p 4063 1 p 4066	20p DA 55p FX	3189E 400p C1408-8 200p (209 750p	TBA6418 TBA651 TBA800	225p 200p 90p	BCY70 18 BCY71/2 22 BD131/2 50	MPS6 MPS6	534 <b>50p</b>	2N706A 20p 2N708A 20p 2N918 45p	2N5457 /8 40p 2N5459 40p 2N5460 80p	For TO5 12p	C106D 45p MCR101 36p 2N3525 120p
7447A 7448	50p 74LS85 100 80p 74LS86 40 17p 74LS90 40	p 4067 4 p 4068 p 4069	22p   CL 20p   CL	7106 850p 8038 340p W7555 80p 856P 950	TBA810 TBA820 TCA940	100p 90p 175p	80135/6 <b>54</b> 80139 <b>56</b> 80140 <b>60</b>	MPSA	12 <b>50p</b> 13 <b>50p</b>	2N930 18p 2N1131/2 20p 2N1613 25p 2N1711 25p	2N5485 44p 2N5875 250p 2N6027 48p	1A 50V 19p 1A 100V 20p	2N4444 140p 2N5060 34p 2N5064 40p
7451 7453	17p 74LS92 70 17p 74LS93 80 17p 74LS96 110	9 4070 9 4071 9 4072	22p LF3 22p LM	358P 75p 10C 425p	TDA1004 TDA1008 TDA1010	320p 225p	BD189 60 BD232 95 BD233 75	MPSA MPSA	43 <b>50p</b> 56 <b>32p</b>	2N2102 70p 2N2160 360p	2N6107 66p 2N6247 190p 2N6254 130p	1A 400V 25p 1A 600V 30p 2A 50V 30p	
7460 7470	17p 74LS107 45 36p 74LS109 80 30n 74LS112 100	4073 4075 4076 1	22p LM 07p LM	311 <b>120</b> p 318 <b>200</b> p	TDA1022 TDA1024 TDA1034	120p 8 250p	80235 85 80241 70; 8D242 70;	MPSU MPSU	06 <b>63</b> p 07 <b>90</b> p	2N2222A 30p 2N2369A 16p	2N6290 65p 2N6292 65p 2SC1172 150p	2A 100V 35p 2A 400V 45p 3A 200V 60p	LOUD- SPEAKERS
7473 7474	34p 74LS113 90 30p 74LS114 45 30p 74LS122 80	4081 4082 4086	72p LM	324 <b>50</b> p 339 <b>75</b> p	TDA1170 TDA2002 TDA2020	∨ 325p 320p	BDX53B 150g BDY56 200g BF200 32g	MPSU OC28		2N2646 46p 2N2904/5 25p	3N128 120p 3N140 100p 3N141 110p	3A 600V 72p 4A 100V 95p 4A 400V 100p	Size 2½" 64R <b>70p</b> 2½" 8R <b>70p</b>
7476 7480 7481 1	35p 74LS123 70p 50p 74LS124 180p 74LS125 60p	4093 4094 <b>2</b>	80p LM 50p LM	348 95p 377 175p 380 75p 381AN 160p	TL071 TL072 TL074 TL081	50p 95p 150p	BF2448 35p BF256B 70p BF257/8 32p	R2008 R2010	8 200p 8 200p	2N2906A 24p 2N2907A 30p 2N2926 9p 2N3053 30p	3N201 110p 3N204 100p 40290 250p 40360 40p	6A 50V <b>80p</b> 6A 100V <b>100p</b> 6A 400V <b>120p</b>	2" 8R 80p 1½" 8R 80p
7483A 7484 1	84p 74LS126 60p 90p 74LS132 95p 00p 74LS133 30p	4096 4097 <b>3</b> 4	LM	709 <b>36</b> p 710 <b>50</b> p	TL082 TL084 TL170	45p 95p 130p	MEMORIES 2102-2L	120p	UART AY-3-101	5P <b>500</b> o	1	L SOCKETS BY TEXAS	5
7486 7489 1	10p 74LS136 55p 34p 74LS138 75p 75p 74LS139 75p 74LS145 120c	4099 20 40100 22	10p LM 20p LM	733 <b>100p</b> 741 <b>18p</b> 747 <b>70p</b>	UAA170 UAA180 UDN6118	50p 200p 200p 320p	2107B 2111-2 2112-2	500p 225p 300p	AY-5-101 IM6402 TMS6011	500p	14 pin 11p	18 pin 22p 24 20 pin 25p 28 22 pin 28p 40	pin <b>38p</b> 📲
7491 7492A	30p 74LS145 120p 80p 74LS147 220p 16p 74LS148 175p 30p 74LS151 100p	40102 16 40103 18	10p LM 10p LM 18m LM	748 <b>35p</b> 2917 <b>250p</b> 3900 <b>70p</b>	UDN6184 ULN2003 XR2206	320p 100p 400p	2114 2114-2L 4027 4044	525p 600p 375p	CHARAC GENERA	TORS	WIRE WRAP SOC	KETS BY TEXAS	
7494 7495A	84p 74LS153 60p 70p 74LS154 200p 85p 74LS155 90p	40105 40106 40107	10p LM	3909 <b>70p</b> 3911 <b>130p</b> 3914 <b>250p</b>	XR2207 XR2211 XR2216	400p 600p 675p	4116 5101 6810	900p 900p 510p 350p	3257ADC MCM657 RO-3-251 RO-3-251	6 £10 3 U.C. 600p	8 pin 30p 14 pin 40p 16 pin 55p	20 pin 75p :	24 pin <b>90p</b> 28 pin <b>110p</b> 40 pin <b>140</b> p
7497 11 74100 13	30p 74LS156 90p 30p 74LS157 60p 36p 74LS158 90ο	40109 <b>10</b> 40110 <b>30</b>	Op MC	4136 <b>120p</b> 1310P <b>150p</b> 1458 <b>48p</b> 1495L <b>360p</b>	XR2240 ZN414 ZN419C	400p 90p POA	74S201 82516	325p 325p	SN74526	2AN 1350p	SUBMINIATURE SWITCHES Toggle	IRONS	. 1
74105	35p 74LS160 130p 34p 74LS161 100p 55p 74LS162 140p	40114 25 4411 110 4502 12	Op MC	1495L <b>360</b> p 1496 <b>100</b> p 3340P <b>120</b> p 3360P <b>120</b> p	ZN424E ZN425E ZN1034E	135p 400p 200p	ROM/PROMs 71301 745188	700p 225p	ENCODE AY-5-237	R	SPST 66 SPDT 65 DPDT 70	P CCN.15W	400p 415p 415p
74111 7 74116 20	70p 74LS163 100p 70p 74LS164 120p 74LS165 180p	4507 <b>5</b> 4508 <b>29</b>	5p MK	TAGE REGULATO	95H90 11C90 RS	800p 1400p	74S287 74S387 74S470 74S471	350p 350p 650p	TRANSFI (prim 220 6-0-6	/ 240V)	DPDT (centre off) 85 Push to make 15 break 25	SPARE BITS	415p 46p
74119 21 74120 11	0p 74LS166 180p 0p 74LS173 110p 0p 74LS174 110p	4511 <b>15</b>	Op 1A Op 5V	d Pleasic TO-220 +ve 7805 80p		−ve 7905 <b>70p</b>	74S571 82S137 93427	650p 650p 750p 400p	9-0-9 12-0-12 0-120	100mA 88p 75mA 92p 100mA 95p 12500mA 280p	Push latching SPC0 60 SLIDE DPOT 18	SPARE ELEME C/CX/X25	180p
74122 4 74123 4	74LS175 110p 18p 74LS181 320p 18p 74LS190 250n 74LS191 100p	4515 30 4516 11 4518 10	Op 15V Op 18V	7812 <b>60</b> p 7815 <b>80</b> p 7818 <b>60</b> p		7912 <b>70</b> p 7915 <b>70</b> p 7918 <b>70</b> p	93436 93446 93448	650p 650p 1000p	0-25V (5V. 9-0-9 1A 12V 2A	A) 250p 270p 350p	ROCKER SPST 28 WAFER 1P/12W 45	K1000	550p
74126 6 74128 7	Op 74LS192 100p 5p 74LS193 100p	4520 10 4521 4526	100m			7924 <b>70</b> p	CPUs 1600	£12	0-12-15 20-24-30 15-0-15-1	1A <b>340</b> p*	3P/4W 45 4P/3W 45 2P/6W 45	VEROBOARDS	550p
74136 7	Op 74LS196 12Op 5p 74LS197 12Op	4527 15 4528 10 4538 12	p 12V p 15V	78L05 <b>30p</b> 78L12 <b>30p</b> 78L15 <b>30</b> p		79L05 <b>70p</b> 79L12 <b>70p</b> 79L15 <b>70p</b>	2650A 6502 6800	£20 £10 900p	(Please add	d 50p p&p charge ed *above our nor-	CRYSTALS 100KHz 300	OIP Breadboard 4.15 × 6.15 (Suitable for 20 >	270p
74141 5 74142 <b>20</b>	Op 74LS240 175p Op 74LS241 175p	4543 18 4553 45 4556 7	Dp LM30	7T 200p	78A625B 78HGKC 78HO5KC	120p 725p 625p	6802 8080A 8085A	1250p 550p 1400p	RESISTO	RS High	1MHz 370 1.008MHz 370 3.2768MHz 350	p Breadboard as ab for 31 way conne	ove with tracks ctor 340p
74147 19 74148 15	Op 74LS243 170p Op 74LS244 195p	4560 <b>25</b> 6 4569 <b>25</b> 6 4572 46	LM 72	23K 550p	78MGT2C 78P05	135p 900p	1NS8060 Z80 Z80A	1100p 1100p 1250	Stab 5% E Carbon Film	n	3.579545MHz 200 4MHz 350 8.867237MHz 400	p (No track cutting)	
74151A 7 74153 7	0p 74LS247 140p 0p 74LS248 140p	4583 90 4584 90 4724 250	P 2N57	777 <b>45</b> p 1 130p / -	ORP60 ORP61	90p 90p	EPROMS 1702A 2516	500p £29	1/4W 1OR-1 one value 1/5W 1OR-1		10.7MHz 350 18MHz 300 26.690MHz 210	31 way Plug 31 way Socket	110p 110p
74155 <b>9</b> 74156 <b>9</b>	Op 74LS251 14Op	40014 90 40085 <b>200</b> 40097 90	OPTO	HSOLATORS 130p	TIL111	70p 90p	2708 2716	800p £29	Miniature P Hor/Ven 10		27 145MHz 210	S-100 Busboard	£12
74159 190 74160 100 74161 100	0p 74LS258 160p 74LS259 180p	14411 <b>1100</b> 14412 <b>1100</b> 14433 <b>1100</b>	D LEDS	400 190p	TIL112 TIL116	90p 90p	SUPPORT DEVICES 3245	400p	Carbon Trac 5K-1M Lo Single	k Pots g or Lin	2 x 10 wey 2 x 15 way 2 x 18 way	85p 2 x 22 way 100p 2 x 25 way 120p	135p 160p
74162 100 74163 100 74164 120	Op 74LS273 175p 74LS279 90p	14500 <b>700</b> 14599 <b>290</b> CD22100 <b>350</b>	TIL20	75p 9 Red 13p	0.2 TIL220 Red TIL222 Gr	16p 18p	6532 6820 6821	1100p 500p 500p	Single with Dual	Switch 60p 72p S 60mm Track	COUNTERS 74C925	475p TTL& EC	i.
74165 130 74166 120 74167 200	Op 74LS324 200p 74LS348 200p	C022101 700 CD22102 700 INTERFACE	P. TIL21:	2 Ye 25p 5 Red 18p	TIL228 Red MV5491 TS Clips	22p 120p 3p	6850 8205 8212	500p 320p 225p	LIN 5K, 10k	C, 50K, 100K 60p 60p	74C928 ICM7216B ICM7217A	600p MC4024 620 MC4044 850p 10116	325p 325p 70p
74170 <b>240</b> 74172 <b>450</b> 74173 <b>120</b>	74LS367 100p 74LS368 100p	ICa DM8123 175 MC1488 100	DL704	200p 1 140p	NSB5881 TIL311	570µ 600p	8216 8224 8228	225p 400p 525p	- TOK		ZN1040E	700p 10231	350p
74174 90 74175 85 74176, 90	74LS374 195p 74LS378 200p 74LS390 160p	MC1489 100 25S10 350 75107 160 75150 175	701 DL747	7 Red 140p 7 Gr 140p 7 Red 225p	TIL312/3 TIL321/2 TIL330	110p 130p 140p	8251 8253 8255	700p 1200p 550p	555			TO 31.1.8	
74177 90 74178 160 74180 93	74LS393 160p 74LS445 140p 74LS668 100p	75154 <b>175</b> 75182 <b>230</b>	FND35	57 <b>120</b> p 00 <b>120</b> p	7750760 DRIVERS 9638	200p	8257 8259 280P1D	1100p 1400p 850p	741 2114L-	£	18/100 16/100 £4.50	7805 7812 7905	£5/10 £5/10 £6/10
74181 160 74182 90 74184A 150	p 74LS670 400p	75322 <b>300</b> ; 75324 <b>375</b> ; 75325 <b>375</b> ; 75361 <b>300</b> ;	MAN3 MAN4	640 175p	9370 UDN6118 UDN6184	200p 320p 320p	Z80CTC MC14411 MC14412	650p 1100p 1100p	2708 2716 (	Plus 5V only)		7912 P&P+VAT Extra	£6/10
74185 150 74186 500 74188 325	p 4000 15p p 4001 17p p 4002 17p	75363 <b>400</b> c 75365 <b>350</b> c 75451 <b>72</b> c	BREA EXP3	ADBOARDS 50 3 6" x 2.1" 3 x 14 pin ICs)	£3.15	BOARDS	D (R) SOLDERLI		(Ree	(EY KEYPAD d Switches)	MEMORY	ER KITS MAPPED VDU INTERI	ACE KIT
74190 90 74191 90 74192 90	p 4006 95p p 4007 18p p 4008 80o	75491/2 <b>96</b> p 8T26 <b>250</b> p 8T28 <b>300</b> p	EXP6	50 3.6" x 2.4" 51 x 40 pin IC) 00 6" x 3.1"	13.00	n sturdy base p B6 6 x 14	4 DIL ICs	€9	rted UHF Reed .20 LOG	Modulators I Switches (12VA) IC PROBE	£3.75 £0.25 SERIAL I/	P VOU INTERFACE KIT	£45.00 £56.00
74193 90 74194 90 74195 95	P 4009 40p P 4010 <b>50</b> p P 4011 <b>17</b> p	8795 <b>200</b> p 8797 <b>200</b> p 81LS95 <b>140</b> p	(Uto 6 EXP6	5 x 14 pin (Cs) 00 6" x 2.4" 1 1 x 40 pin DCs)	£6.30	B100 10 x 14 B102 12 x 14 B103 24 x 14 B104 32 x 14	4 Dit ICs 4 Dit ICs	£11 £22 £34	.80 MUL .95 SUP .45 MICI	TIMETERS ERTESTER 680R ROTEST 80R	£33.00 GIANT MO	RED AND TESTED ONITOR BOARD KIT FOR C RAM BOARD FOR EL	
74196 95 74197 80 74198 150	P 4012 18p P 4013 50p P 4014 84p	81LS96 140p 81LS97 140p 81LS98 140p	IC TE	ST CLIPS	(	The above boar	ds are suitable for al		.95 TMK Pock	500 et multimeter	£22.00 ASCII KEY £4.75 (Please ad	BOARD KIT d 75p p&p to all above	£50.58 items).
74199 150 74200 €1 74221 160	p 4015 84p 0 4016 45p	9601 <b>110p</b> 9602 <b>220p</b> 9603 <b>180p</b>	14 pi 16 pii	n €2.60 n €2.75		£2.90 £2.90	We carry a lar ex-stock delive	ge stock o ries. We v	of 74 and velcome inc	74LS TTLs. CM	DS. Linears, Memor	ries, etc. and can no m local and oversea	ormally offer
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# **New Babanis**

Amaze your friends with the number of uses to which you can put a single IC. You won't be short of ideas with 'Single IC Projects' by R. A. Penfold. This 127 page volume from Bernard Babani is divided into five sections, covering low level audio circuits, audio power amplifiers, timers, operational amplifiers and miscellaneous circuits.

Each circuit suggestion begins with a brief description of the chip used, together with a table of its chief characteristics. In each case a circuit diagram, practical layout, constructional details and parts list is given. These twenty simple projects could be yours for £1.50.

Also from Babani is Book 3 in their Elements of Electronics series. Book 3 continues this introduction to electronics with sections on semiconductor physics and characteristics. Basic semiconductor applications are described, including



rectifiers, amplifiers, oscilators and switches. Book 3 of Elements of Electronics by F. A. Wilson (204 pages) is priced at

£2.25. If you have trouble getting these books they are available direct from the publisher, Bernard Babani (Publishing) Ltd,



The Grampians, Shepherds Bush Road, London W6 7NF. A complete catalogue of Radio and Electronics Books is also available from this address. Please sent a stamped, addressed envelope. When ordering books, please send enough to cover postage.

# **Anti-Gravity** Meter

You won't have a smashing time with this meter. The 3012 from Dorman Smith Instrumentation is a drop proof pocket tester giving DC volts (0V3 to 1000V), DC current (50 uA to 300 mA), AC volts (10V to 1000V) and resistance (10k to 1M ranges).

The meter will withstand being dropped from one metre the height of the average workbench or jacket pocket. It incorporates a taut band move-ment and fuse protection. Power is from a size AA 1V5 hattery.

The 3012 pocket test is available for £27 plus VAT including batteries, test leads, soft case and strap from Dorman Smith Instrumentation, Blackpool Road, Preston PR2 2DQ.

# Tick Talk

If you have about a hundred dollars to spare you can invest it in the latest in alarm watches. The communicator, from Windert, uses a 64 kilobyte memory chip to carry its computer voice. It 'tells' you the time, talks you awake in the morning and nags you if you don't get up (makes the wife redundant).

The time, alarm and snooze messages are to be available in English, French, German and Spanish. In the not-so-distant future Windert have prophesied the development of programmable voice command watches and even the sci-fi cliché - watches with built-in TV screens and transmitters

# See-Thru Tops

Boss Industrial Mouldings have extended their BIM 2000 range of Bimboxes to include a new two part, deep profile version. Base and lid are available in black, grey, orange or blue, with the additional option of a clear lid. As with the rest of the Bimbox range, the new versions have 5.08 mm (0.2in) spaced slots on all sides of the base to support 1.5 mm PCBs.

The clear lid version is ideal for applications where viewing of, but not necessarily access to, internal components is required. The new Bimboxes, each 80.2×150.4×76 mm, are available from Boss Industrial Mouldings Ltd, 2 Herne Hill Road, London SE24 0AU.

# **Sat 54** Where Are You?

Well, it was Satcom 3 actually, but the plot is reminiscent of that old, old American telly series. The Car 54 in this case, however, was an RCA communications satellite, last heard of in December, 22,000 miles above mother Earth.

If anyone finds a communications satellite answering to the name of Satcom 3, send it to RCA, nto us. Mind you, if it has gone up in a puff of smoke, it has probably burned up on its way back to Earth. NASA quick to assure us that it won't cause another Skylab incident. So, you needn't dust off your anti-Skylab umbrella, yet.

# CMOS Class

Having trouble getting to grips with your CMOS? Understanding CMOS Integrated Circuits by Roger Melen and Harry Garland is an introduction to CMOS, covering everything from how the chips are made to a few simple practical CMOS circuits.



Almost half of the book is devoted to a summary of types of logic gates, semiconductor physics and CMOS fabrication techniques. The remainder gets down to the nitty gritty— CMOS circuit design, including waveform generators and information-processing

This 144 page American paperback is available in the UK from Prentice/Hall Interational, 66 Wood Lane End, Hemel Hempstead, Herts, HP2 4RG for £3.60.

# **Key Box**

If you have a QWERTY keyboard, we can now tell you where to put it. Vero have introduced an attractive twotone brown 17in, wide modular keyboard enclosure designed to house most universal layout QWERTY keyboards.

The front panel can be slid out for service or programming by removing the base screws and the end moulding, so there are no visible fixing screws on the front panel.

The enclosure can be supplied in non-standard lengths to allow the addition of extra key-

pads, etc.

The modular keyboard enclosure is available from Vero Electronics Ltd, Industrial Estate, Chandler's Ford, Eastleigh, Hampshire SO5 3ZR.



WATERDO ELECTRONI	ne	TRANSIET	TORC	DEDGE	24		
10n. 15n. 22n. 27n.5p; 33n. 47n. 68n. 100n. 7p; 150n 10p; 22on. 330n 13p; 470n 17p; 680n 19p; 12 42p; 11,5 30p; 2 y 2 34p.    ELECTROLYTIC CAPACITORS: Axial lead type (Values are in μF).   500V: 10 40p; 4   55p; 63V; 0. 47. 10. 1. 5. 2. 2, 3. 3. 4.7. 6. 8. 8. 10. 15. 22. 8p; 47. 32; 11p; 63. 100; 220; 25p; 470. 32p; 1000. 56p; 40V; 22. 33. 8p; 100. 12p; 22o0, 3300. 85p; 4700. 47p; 22o0, 3300. 35p; 22o0, 25p; 32o0. 25p; 4700. 32p; 3300. 32p; 4700. 32p; 4700. 32p; 3300. 32p; 4700. 32p; 4700. 32p; 3300. 32p; 4700. 32p; 3300. 32p; 4700.	TEED. ORDERS ASH/CHEQUE/ EDUCATIONAL PORT INQUIRY SEAS ORDERS  A Hoper In	AC126 AC127 AC128 AC142 AC142 AC142 AC147 AC147 AC118 ACY19 ACY19 ACY19 ACY20 ACY21 ACY21 ACY21 ACY22 ACY28 ACY22 ACY28 ACY22 ACY28 ACY29 ACY21 ACY22 ACY28 ACY39	P BC214L BC328 BC3078 BC3078 BC308 BC328 BC308 BC327 BC328 BC328 BC328 BC328 BC328 BC328 BC328 BC328 BC338 BC441 BC46 BC477 BC46 BC477 BC54 BC54 BC54 BC54 BC54 BC55 BC55 BC55	BFR81 BFR81 BFR81 BFR81 BFR86 BFX86 BFX86 BFX86 BFX86 BFX86 BFX87 BFX86 BFY52 BFY51	64 36 36 38 40 15 16 12 22 22 22 58 60 50 50 170 120 120 120 120 120 130 148 65 55 30 36 55 36 56 56 56 56 56 56 56 56 56 56 56 56 56	TIP31A 38 TIP31C 43 TIP32A 48 TIP32C 55 TIP33C 70 TIP34A 63 TIP34A 63 TIP34A 64 TIP35A 185 TIP35A 185 TIP35A 185 TIP35A 185 TIP35A 185 TIP36C 1	2N1671B 2N2160 350 2N2217 43 2N2218A 22 2N22218A 22 2N2220A 23 2N2222A 23 2N2222A 23 2N2222A 28 28 28 28 28 28 28 28 28 28 28 28 28
259, 270, 300, 330, 360, 390, 470, 600, 800, 820 16p each 1000, 1200, 1800, 2000 20p each Minlature High Stability, Low noise MK	K4027-2 470 K4027-4 350 K4116-4 1025	BC172 11 BC177 15 BC178 14	BF224A BF244B BF256A	24 OC 76 60 OC 77 50 OC 81	36 76 35	40595 <b>90</b> 40603 <b>67</b> 40673 <b>25</b>	2N5777 46 2N6027 40 2N6109 50
Variable	0-3-2513 650 F96364E 1050 C71301 620 IS2716 (3V) 1700,	BC179 15 BC182 10 BC183 10 BC184 10 BC182L 10 BC183L 10	BF257 BF258 BF259 BF451	45 OC82 30 OC83 28 OC84 0C140 0C170 0C171	50 48 45 110 85 46	2N697 40 2N698 30 2N699 19 2N706A 19 2N708 33	2S0234 <b>50</b> 3N128 112 3N140 112
COMPRESSION TRIMMERS 3-40pf; 10-80pf; 25-190pf 30p	1S4039 250 1S4045 1083 1S6011 358	BC184L 10 BC187 22 BC212 9	BF336 BF594 BF595 BFR39	35 OC171 30 OC200 20 TIP29 TIP29B	48 43 56	2N918 28 2N1131 22 2N1132 24 2N1303 50	
GAS & SMOKE DETECTORS . 1040, 1055, 1056, 1058, 1066, 1067, 280	0 CPU 4M 1099 0 P10 660	BC212L 9 BC213 9 BC213L 9	BFR41 BFR79	25 TIP29C TIP30 24 TIP30B	60 32 40	2N1304 50 2N1305 35 2N1613 23	WELCOME
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# **WATFORD ELECTRONICS**

# THE DIGITAL FREQUENCY METER with a Difference



O-150MHz in 5 ranges. Large 8-digit display for high accuracy Period and time interval facility. Unit counter up to 99,999,999 10MHz crystal timebase Hold and reset buttons plus built-in PSU.

All these features and more for less than half the price of an ordinary frequency meter. The OFM 2000 has all its components including the displays, switches and transformer mounted on one double sided PC board. Assembly is simplicity itself especially since interwiring has been eliminated. This is a high quality design and will make a truly professional digital frequency meter that anyoconstructor will be proud to own.

Price: Only £64.50 Kit (P&P 65p).

Probes: Optional extra £8.75

# **OHIO SUPERBOARD II** Only £188.00

Superboard II is supplied fully assembled and tested to British TV specification. Also included at no extra cost 4 manuals and a Cassette with programmes. Requires +5V at 3A and a Video Monitor or TV with RF Convertor to be up and running. (Data sheet supplied. We can also supply the RF Convertor and Power Supply in Kit form or ready-builti

supply the Nr Conventor and rower supply in Nr United Ready-builty.

8K Microsoft BASIC in ROM. 4K Static RAM — on BOARD expandable to BK. Full 53 Key Keyboard with Upper/Lower Case & User programmability and a lot more. See in Gry yourself. Continuous demonstration on at our retail shop.

Power Supply Kit (SV/3A) incl. RF Convertor. E21.50 Ready-built & Tossic March 44 E35.00 E22.50 E23.50 E23.50 E23.50 E23.50 E23.50 E23.50 E23.50 E25.50 E25.50

£28.50 £35.00 £25.00 £188 £25 £10 £27 Specially Designed Case 610 Expansion Board with 8K RAM Assembler Editor plus Manual Extended Monitor plus Manual Basic Tutor Tapes

1A 5V 12V 15V 18V

1A 5V 12V 15V 18V 24V

100r

5V 6V 8V 12V 15V

TO3 7805 7812 7815 7818 + ve 145p 145p 145p 145p

78L05 30p 78L62 30p 78L62 30p 78L82 30p 78L12 30p 78L15 30p

	100
SWITCHES TOGGLE: 2A, 2 SPST DPST DPDT 4 pole on/off	250V. 28p 34p 38p 54p
SUB-MIN TO	GGLE

SP changeover SPST on/off SPST biased DPDT 6 tags DPDT centre off DPDT 8 iesed

SLIDE 250V: 1A DPOT 1A DPDT c/over ½A DPDT 4 pole 2-way PUSH BUTTON

SPDT c/over DPDT 6 Tag MINIATURE Non Locking Push to Make Push Break 15p 25p

PANEL

**METERS** FSD 60x46x

445p each

41/4×31/4×11/5" 0-50μA 0-100μA 0-500μA 595p each

ROTARY: Make your own multiway Switch.
Adjustable Stop Shafting Assembly. Accommodate up to 6 Wafers
Mains Switch DPST to fit
349 ROTARY: Make your own multiway 5w. Adjustable Stop Shafting Assembly. Acc modate up to 6 Wafers Mains Switch DPST to fit Break Before Make Wafers. 1 pole/12 v 2p/6 way 3p/4 way 4p/3 way. 6p/2

Spacer and Screen

ROTARY: (Adjustable Stop)

1 pole/2 to 12 way, 2p/2 to 6 way, 3
pole/2 to 4 way, 4 pole/2 to 3 way

ROTARY: Mains 250V AC, 4 Amp

45p

CRYSTA	LS
100KHz	323
455KHz	383
1 MHz	323
1.008M	398
1.28MHz	392
1.6MHz	323
1 GAAH»	222

1.6MHz 323 1.8MHz 323 1.8432MHz 32 2.45768MHz 362 2.2768M 362 3.2768M 362 3.2768M 362 4.032Mhz 323 4.433619M 355 5.185M 323 6.5536M 323 6.5536M 323 6.5536M 323 10.7MHz 323 1

FTI Projects Parts ava for: Click DFM 2000 Frequency Meter, DM900. Audiophile Amp, 60W Amplifier System. S SAE plus 5p

TRANSPORMERS (Mains P	rim, 220-2	
6-0-6V; 9-0-9V; 12-0-12V 10	00mA	95p
3VA: 0-6V 0-6V (PCB mount	ing)	150p
BVA: 6V5A 6V5A; 9V4	A 9V4A;	12V-3A
12V3A: 15V25A 15V25		195p
12V: 4.5V-1.3A 4.5V-1.3A		
12V5A 12V5A; 15V4A	15V:4A;	20V3A
20V3A	220p (2	20p p&p
24VA: 6V-1.5A 6V-1.5A;	9V-1.3A 9	IV-1.3A;
12V-1A 12V-1A; 15V8A	15V8A.	20V6A
20V6A	290p (4	5p p&p).
50VA: 6V-4A 6V-4A: 9V-2.	5A 9V-2.5A	: 12V-2A
12V-2A; 15V-1.5A 15V-1.	5A; 20V-1.	2A 20V-
1.2A: 25V-1A 25V-1A; 30V-		
		Op p&p).

350p (50p p&p). 100VA: 12V-4A 12V-4A: 15V-3A: 15V-3A: 20V-2.5A: 20V-2.5A; 30V-1.5A: 30V-1.5A: 40V-1.25A: 40V-1.25A; 50V-1A: 50V-1A: 650p (60p p&p). (N.B. p&p charge to be added above our normal postal charge.) **VOLTAGE REGULATORS** 

Plastic Casing 65p 65p 65p 65p 65p

TO92 Plastic Casing

65p

65p 65p

# ALUM. BOXES

60x46x 35mm 0-50µA 0-100µA 0-500µA 0-1mA 0-5mA 0-10mA 0-50mA 0-100mA 0-2A 0-25V 0-25V 0-300V AC 3x2x1" 2\4x5\4x1\2" 72 72 70 88 72 98 108 145 185 4x4x11/2" 4x4x1½" 4x2¾x1½" 4x5¼x1½" 4x2½x2" 5x4x2" 6x4x2" 7x5x2½" 8x6x3" 8x6x3" 10x7x3" 10x4'4x3" 12x5x3" 12x8x3"

# ОРТО ELECTRONICS

LLLOIN	
LEOs with Clips	
TIL209 Red	13
TIL211 Grn.	17
TIL212 Yel.	18
TIL220 .2" Red	14
.2" Green, Yellow	
or Amber	18
Square LEDs, Red,	
Grn., Yel.	36
TIL32 Infra Red	58
TIL78	

Square LEDs, Re	ed,		_
Grn., Yel.	36		
TIL32 Infra Red	58	7 Segment Dis	plays
TIL 78		TIL307	675
		T1L312 .3" CA	105
		TIL313.3" CC	105
LS400	255	TIL321 .5" CA	115
OCP71	120	TIL322 .5" CC	115
ORP12	63	DL704 .3" CC	99
ORP61	85	DL707 .3" CA	99
2N5777	45	DL747.6" CA	180
		FND357 Red	120
ISOLATOR	s	3" Green CA	180
IL74	48	.6" Green CA	225
TIL111/2	85		
TIL114	95	LCD 31/2 Digit	875
TIL117	110	LCD 4 Digit	975

Meter, DM900, Audiophile Amp, 60W Amplifier System. Send SAE plus 5p or list.	LM305H 1 LM309K 1 LM317K 3 LM323K 1 LM325N 2	70p LM32 40p LM72 35p TAA55 150p TBA62 150p TDA14	3 38p 50 <b>50</b> p 258 <b>95</b> p	IL74 TIL1 TIL1	61 777 <b>SOLATORS</b> 11/2 14	85 DL 45 DL FN .3 48 .6 85 95 LC	704 .3" CC 707 .3" CA 747 .6" CA 10357 Red " Green CA " Green CA " Green CA	
326 284 127 286 148 148 148 148 148 155 228 155 228 155 156 156 157 157 160 177 180 177 180 177 180 177 180 177 180 177 180 177 180 177 180 177 180 177 180 177 180 177 180 177 180 177 180 180 177 177 177 177 177 177 177 177 177 17	4010 38 4011 128 4012 18 4013 42 4014 80 4015 82 4016 42 4017 82 4018 87 4019 38 4020 99 4021 95 4022 85 4023 22 4024 66 4025 19 4026 180 4027 45 4028 81 4029 99 4030 58	4049 4050 4051 4052 4053 4054 4055 4056 4055 4056 4059 4061 4061 4061 4062 4062 4063 4066 4067 4068 4069 4070 4071	80 4410 15 4411 000 4412F 95 4412V 4415F 4415V 80 4419 4422 4433 32 4435 4440	145 109 109 109 109 110 99 108 720 720 720 958 1250 1050 280 545 995 825 825 1275	4516 4517 4518 4519 4521 4522 4526 4527 4528 4530 4530 4531 4532 4534 4538 4538 4538 4538 4538	120 382 102 55 108 228 149 152 99 145 85 135 115 365 142 105 135	4549 4554 4555 4556 4556 4557 4559 4560 4561 4562 4566 4572 4580 4572 4581 4582 4583 4584 4585	378 398 150 68 72 461 108 378 210 68 533 156 280 297 130 695 297 130 68 77 130 168
398 276 399 230 445 150 447 144 490 180 668 182 669 182 669 182 6670 248  CMOS★ 4000 13 4001 18 4001 18 4002 15 4006 87 4008 82 4008 82	4031 208 4032 100 4033 145 4034 199 4035 111 4036 335 4037 100 4038 108 4039 320 4040 105 4041 80 4042 75 4043 94 4044 95 4045 148 4046 128	4073 4075 4076 4077 4078 4081 4082 4085 4086 4089 1 4093 1 4095 1 4095	21 4450 21 4451 23 4452 4490F 4490F 4501 20 4502 21 4503 4502 4507 4508 4508 4508 4508 4508 4508 4508 4508	295 295 695 525 19 20 69 51 55 297 150 98 206 265 299	Full range modules av ILP's adver	of these frailable trailable trailable trailable trailable decided 56 frailable trailable traila	(ay Keyboari	ed the

Full &CCII coded 56 Kay Keyboard

	£42.50
4" × 4" Keypads	£4.50
RF Modulators	£2.50
Wideband Modulators	£4.70
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# **Direct Meter**

Zycomm's combined VSWR and power meter offers direct reading of both functions without interpolation.

Autoranging for power output covers 20 W to 2 kW in three ranges. VSWR can be measured from 1:1 to infinity.

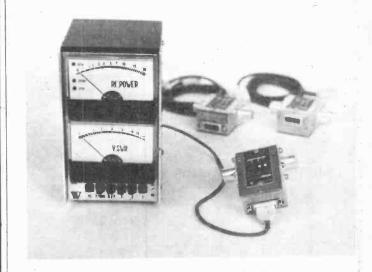
Separate sensing heads, sup-plied to cover each frequency range, can be connected at any position in the feed line. Forward and reverse power can be displayed as either peak or rms readings.

The electronic comparator included in the meter allows constant readout of VSWR regardless of power variation. It gives a true indication during speech on SSB.

You'll need a 240 V 50 Hz

supply to operate the meter.

The combined VSWR and power meter is available from ZycommElectronics Ltd, 47-51 Pentrich Road, Ripley, Derbyshire DE5 3DS.



# **End of Chess**

If you saw our survey of Chess Machines in December, you will have gathered that the idea is to play a game from start to finish against the computer. The latest chess machine is a little different in that it only plays end games.

It's a mini machine, measuring only 105 x 63 x 8 mm - not much bigger than a credit card calculator. It looks a bit like a calculator, too. On the front panel there are eight buttons numbered one to eight (for listing moves) and five instruction buttons - E (to enter move), C/E, S (score), P (peek?) and R (response). On top of all that there is a four digit LCD dis-

play.
With the mini mind you get seven booklets, each containing fifty different problems. More booklets will be printed to catch up with the Chess Master's memory of several thousand problems. Each booklet represents a different level of play

Li and Fung Trading are making a thousand Chess Masters everyday in Hong Kong. More on the mini mind when we can get one to play with.

# Vee Needen Sie

With a bit of luck we will once again be amazed, astounded and generally boggled by the versatility of ETI readers. This time, we'd like to hear from anyone who can translate technical German (ideally Dutch, too) into English for us.

We could employ the services of professional agencies in the field, but we'd prefer to get an ETI reader in on the act. So, if you think you're up to taking

the odd page of unpronouncable tutonic text and turning it into the equally odd page of English, why not drop us a line or two or three

Although we moved offices a few months ago, a lot of our mail is still being sent to our old address, so make sure you send the account of your terrific translational talents to us at 145 Charing Cross Road, WC2 (full address on the contents page.)

# SUPER SOUND SAVING! **DINDY LOW NOISE CASSETTES**

\$J55 10 C46 23 min per side (LP) \$2.5 SJ31 10 C90 45 min per side \$2.5 \$3.5 \$3.5 \$3.5 \$3.5 \$3.5 \$3.5 \$3.5 \$3	SJ55 10 C46 SJ31 10 C90	C30 15 min per side C46 23 min per side (LP) C90 45 min per side		£2.00 £2.50 £3.50 £4.50
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16201	18 electrolytics	4.7uf-10uf	
16202	18 electrolytics	10uf-100uf	
16203	18 electrolytics	100ut-680uf	
	ALL 3 at	SPECIAL PRICE of £1.30	
16160	24 ceramic caps	22pf 82pf	
16161	24 ceramic caps	100pf-390pf	
16162	24 ceramic caps	470pf-3300pf	
16163	24 ceramic caps	4700pf-0.047pf	

### ALL 4 at SPECIAL PRICE of £1.80 RESISTOR DAVE

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16213	60 %w resistors	100ahm-820ahm
16214	60 ¼w resistors	1K-8.2K
16215	60 1/4 w resistors	
16216	60 1/4 w resistors	100K-820K
ALL 4 at SPECIAL PRICE of £1.50		
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16218	40 1/2 w resistors	1K-8 2K
16219	40 1/2 w resistors	10K-82K
16220	40 V <sub>2</sub> w resistors	100K-820K
	All 4 st CD	ECIAL PRICE 4 C4 CC

IC SOCKET	PAKS	F.E.	T.s
SJ36 14 SJ37 12 SJ38 11 SJ39 8	8 pin 14 pin 16 pin 18 pin	2N3819 2N5458 2N4220 2N4860	£0.17 £0.18 £0.28 £0.25
SJ40 7 SJ41 6 SJ42 5 SJ43 4	20 pin 22 pin 24 pin 28 pin	(PROGRAI Unijun	
SJ44 3 ALL at ONLY £1.	40 pin 00 EACH	2N6027 BRY56	£0.25

# **VOLTAGE REGULATIONS**

Positive	Case T0220	Negative
uA 7805 uA 7812	£0.65 UA7905	€0.70
uA7815 uA7818	£0.65 UA7915 £0.65 UA7918	£0.70
uA 7824 uA 723 14 pin DIL	£0.65 UA7924	
LM309K T03	£1.10	

# OPTOELECTRONICS

1511	707 LED display 747 LED Display 727 LED Display	747 LED Display Price each	
		L.E.D.s	
SJ 78	.125 LED Diffuse	d RED	Price each'

		Price each'
.125 LED Diffused	RED	€0.08
	RED	€0.08
	RED	£0.09
2 LED Bright	RED	£0.09
.125 LED Diffused	GREEN	€0.11
2 LED Diffused	GREEN	€0.11
	YELLOW	£0.11
	YELLOW	£0.11
	YELLOW	£0.14
2 LED Clear illuminating	RED	€0.10
125 LED Clear illuminating	RED	€0.10
	.2 LED Diffused .125 LED Bright .2 LED Bright .125 LED Diffused	2 LED Dirfused         RED           125 LED Bright         RED           2 LED Bright         RED           125 LED Diffused         GREEN           125 LED Diffused         GREEN           125 LED Diffused         YELLOW           2 LED Diffused         YELLOW           2 LED Diffused         YELLOW           2 LED Diffused         YELLOW           2 LED Clear illuminating         RED

# 2nd QUALITY L.E.D. PAKS

1507 S122 S123	10 10 10	assorted 125 .2	RED RED	£0.65 £0.50 £0.50
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1508/.125 1508/.2		125	5 for £0.10 5 for £0.12	
SJ81	1	Infra RED emitter — Fairchild FP 100	00.00	
SJ 98	5		£0.25	
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ORP12		NORP12 Cad Cell	€0.45	
SJ99	4	ITT 5870 ST Nixie Tubes	£1.00	

SJ29 Texas NPN silicon transistors 2S503 = BC108 TO-18 metal can — perfect & coded 50 off £2.50 — 100 off £4.00 — 1,000 off £35.00

SPECIAL OFFER
SJ 100 12v Electric Drill 7,500 RPM for all your PCB drilling complete with 2 drills .1 & 15 £5.50

# SUPER DUPER COMPONENT BOX

Min. 3 lbs in weight consisting of a fantastic assortment of Electronic Components — Pots, Resistors, Condensors, Switches, Politics Relays.
Board-Semiconductors, wire, hardware, etc., etc., etc.
This is a large box and is sent separate to your order
\$140 £2.50 including p&p

GOM 2-C500 CALCULATOR CHIP 24 pin MOS

IC INSERTION/EXTRACTION TOOL

# **BI-KITS AUDIOMODULES AT PRE-INCREASE PRICES!**

	AMPLIFIERS	
AL10 AL20	3 watt Audio Amplifier Module 22-32v supply 5 watt Audio Amplifier Module 22-32v supply	£2.87 £3.74
AL30A	7-10 watt Audio Amplifier Module 22-32v supp	ly
AL60	15-25 watt Audio Amplifier Module 30-50v sup	£4.36
AL80 AL120	35 watt Audio Amplifier Module 40-60v supply 50 watt Audio Amplifier Module 50-70v supply	£5.39 £8.44
AL250	125 watt Audio Amplifier Module 50-80v suppl	E13.74
		E20.49

	STEREO PRE-AMPLIFIER
PA12	Supply voltage 22-32 volts input sensitivity 300mv suit: AL10/AL20/AL30 67.78
PA100	Supply voltage 24-36 volts inputs: Tape, Tuner, Mag P.U., suit: AL60/AL80 £16.05
PS 200	Supply voltage 35-70 volts inputs: Tape, Tuner, Mag P.U., suit: AL80/AL120/AL250 £16.59
	MONO PRE-AMPLIFIERS

Supply voltage 40-65 volts inputs: Mag. P.U.

MM100G	Supply voltage 40-65 volts inputs: 2 Guitars, Microphones, Max output 500mv £11.30
FUERE	POWER SUPPLIES
PS12	24v Supply suit 2 × AL10, 2 × AL20, 2 × AL30 & PA12/S,450 £1.50
SPM80	33v Stabitised supply suit 2 × AL60, PA100 to 15 watts
SPM120/45	45v Stabilised supply - suit 2 x AL60, PA100 to 25

511111207-5	watts
SPM120/55	55v Stabilised supply - suit 2 x AL80, PA200 €5.80
SPM 120 / 65	65v Stabilised supply — suit 2 x AL120, PA200, 1 x AL250, PA200 £5.80
SG30	15-0-15 Stabilised power supply for 2 x GE100MKII
	£3.80
	MISCELLANEOUS
MPA 30	Stereo Magnetic Cartridge Pre-Ampifier — input 3.5mv Output 100mv £2.98
S.450	Stereo FM Tuner supply voltage 20-30v — Varicap tuned £23.24
STEREO 30	Complete 7 watt per Channel Stereo Amplifier Board — includes amps, pre-amp, power supply, front panel, knobs etc — requires 2050 Transformer £19.18
BP124 GE100MK11	5 watt 12 volt max. — Siren Alarm Module £3.50 10 channel mono-graphic equaliser complete with
VPS30	sliders and knobs  Variable regulated stabilised power supply 2-30 volts 0-2 amps  £23.00  £7.60
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	€3.78

-	and the second s	£3.78
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2034 2035 2036 2040	1 7 amp 35v suit SPM80 2 amp 55v 750mA 17v suit PS12 1.5 amp 0-45v-55v suit SPM120/45,	
2041	2 amp 0-55v-65v suit SPM 120 / 55, S	
2050 1725	1 amp 0-20v suit Stereo 30 150mA 15-0-15v suit SG30	£6.80 £3.25 £1.77
	ACCESSORIES	

139	Teak Cabinet suit Stereo 30, 320 × 235 × 81mm
140 FP100 BP100 GE100FP 2240	Teak Cabinet suit STA15 425 × 290 × 95mm 67.5 Front Panel for PA100 & PA200
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Туре	Price	Туре	Price	Type	Pric
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BA100	€0.08	OA79	£0.08	IN4005	€0.0
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BA173	£0.13	OA90	£0.08	IN4007	€0.0
BAX13	€0.05	OA91	£0.08	IN5400	€0.1
BAX16	£0.06	OA95	€0.08	IN5401	€0.1
OA200	£0.06	IN34	£0.06	IN5402	£0.1
OA202	£0.07	IN60	€0.07	IN5404	€0.1
BY100	£0.18	IN4148	€0.05	IN5406	£0.1
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		114000	20.00	1344	LU.U.
			FAR		TANK
Type CA270 CA3089 CA3090 LM380 LM381 LM3900	Price £0.95 £1.70 £3.00 £0.80 £1.35 £0.50	Type SL414A SN76013N SN76D23N SN76115 TAA550 TAA621A	Price £1.75 £1.65 £1.60 £1.60 £0.30 £1.80	Type TBA810 TBA820 UA703 UA709C UA710 UA711	Price £0.85 £0.65 £0.20 £0.25 £0.25
MC1310P NE555 NE556	£0.85 £0.18 £0.55	TBA120B TBA641A TBA800	£0.60 £1.10 £0.75	741P TAA661 TAA661B	£0.16 £1.25 £1.25
10 y 10 2 10	Sand	VOUR Orde	TO VALLE	SERT ET	

# SPECIAL OFFER

# **COMPONENT PAKS**

O/NO Quantity

	Quantity	£	P
SJ1	200 Resistors mixed values	0.	50
SJ2	200 Carbon resistors ¼-½ watt preformed	Õ.	
- \$J3 SJ4	100 ¼ watt resistors mixed values 60 ½ watt resistors mixed values	0.	50
SJ5	60 ½ watt resistors mixed values 50 1-2 watt resistors mixed pot values	0.	
SJ6	50 Frecision resistors 1-2" tol. mixed	0.	
SJ7 SJ11	30 5-10 watt wirewound resistors mixed	0.	50
SJ12	150 Capacitors mixed types & values 60 Electrolytics all sorts mixed	0.	
SJ13	50 Polyester / polystyrene capacitors mixed	0.	
SJ14	50 C280 type capacitors mixed	1.	
SJ15 SJ16	40 High quality electrolytics 100-470mf	1.	00
5J17	40 Low volts electrolytics mixed up to 10v 20 Electrolytics transistor types mixed	0. 0.	
SJ18	20 Tantalum bead capacitors mixed	o.	50
SJ20 SJ21	Large croc clips 25A rated     Large 7½" 'Mains Neon Tester' screwdriver     Small pocket size 'Mains Neon Tester'	0.	30
SJ22	Small nocket size 'Mains Neon Tester'	0.	85
SJ23		rati	nα
SJ24	Small pocket size 'Mains Neon Tester' Slemens 220v AC Relay DPDT contacts 10amp - housed in plastic case	1.0	oŏ
3324	housed in plastic case Black PVC tape (%) 15mm × 25m strong tal electrical & household use 0.35 roll 1.50 5	26	hor
SJ25	100 Silicon NPN transistors all perfect & coded - I		
0.100	types with data & equivalent sheet	2.	50
SJ26	100 Silicon PNP transistors all perfect & coded — r types with cases data and equivalent	nix	ed
SJ27	50 Assorted pieces of SCR's diodes & rectifiers incl.	2.5	ud
	types all perfect — no rejects fully coded — data in	ıcl.	
SJ28	20 TTL 74 series gates — assorted 7401 — 7460	1.0	50
SJ33	PC Board — mixed bundle PCB fibreglass paper sin	1.t	2
	double sided — super value!	0.7	5
SJ34 SJ3?	200 sq. ins. (approx) copper clad paper board	0.1	50
SJ4?	100 sq. ins. (approx) copper clad fibre glass 8 Dual gang carbon pots log & lin mixed values	1.0	3O
SJ50	8 Dual gang carbon pots log & Iln mixed values 20 Assorted slider knobs — chrome/black	1.0	ю
SJ51 SJ52	1 Switchbank 5 way incl silver knobs	0.5	50
SJ 53	Pak of vero board approx 50 sq. Ins mixed     Mammoth IC Pack: approx 200 200pcs assortall-out integrated circuits including logic 74 s	T.U	ou od
	fall-out integrated circuits including logic 74 s	erie	95,
	Inear-audio and DTL many coded devices but unmarked — you to identify	sor	ne
SJ54	20 Slider pots mixed values & sizes	1.0	m
SJ56	20 Slider pots mixed values & sizes 6 100K lin 40mm slider pots 6 100K log 40mm slider pots	1.0	
SJ57 SJ58		0.5	
SJ59	6 5K lin 40mm slider pots	0.5	0
SJ60	4 5K log 60mm single	0.5	0
SJ61 SJ62		0.5	0
SJ63	1 Instrument knob — black winged (29 x 20mm)	wi	th
SJ64	pointer %" standard screw fit  1 Instrument knob — black / silver aluminium	0.1	5
	1 Instrument knob — black/silver aluminium (17×15mm) %" standard screw fit	0.1	2
SJ65	L SLIDER POTS: 45mm travel		
SJ66	100K lin 0.25	BBC BBC	an ah
SJ67 SJ68	Chrome slider knobs to fit 0.10		h
2709		<b>80</b> C	
	30 ZTX300 type transistor NPN pre-formed for P/c B	oar	d
SJ69	colour coded blue — all perfect 30 ZTX500 type transistor PNP pre-formed for P/c B	0ar 1.0	d
	colour coded blue — all perfect 30 ZTX500 type transistor PNP pre-formed for P/c B	0ar 1.0	ď
SJ70	colour coded blue — all perfect 30 ZTX500 type transistor PNP pre-formed for P/c B colour coded white — all perfect 25 BC107 NPN to 106 case perfect transistors of C1359	0ar 1.0 0ar 1.0	0 d o e o
	colour coded blue — all perfect 30 ZTX500 type transistor PNP pre-formed for P/c B colour coded white — all perfect 25 BC107 NPN to 106 case perfect transistors of C1359 25 BC177 NPN T0106 case perfect transistors of	081 1.0 081 1.0 00d 1.0	0 d o e o e
SJ70 SJ71	colour coded blue — all perfect 30 ZTX500 type transistor PNP pre-formed for P/c B colour coded white — all perfect 25 BC107 NPN to 106 case perfect transistors ( C1359 25 BC177 NPN T0106 case perfect transistors ( C1395	0.0 0.0 0.0 1.0 0.0 1.0 0.0 1.0	0 0 0 0 0
SJ70 SJ71 SJ72	colour coded blue — all perfect 30 ZTX500 byee transistor PNP pre-formed for P / c B colour coded white — all perfect 25 BC107 NPN to 105 case perfect transistors ( C1359 25 BC177 NPN T0106 case perfect transistors ( C1395 4 ZN3055 silicon power NPN transistors T03 6 T064 SCRS 5 amo assorted 50%-400y all coder	1.0 087 1.0 00d 1.0 0.0d	0 do e 0 e 0 o o
SJ70 SJ71	colour coded blue — all perfect 30 ZTKS00 type transistor PNP pre-formed for P/c B colour coded white — all perfect 25 BC107 NPN to 106 case perfect transistors ( C1359 25 BC177 NPN T0106 case perfect transistors ( C1395 2 X3055 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400 all coded 8 Way ribbon cable — colour coded individually	1.0 0ar 1.0 0d 1.0 1.0	0 d 0 a 0 a 0 0 0 C
SJ70 SJ71 SJ72	colour coded blue — all perfect 30 ZTX500 hype transistor PNP pre-formed for P/c B colour coded white — all perfect 25 BC107 NPN to 106 case perfect transistors of C1359 25 BC177 NPN T0106 case perfect transistors of C1395 4 ZN3055 silicon power NPN transistors T03 6 T064 SCRS 5 amp assorted 50v-400 vall coded 8 Way ribbon cable — colour coded individually insulated solid timed copper conduction 0.2 m	1.0 08r 1.0 0.0d 1.0 0.0d 1.0 1.0	0 d o e o e o o c e
SJ70 SJ71 SJ72 SJ73 SJ74	colour coded blue — all perfect 30 ZTX500 hype transistor PNP pre-formed for P/c B colour coded white — all perfect 25 BC107 NPN to 108 case perfect transistors of C1359 25 BC177 NPN T0106 case perfect transistors of C1395 4 ZN3055 silicon power NPN transistors T03 6 T064 SCR5 5 amp assorted 50v-400 all coded 8 Way ribbon cable — colour coded individually insulated solid timed copper conduction 0.2 m FM caax cable — plain copper conduction cell polythere insulated and plain comper braided	1.0 0ar 1.0 0d 1.0 1.0 1.0 PV etr ula PV	0 do e 0 e 0 o 0 c e r C
SJ70 SJ71 SJ72 SJ73 SJ74	colour coded blue — all perfect 30 ZTKS00 type transistor PNP pre-formed for P/c B colour coded white — all perfect 21 BC107 NPN to 106 case perfect transistors of C1359 2 BC177 NPN T0106 case perfect transistors of C1395 2 N3055 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400 all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction call polythene insulated and plain copper braided sheath — impedance 75 ohms 0.10 m S00 SCR 5 amp assorted S00 SCR 5 amp S00 SCR 5 am	1.0 0ar 1.0 codd 1.0 codd 1.0 1.0 etr ula PV	0 d 0 a 0 a 0 a 0 C a r C a
SJ70 SJ71 SJ72 SJ73 SJ74	colour coded blue — all perfect 30 ZTX500 hype transistor PNP pre-formed for P/c B colour coded white — all perfect 25 BC107 NPN to 108 case perfect transistors of C1359 25 BC17 NPN T0108 case perfect transistors of C1395 4 ZN3055 silicon power NPN transistors T03 6 T046 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction cell polythere insulated and plain copper braided sheath — impedance 75 ohms 0.10 m 1 Board containing 2.2 fo in DIN syckets 180° 0.2.	1.0 oar 1.0 cod 1.0 cod 1.0 1.0 etr ula PV	0 d 0 a 0 a 0 a 0 C a r C a c
SJ70 SJ71 SJ72 SJ73 SJ74	colour coded blue — all perfect 30 ZTXSOD type transistor PNP pre-formed for P/c B colour coded white — all perfect 28 BC107 NPN to 108 case perfect transistors of C1359 28 BC177 NPN T0108 case perfect transistors of C1305 2 ZN3055 silicon power NPN transistors T03 3 T046 SCRs 5 amp assorted 50v-400v all coded 3 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction cell polythere insulated and plain copper braided sheath — impedance 75 ohms 0.10 m 1 Board containing 2 X 5 pin DIN sockets 180° 02.2 DIN loudspeaker sockets A5 pin DIN 180° chassis/normal socket incl. D	1.0 oar 1.0 cod 1.0 cod 1.0 1.0 etr ula PV	0 d 0 a 0 a 0 a 0 C a r C a c
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ76	colour coded blue — all perfect 30 ZTXS0 Orpet transistor PNP pre-formed for P / c B colour coded white — all perfect 21 SC107 NPN to 106 case perfect transistors of C1359 2 SC177 NPN T0106 case perfect transistors of C1395 2 N30355 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms 0.10 m 1 Board containing 2×5 pin DIN sockets 180° 02- DIN loudspeaker sockets A5 pin DIN 180° chassis/normal socket incl. D	oar 1.0 oar 1.0 cod 1.0 d.0 1.0 etr ula PV etr 2 pi PD .2	0 d 0 e 0 e 0 0 0 C + r C + r 0 T 0
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ77 SJ83 SJ84	colour coded blue — all perfect  30 ZTKSD0 type transistor PNP pre-formed for P / c B colour coded white — all perfect 25 BC107 NPN to 105 cease perfect transistors c C1359 25 BC177 NPN T0106 case perfect transistors c C1395 2N3055 silicon power NPN transistors T03 36 T084 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction 0.2 m FM coax cable — plain copper conduction cell polythene insulated and pialn copper braided sheath — impedance 75 ohms 0.10 m 1 Board containing 2 x 5 pin DIN sockets 180° 02: DIN foundspeaker sockets All 100° chassis / normal socket incl D switch in CCP1 type photo (rapsistor) 6 germ CCP1 type photo (rapsistor)	1.0 oar 1.0 cod 1.0 cod 1.0 1.0 PV etr ula PV etr 2 pi 2.0 0.2 0.2	0 d 0 e 0 e 0 0 0 C e r C e n 0 T 0 0
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ77 SJ83 SJ84 SJ84 SJ85	colour coded blue — all perfect 30 ZTXSOD type transistors PNP pre-formed for P/c B colour coded white — all perfect 28 BC107 NPN to 108 case perfect transistors of (1359) 25 BC177 NPN T0108 case perfect transistors of (1305) 37 ST NPN T0108 case perfect transistors of (1305) 38 T046 SCRs 5 amp assorted 50v-400v all coded 38 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction cell polythere insulated and plain copper braided sheath — impedance 75 ohms 0.10 m 18 board containing 2.8 pin DIN sockets 180° 02.0 DIN loudspeaker sockets A5 pin DIN 180° chassis/normal socket incl switch Germ. OCP71 type photo transistors 10 BD131 NPN transistors low Hig rejects 8 PNP Derfingting no Power Transistors 10.166 8 PNP Derfingting no Power Transistors 10.166 8 PNP Derfingting no Power Transistors 10.166	1.0 0 ar 1.0 0 cod 1.0 0 c	0 d 0 e 0 e 0 0 0 C + r C + r 0 T 0 0 0 n
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ77 SJ83 SJ84	colour coded blue — all perfect 30 ZTKSD0 type transistors PNP pre-formed for P / c B colour coded white — all perfect 21 BC107 NPN to 106 case perfect transistors of C1359 2 BC177 NPN T0106 case perfect transistors of C1395 2 N3055 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction coll polythene insulated and plain copper braided sheath — impedance 75 ohms	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	0 d 0 e 0 e 0 0 0 C + r C + r 0 T 0 0 0 B
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ77 SJ83 SJ84 SJ86 SJ86 SJ86 SJ87	colour coded blue — all perfect 30 ZTKS00 type transistors PNP pre-formed for P / c B colour coded white — all perfect 21 BC107 NPN to 106 case perfect transistors of C1359 2 BC177 NPN T0106 case perfect transistors of C1395 2 N30355 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction of 0.2 m FM coax cable — plain copper conduction of 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	0 d 0 e 0 e 0 e 0 C e r C e n 0 T 0 0 0 B D
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ76 SJ77 SJ83 SJ86 SJ86 SJ86 SJ86 SJ87 SJ88	colour coded blue — all perfect 30 ZTKSD0 type transistors PNP pre-formed for P / c B colour coded white — all perfect 21 BC107 NPN to 106 case perfect transistors C 1359 C 1359 C 1375 C 1395	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	0 do a 0 e 0 0 0 C • r C • n 0 T 0 0 0 B 0 0 0
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ77 SJ83 SJ84 SJ85 SJ86 SJ87 SJ88	colour coded blue — all perfect 30 ZTKS00 type transistors PNP pre-formed for P / c B colour coded white — all perfect 21 BC107 NPN to 106 case perfect transistors of C1359 2 BC177 NPN T0106 case perfect transistors of C1395 2 N30355 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms	1.0 oar 1.0 oar 1.0 oar 1.0 1.0 oar 1.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 do e 0 e 0 0 0 C e r C e n 0 T 0 0 0 0 B 0 0 0 0
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ77 SJ83 SJ84 SJ86 SJ86 SJ87 SJ88 SJ89 SJ90 SJ90	colour coded blue — all perfect 30 ZTKS00 type transistors PNP pre-formed for P / c B colour coded white — all perfect 21 SC107 NPN to 106 case perfect transistors of C1359 2 RC177 NPN T0106 case perfect transistors of C1395 2 N30355 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms	1.0 oar 1.0 oa	0 do e 0 e 0 0 0 C e r C e n 0 T 0 0 0 B 0 0 0 0
SJ70 SJ71 SJ72 SJ73 SJ75 SJ76 SJ77 SJ83 SJ84 SJ86 SJ87 SJ88 SJ88 SJ89 SJ89 SJ89 SJ90 SJ91 SJ91 SJ91	colour coded blue — all perfect 30 ZTKSD0 type transistors PNP pre-formed for P / c B colour coded white — all perfect 21 BC107 NPN to 106 case perfect transistors ( 21359 2 BC177 NPN T0106 case perfect transistors ( 21395 2 K13055 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms   0.10 m 1 Board containing 2 x 5 pin D1N sockets 180° 0.2- D1N foundspeaker sockets A5 pin D1N 180° chassis/normal socket incl. D switch SW131 NPN transistors tow Hfs rejects 6 PNP T0.3 germ. Power Transistors T0.126 6 PNP T0.3 germ. Power Transistors XUTS10-200 20 Asst, heat sinks T01/5/18/92 2 Post Office relays 2 Mised values 400mW zener diodes 3-10v Mised values 400mW zener diodes 3-10v Mised values 10x sener diodes 3-10v Mised values 10x sener diodes 3-10v Mised values New Zener diodes 3-10v Mised values 10x zener diodes 3-10v Mised values New Zener diodes 3-10v	1.0 oar 1.0 oar 1.0 oar 1.0 1.0 oar 1.0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 do e 0 e 0 0 0 C + r C + r O T 0 0 0 0 B 0 0 0 0 0
SJ70 SJ71 SJ72 SJ73 SJ75 SJ76 SJ76 SJ77 SJ83 SJ84 SJ86 SJ86 SJ88 SJ88 SJ889 SJ889 SJ890 SJ91 SJ92 SJ95	colour coded blue — all perfect 30 ZTKSD0 type transistors PNP pre-formed for P / c B colour coded white — all perfect 21 BC107 NPN to 106 case perfect transistors of C1359 2 BC177 NPN T0106 case perfect transistors of C1395 2 X13055 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms	1.0 0 ar 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	0 d0 e0 e000 C e r C e no T 0 0 0 0 0 0 0 0 0 0 0
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ77 SJ83 SJ86 SJ87 SJ88 SJ86 SJ87 SJ89 SJ90 SJ90 SJ99 SJ90 SJ99 SJ90 SJ99 SJ99	colour coded blue — all perfect 30 ZTKS00 type transistors PNP pre-formed for P/c B colour coded white — all perfect 21 SC107 NPN to 106 case perfect transistors of C1359 2 RC177 NPN T0106 case perfect transistors of C1395 2 N3055 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms	1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	0 do a 0 a 0 a 0 a 0 a a 0 a a 0 a 0 a 0 a
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ77 SJ83 SJ84 SJ86 SJ88 SJ88 SJ89 SJ89 SJ89 SJ89 SJ89 SJ89	colour coded blue — all perfect 30 ZTKSD0 type transistors PNP pre-formed for P / c B colour coded white — all perfect 21 BC107 NPN to 106 case perfect transistors ( 21359 2 BC177 NPN T0106 case perfect transistors ( 21395 2 K13055 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms   0.10 m 1 Board containing 2 x 5 pin D1N sockets 180° 0.2- D1N loudspeaker sockets A5 pin D1N 180° chassis/normal socket incl D switch Switch SW 180° CP71 type photo transistors 10 BD131 NFN transistors tow Hfs rejects 6 PNF 10-3 germ. Over Transistors XUTS 10-20 20 Asst. haet sinks T0 1/5/18/92 2 Post Office relays 20 Mixed values 400mW zener diodes 3-10v Mixed values 1W zener diodes 11-33v 8 Silicon Bridge Rectifiers up to 4Amp 200v + Oata	11.0 11.0 11.0 11.0 11.0 11.0 11.0 11.0	0 do e0 e0 00 co e C e no T 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ77 SJ83 SJ84 SJ85 SJ86 SJ87 SJ88 SJ89 SJ90 SJ99 SJ90 SJ99 SJ90 SJ91 SJ92 SJ91 SJ92 SJ96 SJ96 SJ96 SJ96 SJ96 SJ96 SJ96 SJ96	colour coded blue — all perfect 30 ZTKSD0 type transistor PNP pre-formed for P / c B colour coded white — all perfect 21 BC107 NPN to 106 case perfect transistors of C1359 2 BC177 NPN T0106 case perfect transistors of C1395 2 N33055 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms	1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	0 do e 0 e 0 0 0 C + r C + n 0 T 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ77 SJ83 SJ84 SJ85 SJ86 SJ87 SJ88 SJ89 SJ90 SJ99 SJ90 SJ99 SJ90 SJ91 SJ92 SJ91 SJ92 SJ96 SJ96 SJ96 SJ96 SJ96 SJ96 SJ96 SJ96	colour coded blue — all perfect 30 ZTKSD0 type transistors PNP pre-formed for P / c B colour coded white — all perfect 21 SC107 NPN to 106 case perfect transistors of C1359 2 RC177 NPN T0106 case perfect transistors of C1395 2 RN3055 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m FM coax cable — plain copper conduction 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms	1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	0 d 0 e 0 0 0 0 C e r C e n 0 T 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ76 SJ77 SJ83 SJ84 SJ86 SJ86 SJ89 SJ89 SJ89 SJ89 SJ89 SJ89 SJ89 SJ89	colour coded blue — all perfect 30 ZTKSD0 type transistor PNP pre-formed for P / c B colour coded white — all perfect 21 BC107 NPN to 106 case perfect transistors of C1359 2 BC177 NPN T0106 case perfect transistors of C1395 2 N3055 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400v all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction of 0.2 m FM coax cable — plain copper conduction of 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms	0 ar 1.0 cold 1.0 col	0 d 0 e 0 e 0 0 0 0 C e e r C e e 0 0 T 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ76 SJ77 SJ83 SJ84 SJ86 SJ86 SJ89 SJ89 SJ89 SJ89 SJ89 SJ89 SJ89 SJ89	colour coded blue — all perfect 30 ZTKSD0 type transistor PNP pre-formed for P / c B colour coded white — all perfect 21 BC107 NPN to 105 case perfect transistors of C1359 2 BC177 NPN T0106 case perfect transistors of C1395 2 N3055 silicon power NPN transistors T03 6 T064 SCRs 5 amp assorted 50v-400 all coded 8 Way ribbon cable — colour coded individually insulated solid tinned copper conduction of 0.2 m FM coax cable — plain copper conduction of 0.2 m FM coax cable — plain copper conduction cell polythene insulated and plain copper braided sheath — impedance 75 ohms	0 ar 1.0 co 1.0	0 d 0 a 0 a 0 a 0 c a c a c c a c a c c a c
SJ70 SJ71 SJ72 SJ73 SJ74 SJ75 SJ76 SJ77 SJ83 SJ86 SJ87 SJ88 SJ86 SJ87 SJ89 SJ90 SJ90 SJ91 SJ92 SJ91 SJ92 SJ91 SJ92 SJ96 16168 16169 16170 16172 16177	colour coded blue — all perfect 30 ZTKSD0 type transistors PNP pre-formed for P / c B colour coded white — all perfect C1359 C1359 C1359 C1359 C1359 C1359 CN3055 silicon power NPN transistors T03 C1036 SCRS 5 amp assorted 50v-400v all coded Way ribbon cable — colour coded individually insulated solid tinned copper conduction 0.2 m PM coax cable — plain copper conduction 0.2 m PM coax cable — plain copper conduction of 0.2 m PM coax cable — plain copper conduction of 0.3 m Board containing 2 x 5 pin DIN sockets 180° 02- DIN floudspeaker sockets A blue 1 produce 1 point of 10 production cell A blue 1 production of 10 production cell Serm C021 Type photo transistors DB DI31 NPN transistors low Hife rejects PNP Darlington Power Transistors T0-126 PNP Darlington Power Transistors T0-126 PNP T0-3 germ. Power Transistors at VLTS 10-20C Asst. heat sinks T01 / 5 / 18 / 92 Post Office relays Mixed values 400mW zener diodes 3-10v Mixed values 400mW zener diodes 3-10v Mixed values 1 W zener diodes 11-33v Silicon Bridge Rectifiers up to 4Amp 200v + Oata Battery holder to take 6 x HP7's Sasorted ferrite rods Tuning gangs MW / LW Meters asst. colours single strand wire Rectifiers produce 1 produce 1 produce 1 produce 2 produce 3 prod	0 ar 1.0 car 1.0 car 1	0 d 0 a 0 a 0 a 0 c a c a c c a c a c c a c a c a c c a
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# Greenweld 1980

We've just received our copy of Greenweld's 1980 component and equipment catalogue.

Every catalogue is sent out complete with a first class reply paid envelope (worth a small fortune these days) and five 12p discount vouchers to offset the cost of the catalogue.

Why should you buy the latest edition, if you have last year's? Well, if you don't send off for the 1980 edition, you'll miss out on all the new lines appearing in the catalogue AND somehow Greenweld have managed to reduce some of their prices. You'll also miss out on a copy of the latest bargain list (sent with every catalogue). As soon as the new Vero catalogue is available, that will be included too.

You can get all this for 40p plus 20p postage from Green-weld Electronics, 443 Millbrook Road, Southampton SO10HX.

# Sci-Fi Easter

If you're into sci-fi, don't make any plans for Easter. Write 100 times in your gold embossed, leather-bound, page-a-day desk diary (or the nearest cigarette packet) – Albacon 80, the 31st UK Science Fiction Convention will be held in Glasgow over the Easter weekend.

From 4-7 April 1980 at the Albany Hotel, Glasgow, you can drift off into another world of sci-fi movies, lectures, discussions, a banquet and even a fancy dress do. You can join Albacon by sending off your £7 to the membership secretary Gerry Gillin, 9 Dunnottar Street Ruchazie, Glasgow G33.

# Synthesiser (Feb)

There were a couple of minor errors in the Synthesiser project last month. The circuit diagram of the Power Supply on page 65 of the February issue shows C3 and C8 as 2n2. The correct value is, as shown in the Parts List, 2u2 25V tantalum. Now have a look at Fig 4 on page 69. C1-4 should go to ground. Also, PR3 should go to ground

Now the bad news for anyone who uses the foil patterns published in ETI. The synthesiser foil patterns somehow got turned round the wrong way.

# **Audiophile** AMP (Oct)

Some readers have experienced problems with RF oscillation in the power amp modules. If you're having trouble with this, place a 1000 p capacitor across each output transistors base/ collector leads.

# Super Index

In January we published an index to our 1979 projects and features. Thank goodness indexing only comes round once a year. We recently received a copy of a monster catalogue, listing projects published during 1978 in sixteen popular electronics and hi-fi magazines, including ETI, Hobby Electronics and Computing Today.

The projects are listed under 36 subject headings, from aerials to time-keeping. Also included are dates of publication of alterations and amendments to projects published up to August 1979, together with additions to the 1972-77 index. Unlike our own index this one includes ETI Tech Tips features.

The 1978 volume of the Electronics Projects Index is available for £1.30, including post and packing, from its compiler (obviously a very patient man) Mr M L Scaife, Central Library, Northumberland Square, North Shields, Tyne & Wear, NE30, 10U.

# Vero Cat

Last month, we gave you details of the new Vero packaging catalogue. Vero Electronics have asked us to point out that this catalogue is only available to the electronics trade. Their press release was sent to us in error. However, the good news is that Vero's new catalogue for the hobbyist will be available at the beginning of March.

# **Pet Chip**

This should appeal to those of you who spent your hardearned pennies on a 'pet rock,' when they were all the rage.

We recently received a letter from an anonymous dad who made an apparently trivial Christmas presi for his daughter. However, since then he has been inundated with orders.

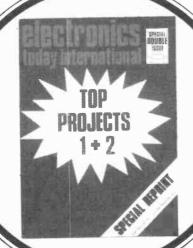
Mr A. Nonymous painted a face on one end of an IC (pet IC, you see) and made a matchstick cage for it complete with watch battery feeding bowl.

The chip should quickly LATCH on to its new OHM. As for feeding, a few BITS of CURRENTS a day should be AMPle. Just let it NOR away to its heart's content. You can teach it tricks. In time it will learn to CHARGE and FLIP-FLOP, or even VOLT small objects.

Ta, Mr Nonymous. We haven't had a good groan in



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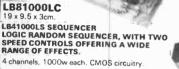
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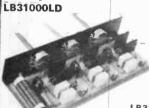
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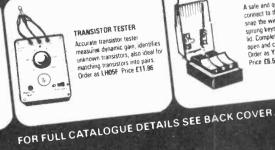
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# THEORY THOLE

You've read the book and seen the film, now hear the gospel on Black Holes according to lan Graham

# Great Balls Of Fire

The final episode in the star's life depends on its mass. Let's take the route that will take us to a black hole. The core continues contracting, helium fusing to form carbon and successively heavier elements. Eventually it collapses successively heavier elements. Eventually it collapses tapidly, blowing off the envelope in a supernova explosion during which the single star may outshing an entire galaxy.

collapses under the immense pressure of the upper layers sending more helium to the core. Eventually the core The remaining hydrogen is burnt off in the outer layers, at the envelope ie the star appears to be growing largan remporarily halting contraction and causing an expansion it Contraction of the core causes a rise in temperature. blow the star apart and gravitational forces trying to crush There is a constant battle between thermal forces, trying to relatively heavy core surrounded by a lighter envelope se tud , seg gnimud to lled sucenegomod e se ton the core begins to contract. We must now look at the starannost exhausted, the star's temperature begins to fall and deep into the core. Eventually, when the hydrogen is with burning its hydrogen fuel, forming helium, which sinks The greater part of the star's life-time is then occupied confraction ceases temperature is high enough for hydrogen fusion to bag.n.

whose gravitational fields grow gradually stronger as mutese and more material is attracted towards them. As these embryonic stars (protostars) continue to contract their temperature begins to rise, producing internal heating and temperature degins to rise.

regions of increased density form condensation muder

clouds collapse under their own gravitational fields. Local

within the clouds of material between the stars. These

under the right conditions, the death of a star may herald the birth of a black hole. The birthplace of stars is

formed, let's first have a look at the life of a star, for,

o understand what a black hole is and how it is

and this is accompanied by an enormous expansion of the

envelope, forming a red giant

The explosion may destroy the core completely or it may leave a small core. However, if the star was more than two or three times as massive as our own Sun, the core surviving a supernova will rapidly collapse. Theorists predict that the collapse will continue until the core radius reaches zero. This hugely massive, but dimensionless point in space is called a singularity

# No Escape

The singularity has such a strong gravitational field that light itself cannot escape ie the escape velocity of the body is greater than the speed of light. The further we are from the black hole, the lower is the escape velocity (the gravitational force decreases with the square of our distance from the body). At a particular distance from the singularity, the Schwarzschild radius, the escape velocity equals the speed of light. Within this event horizon, nothing escapes.

For a body of mass (M), the Schwarzschild radius (Rs) is given by

$$R_{S} = 2GM$$

$$C^{2}$$

(G is Newton's gravitational constant and c is the speed of

light)

If we let M be the mass of our own Sun,  $R_{\varsigma}$  turns out to be 3 kms. So, why isn't the Sun a black hole? Its radius is much larger than 3 kms, so beyond this event horizon the Sun's hydrogen fusion reactor can radiate its energy out into space, but if the Sun's mass was to be compressed to a diameter of less than 3 kms, it would become a black hole.

If we look at our own Earth and the bodies around us in the solar system and even the Milky Way galaxy as a whole, we find that they all rotate ie they all have angular

momentum.

The angular momentum (L) of a rotating body of mass (m), radius r) at an angular veloc ty of w is given by

L = mwr

If a rotating body such as the remnant of an exploded star. begins to contract ie r gets smaller, the angular velocity (w) must increase in order that angular momentum may be conserved: Depending on its mass a black hole may rotate at about 1000 times a second. A black hole is such a dense body that one the size of a proton would weigh in at about ten thousand million tonnes!

Just as the Earth bulges slightly at the equator and is flattened at the poles due to centrifugal force, the much greater rotation of a black hole results in a much more severe deformation. The equations predict that a black hole is not a sphere at all. It may be similar in profile to a spiral galaxy (like the Milky Way) ie a disc with a bulge at its centre.

All this speculation on the formation and structure of a black hole may seem to be purely academic. After all, how do you go about finding a black nole to prove that it exists and verify its structure and behaviour? Even if you knew where to look, how would you observe something from which no light can escape?

# Stellar Striptease

You may not be able to see the black hole itself, but it should be possible to observe what it does to any matter near it. The best candidate for detection would be a black hole and a star orbiting each other — a binary system. Material should be stripped from the star and wind its way round the plack hole, forming a disc, finally disappearing beyond the Schwarzschild radius like water funnelling down your bath plug-hole. As the matter crowds together for its last cive to oblivion, its temperature rises until it is hot enough to radiate at X-ray wavelengths

The search for X-ray sources could not begin until the space age because radiation in the X-ray region of the spectrum cannot penetrate the Earth's atmosphere. One of the earliest X-ray sources discovered by orbiting telescopes was Cygnus X-1, in the constellation of Cygnus. The X-ray source accompanies a visible blue giant star. The visible star's speed was found to be varying along a sine wave, so it must have an invisible companion around which it is orbiting

Most of the light emitted by the system appears to arise. not from the visible blue star, but from helium gas sucked from it and circulating around its invisible companion. The companior's mass has been calculated as more than the critical three solar masses, so it is likely to be a black hole.

Another system likely to become a household name among black hole hunters is V861 Scorpii (the V indicates that its brightness appears to vary). This variation over a period of about eight days is due to a dark body orbiting

(and ecl psing) a blue supergiant. Like Cygnus X-1, V861 Scorpii is a binary system.

# Dark Star

In both these cases, the dark star could be either a black hole or a neutron star. A neutron star is a body where the matter from a collapsed star core is compressed so tightly that electrons and protons are pushed together to form neutrons. Again, mass is the determining factor. If the mass is less than about three Suns, the body will be a neutron star. If it is above the critical mass, it should be a black hole.

# Shaking The Edifice

Life was much simpler for scientists in Victorian times. Through classical Newtonian physics, everything under the Sun (and beyond it) seemed describeable and predictable. It was just a matter of time before the scientists achieved a comprehensive understanding of the universe and determined the physical laws to describe all the processes therein, from the subatomic level upwards. Then along came trouble-makers like Planck and Einstein, who showed that an electromagnetic wave could behave like a steam of particles. In classical physics a wave is not the same as a particle and never the twain shall meet. Not content with shaking the foundations of prevailing physics, Einstein (leader of the popular front for the liberation of physics) went on to predict the effects of very dense bodies on time itself.

Space and time are inextricably intertwined. Close to a black hole space is curved so severely that time itself loses its meaning. Stephen Hawking and Roger Penrose working at Cambridge saw the possibility that any object (including a spacecraft) falling towards a rotating black hole may not fall into the murderous singularity, but may miss it, to reappear elsewhere in our universe (or another universe) an instant later. Einstein's theories predicted the possibility of bridges between the warped planes of space. However, black holes were then believed to be non-rotating bodies, so that any matter falling over the event horizon could not help but hit the singularity.

# **Instant Travel**

If only a small fraction of the matter falling into a rotating black hole misses the singularity, what becomes of it? It must reappear at the other end of the tunnel an instant later, maybe light years away from where it disappears. So, there must be points in space where matter appears to be spewing forth from nowhere — white holes. Now, if black holes are almost undetectable because of their blackness.

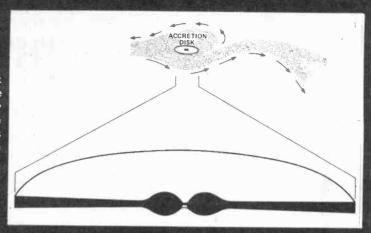


Fig. 2. As matter is sucked from the giant star towards the black hole, it builds up an accretion disc around the event horizon.

the detection of white holes should be simplicity itself. Indeed there are galaxies, known as Seyferts (after the man who identified them in 1943) which resemble galaxies like the Milky Way, but for one characteristic. The centre of a Seyfert is very bright and smaller than usual, and it emits radiation at frequencies which the Milky Way absorbs. The galactic nucleus seems to be an exploding ball of matter and energy — possibly a white hole.

# Sci~Fi

The black hole may seem to be a futuristic concept. In fact, Laplace realised that if a body was massive enough, its escape velocity would exceed that of light, as far back as 1798. That black holes might make possible travel across light years of space in an instant (or even time travel) sounds more like science fiction.

Before we can verify the theories and check out the equations we will have to get the hang of interstellar travel, or find a black hole in the solar system. Cygnus X-1 is about 600 light years away. As for black holes in the solar system—it's not as crazy as you might at first imagine. The Big Bang, from which the universe is believed to have begun, would have produced the magnitude of pressures necessary to produce black holes in their millions. Our galaxy could be sprinkled with these tiny Big Bang black holes. When a study of the Sun, looking for neutrinos produced in nuclear reactions at its centre, found none, one researcher suggested that a small black hole in the Sun itself may satisfy the findings.

It may sound like science fiction . . . but for how much longer?

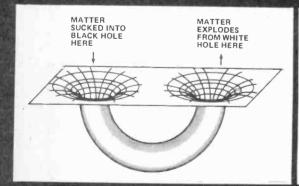


Fig. 1. If all the matter disappears into a black hole, it must appear somewhere else at a White Hole.

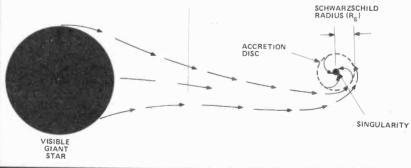


Fig. 3. The black hole and its giant companion star orbit one another, as the hole strips material from the star.

# "S HOPPE 15

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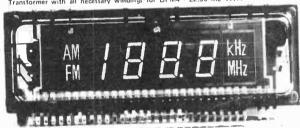
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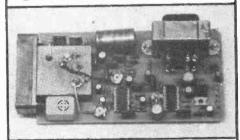
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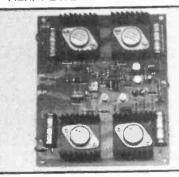
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reduction

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t has been said that a signal tracer is just an amplifier with a diode at the front. In fact, for many applications, just such an arrangement is all that is required. This design fulfills the above description and then some!

Boasting a high input impedance and good sensitivity, the unit drives a small loudspeaker or personal earphone with good volume. Power may be derived from the equipment under test or a separate nine volt supply may be used. Use of the specified case ensures a neat and attractive project. The case is identical to that used in the CSC logic probe kit and comes complete with detachable probe, power supply leads and a small piece of perforated board (not needed here). Its place is taken by the PCB. The case comes complete with cut-outs for three indicator LEDs. Only one is used in this design to accommodate the power indicator LED and the other two may be blanked off or simply left vacant.

# Construction

Use of the PCB is really essential. Quite apart from the problem of fitting all the bits in the case, layout is critical to avoid stray feedback and spurious oscillation. Owing to the limited space available in the case, the physical size of the components is important and the smallest available components should be used. Note that C3 lies over R3, 4 and capacitors C5, 9 need to lie on their sides. A flying lead link should be taken from R2 (Q1 drain) to C2. This may be done on the underside of the board and should be as short and direct as possible. LED 1 is mounted on the board and is self-supporting.

In use, the unit should be connected to a nine volt supply and a loudspeaker plugged into SK1; use screened cable to avoid stray feedback. As a simple test, hold the probe within a couple of centi-

# PARTS LIST

Resistors	
R1	10M
R2,12	1k0
R3,10	1k5
R4	2k7
R5	150k
R6	18k
R7	10k
R8	470R
R9	2k2
R11	10R
Capacitors	
C1	10p ceramic
C2,4,6	10n ceramic
C3	6u8 tantalum
C5,9	47u tantalum
C7	220u electrolytic
C8	2u2 tantalum
C10	47n ceramic
C11	100u tantalum
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Q1	2N3819
Q2	BC109
LED 1	any 0.125" LED
D1	1N4004
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case, socke	et, 8 ohm earphone or

# HOW IT WORKS

To provide high input impedance with good sensitivity a FET input stage is used. Q1 is connected as a common source amplifier, decoupled to AC by C3, with the output taken across R2. This stage is coupled to Q2 by C2. Q2 operates as an AM detector and audio amplifier. The output is taken across R7 and is decoupled to RF by C6. across R7 and is decoupled to RF by C6. The power supply to this section of the circuit is provided via R10 smoothed by C7. A small integrated audio amplifier forms the output stage. IC1 provides its own input bias and the output automatically centres at half the supply voltage. C10 and R11 prevent instability. The output is coupled via C11 to an eight ohm personal earphone or loudspeaker. Shielded cable should be used to prevent stray feedback to the input stage. Overall power is supplied via DI which protects against accidental reversal of the supply leads. Power is indicated by LED 1. As this component is sited near the input stage its power supply is decoupled by C9 to prevent instability due to stray feedback. When used with 9 volt battery equipment, power may be derived from the circuit under test. When a separate supply is used to power the probe. A connection should be made from 0 V to the earth of the equipment under test. Bear in mind the voltage rating of C1. For a small ceramic capacitor, this may be only fifty volts or so.

# BUYLINES

The LM386 is available from Watford Electronics. The remaining components are unexceptional and should be readily available. The case is manufactured by Continental Specialties Corporation, type CTP-1. Continental Specialties Corporation, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AO.

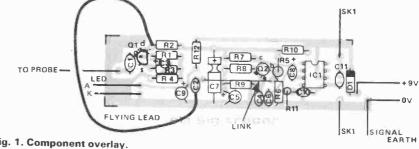
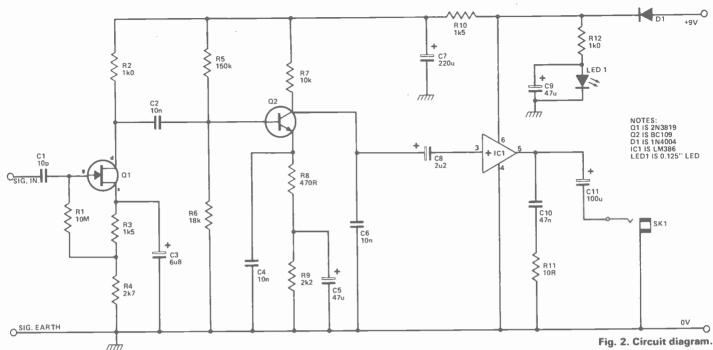


Fig. 1. Component overlay.

loudspeaker.



metres of a live mains lead. A loud hum or buzz should be heard. When using the tracer with a separate power supply from the equipment under test a wire should be taken from 0 V to the equipment's earth to provide a signal return

path. Remember that the input capacitor C1 may only be rated at about fifty volts if you are thinking of working with high voltage equipment. As well as detecting low level audio, the probe may also be used to detect radio-

frequency signals at frequencies up to and above 10 MHz. Sensitivity is quite adequate to make the unit useful with TRF receivers and signals are easily detected in conventional medium-long wave superhets.



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100nF, 150nF		7p	OA202	9
220nF, 330nF		8p	1N916	5p
470nF: 9p 680nF	10-	op	1N4148	4
1uF: 14p 2.2uF:	. 10p	10.	1N4001/2	4p
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470/25.500/30		13p	1110404	ιομ
1000/10: 14p 10	000/25: <b>22p</b>		4 400 - 0 -	
1500/25: 26p 2:	200/6: <b>20p</b>	- 1	LINEAR	
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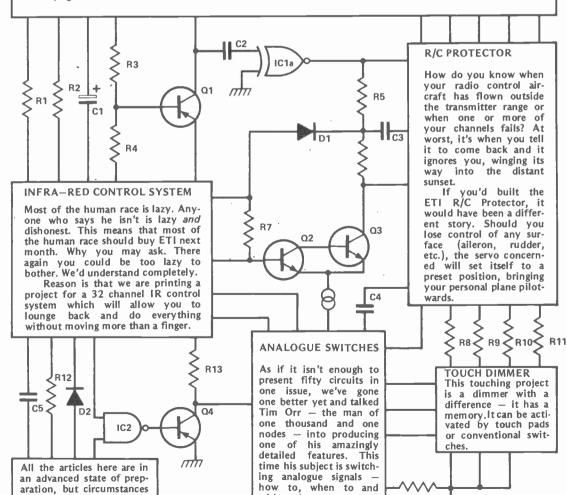
What to look for in the April issue: on sale March 7th

# CIRCUIT SUPPLEMENT

Next months ETI carries something really special — a SIXTEEN PAGE circuit supplement for the experimenter. All the circuits have been tried and tested by us, making this the most reliable reference yet. If there is anything you need a circuit for or any circuits you need something for this is the place to find it. No less than 50 in all. Half a hundred of the best you'll find anywhere.

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with

what.

R14

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in the final issue.

may dictate slight changes

# **THE 1537 VCA**

Keith Brindley brings you up to date with the latest offspring of the silicon chip family - complete with practical applications.

here is always a great deal of excitement generated in electronics on the arrival or introduction of a new circuit, concept or chip, particularly if the system is potentially a field leader. The 1537A chip is just that! The specifications which the device can offer in situ are well above those of any similar preceding systems. Table 1 gives a listing of specifications, which can be obtained in the correct applications.

Parameter	Specification
Bandwidth	DC-200kHz
T.H.D., 20Hz-20kHz	0.004%
I.M.D. (SMPTE TEST)	0.03%
Noise	-90dBv, ± 1dB (worst case, unity gain)
Overshoot and Ringing	None
Slew Rate	> 10v/usec, symmetrical & constant
Input Impedance	20ΚΩ
Maximum Input Level	+20dBv
Gain	0dB (Unity)
Maximum Attenuation	>94dB
Control Voltage	0 to +10V
DC shift vs. Attenuation	≤5mV
Power Requirements	Regulated ± 15V at +25, -33mA

Table 1. The maximum possible specifications available from a 1537A system.

With harmonic distortion of 0.004% and a signal / noise ratio of over 90 dB the system is of course well suited to studio applications, although use in this environment is by no means its only area of involvement. The IC itself seems at first glance, somewhat highly priced at around £6, but nevertheless, it requires few extra components to produce a VCA system of the superb quality (suggested in the specifications of Table 1) and overall represents good value for money to the amatuer and professional engineer alike.

# **Amplifier Or Attenuator**

The term VCA is normally used as an abbreviation of the phrase Voltage Controlled Amplifier, but in its simpler modes the 1537A is, strictly speaking, a voltage controlled attenuator ie with a maximum gain of unity. The inventors do, however, stress that connection of the 1537A into the feedback loop of an amplifier (such as an op amp) produces a voltage controlled amplifier. The applications section of this article show how this can be achieved.

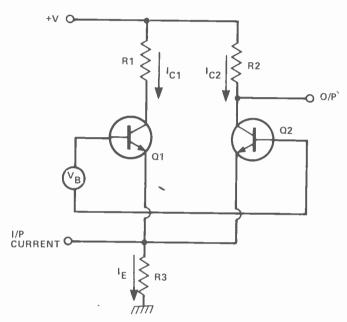


Fig. 1. A differential pair of transistors — the basis of a VCA.

The operation of the 1537A VCA depends upon the gain control function of a differential pair of transistors as in Fig. 1. The transistors in Fig. 1 are connected at their emitters. The current through R3 ( $I_{\rm E}$ ) is, therefore, approximately equal to the sum of their two collector currents  $I_{\rm C1}$  and  $I_{\rm C2}$  through R1 and R2 respectively. The relative bias voltage,  $V_{\rm B}$ , between the two bases determines the relative collector currents. If we now apply an input signal current to the joined emitters we obtain output signal currents through R1 and R2, the sizes of which are determined by the bias voltages. In other words, by altering this bias voltage we alter the size of the output signals.

Figure 2 shows a simplified internal circuit of the 1537A chip giving pin numbers and external load and emitter resistors necessary for operation. There are two basic gain control circuits within the chip, similar to that in Fig. 1 (built around Q1, 2 and Q5,6) except for three main differences: — the diode connection of the transistor pair not used for signal output ie Q1 and Q6, which reduces the distortion due to transistor gain differences.

— the addition of buffers around Q4 and Q8 to reduce loading of the output collectors of the gain transistors, in turn allowing idealised characteristics over the full gain range.

— the use of transistors Q3 and Q7 as voltage to current converters enabling the input to be applied as a voltage rather than as a current.

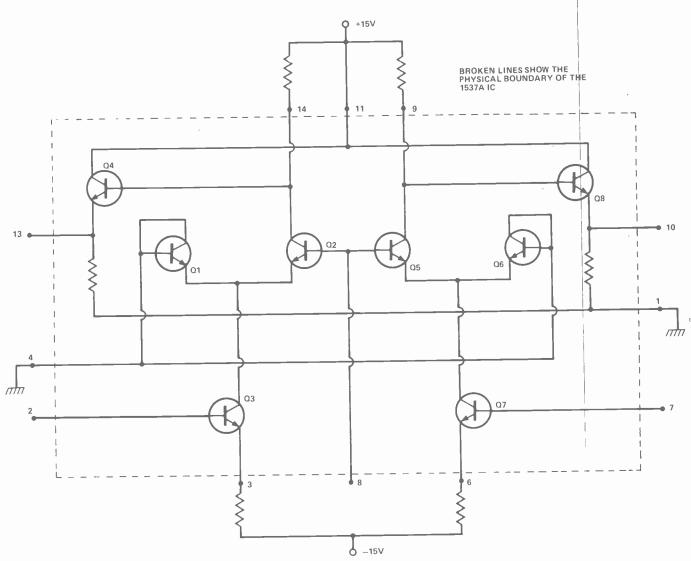


Fig. 2. A much simplified internal circuit of the 1537A IC, showing external load and emitter resistors.

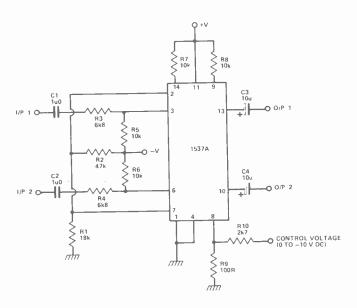


Fig. 3. The simplest mode of operation of the 1537A — a low input impedance stereo VCA with a negative going control voltage.

There is, however, a much more subtle difference, on top of this and that is the use of large geometry transistors. The effect of larger geometry transistors can improve second order intermodulation by as much as ten times for a tenfold increase in transistor size. Noise can also be reduced by about 10 dB for a similar increase in geometry.

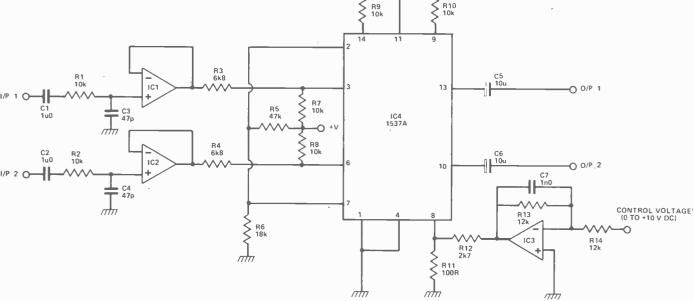
This leads us now to the simplest mode of operation of the 1537A using each gain control circuit individually, although the control voltage affects the gain of each circuit simultaneously (Fig. 3).

The ratio of R9 and R10 is calculated to allow a control voltage range of 10 volts (ie 0 to minus 10 V), altering the gain of the system from 0 dB to about —90 dB. The input impedance of the circuit to applied signal is low and ideally buffers should be placed before this circuit. Although this circuit does not give studio quality specifications it will, however, still produce results in the "high fidelity" range, providing impedance matches are considered.

Figure 4 shows a circuit application which gives a higher impedance input. Also included is an inverting stage in the control voltage link which allows a voltage of 0 to + 10 volts to be used for controlling attenuation.

Although any operational amplifier could be used for ICs 1, 2 and 3 in the previous circuit, it should be fairly

Ŷ Fig. 4. A higher input impedance stereo VCA with positive going control voltage. R9 10k



apparent that the noise, distortion and bandwidth specs of the circuit are limited to those of the op amps used.

Either of the two circuits of Figs. 1 and 2 can be adopted as the voltage controlled gain heart of a stereo system. Their outputs are about 10 dB down on the inputs so necessary amplification should be given before or after the attenuator.

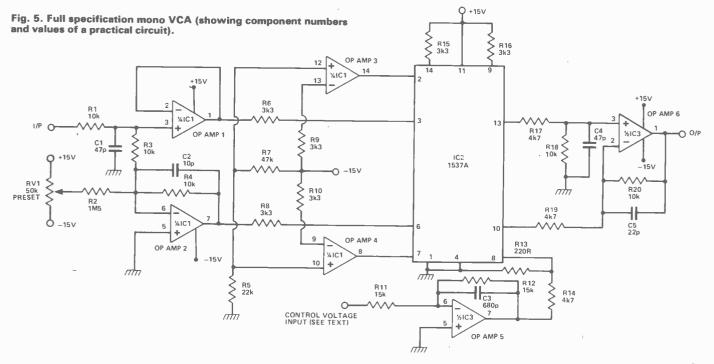
# **Coming Up To Scratch**

Now, three more developments to the circuitry can be undertaken to improve the specifications to those of Table 1. Figure 5 shows the circuit of the ideal system capable of these high specs.

Firstly, actively linearised voltage to current sources (op amp 3 and 4 in Fig 5) improve distortion figures when using a wide range of input signal voltages.

Secondly, parallelling of the two individual gain control circuits (ie the same input signal is fed to both devices at their inputs and mixed at their outputs) gives a 3 dB improvement in S/N ratio.

Finally, a technique is utilised which is complementary to the previous development of parallel devices, whereby the same input is applied to both gain control devices but 180 degrees out of phase. The two outputs are combined in a differential amplifier to give a single ended output. The differential amp is formed around op amp 6. This technique has the effect of reducing DC shift caused by bias and control voltages and with careful adjustment of RV1, the minimal DC shift now left at the output can be reduced even.



further to near (if not actually) zero. The prototype circuit shown, upon testing, actually gave no DC shift at all (or at least none measureable on our test equipment).

The complete circuit can be used as an exceptionally high quality VCA whose signal input can be anything from a few millivolts through to about 20 volts pk to pk without distortion. The lack of DC blocking capacitors at the input and output means that the system can be used to control a DC voltage applied to the input. AC signals up to well over 200 kHz are easily catered for, due to the system's wide bandwidth.

The overlay in figure 6 shows the component layout on printed circuit board of the circuit. The PC design is given in the Foil Pattern section of this issue and will enable interested readers to build the system and get first hand experience of it. As far as we know this article is the first of its kind to present a circuit in a form where "experimenters" can benefit easily and directly from the written text whilst simultaneously using the device in a tried and tested form.

# Construction

If the circuit board layout is followed then there should

be no problems. IC holders are advisable though by no means necessary. RV1 should be a good quality type (cermet), to assist in setting up the output offset shift to zero, cheaper quality presets can sometimes be tricky to adjust in low voltage DC applications of this nature. Op amps 1 to 4 in the circuit are combined in IC1 and can be of a wide range of types from a quad 741 type (3403) upwards. Obviously, if you wish to obtain the best specs the quality of the op amps are critical. LF 347 or TL 074 will give the best results.

Similarly op amps 5 and 6 are included in IC3 and LF 353 or TL 072 are of optimal quality.

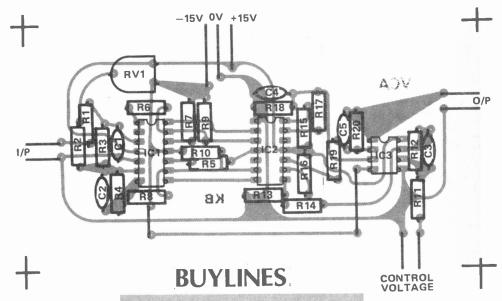
# **Setting Up**

The system should work without any adjustment for an AC signal and varying the control voltage from 0 to 10 volts should give total control over the output amplitude. Some setting up will be required if the input is to be DC, though. This is best achieved by earthing the input. Measure the output voltage using a high impedance voltmeter (it should only be the order of a few millivolts). Adjust RV1 until a complete sweep of control voltage ie from 0 to 10 volts produces only minimal change in DC output voltage. The

Fig. 6. Overlay of PCB of the 1537A VCA module.

# **PARTS LIST**

RESISTORS	All 4W, 5%
	10k ·
20	
R2	1M5
R5 R6,8,9,10,	22k 3k3
15,16	ORD
R7	47k
R11,12	15k
R13	220R
R14,17,19	4k7
PRESET	
RV1	50k min horiz cermet
CAPACITO C1,4 C2 C3 C5	A7p polystyrene 10p polystyrene 680p polystyrene 22p polystyrene
SEMICOND	UCTORS
IC1	TL074, LF347 etc.
IC2	1537A
IC3	TL072, LF353 etc.
MISCELLA IC Holders PCB	NEOUS



Most of the larger mail order companies will be able to help with the quad and dual op amps if you experience any difficulty in obtaining them.

The 1537, however, is presently obtainable only from Aphex Audio Systems Ltd. Their address is 35 Brittania Row, London N1 80H. They have kindly agreed to offer the IC to ETI readers at the reduced rate of £5.85 each including VAT, which is 15% off the normal price. However, this is dependent on small quantity CWO orders and the special code 'ETI APHEX 101' must be quoted with your order.

All other components should be easily obtainable.

circuit is now completely set up to accept an input signal in the frequency range DC to 200 kHz. At minimum attentuation the system operates as a unity-gain wide range, high quality buffer, with a reasonably high input impedance and low output impedance. Variation of the DC control voltage over the range 0 to 10 volts will produce over 90 dB of attenuation of the output signal.

If an overall gain is required in the circuit, resistors R18 and R20 can be changed as in Table 2.

GAIN	R18 & R20					
0dB	10k					
6dB	22k					
10dB	33k					
15dB	56k					

Table 2. The values of R18 and R20 to give the required overall gain in the VCA system of Fig. 5.

The control voltage range of 10 volts can be altered as required simply by changing the ratio of resistors R13 and R14 to suit.

To our knowledge, there is no officially recognised standard symbol for a VCA and rather than redraw the whole circuit of figure 5 upon every reference to the circuit we thought it better to invent a symbol for the purposes of this article. A horizontal trapezoid shape appeared to be the ideal symbol, as shown in Fig. 7. It symbolizes the system as a modular buffer amplifier, whose output (symbolized by the top line), decreases as the control voltage (the bottom line). increases. We shall use the modular sumbol of a VCA whenever reference is made to the circuit of Fig. 5, although any VCA module of another design should function in the applications which we give.

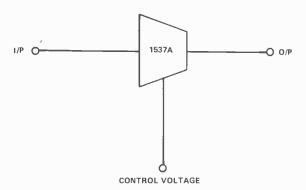


Fig. 7. The ETI symbol of a VCA module.

Use of the 1537Å system module as a DC controlled analogue gate can produce many effects. Amplitude modulation of the signal occurs and the usual associated effects are observed. For instance, in Fig. 8 we can see a simple but high quality tremelo unit. Transistors Q1 and Q2 are connected as a phase shift oscillator and buffer, with speed and depth controls whose varying DC output is connected directly to the control port of the 1537A module. The frequency range of the oscillator is approximately 2 to 5 Hz. Altering the values of all three capacitors will change the main frequency, though that stated will give the best results.

The control voltage in the last application was varied as a sine wave of course, but there is no reason why other waveforms eg square, could not be used for control purposes. Figure 9 shows a 555 operating in the astable

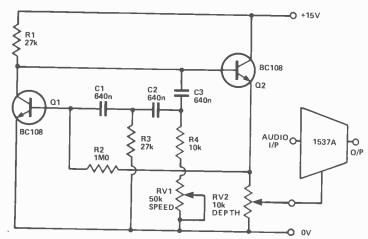


Fig. 8. A simple tremolo circuit.

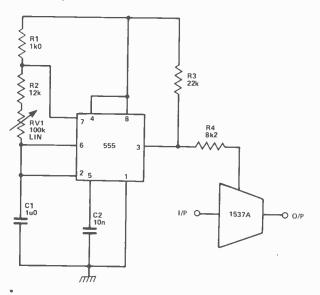


Fig. 9. A Dalek type sound generator.

mode with a frequency range of approximately 5-50 Hz. The output signal will be modulated with the square wave and the overall product is a Dalek type sound if a vocal signal is applied to the 1537A module.

This square wave control can be taken one stage further if the control voltage is the output from a monostable as in Fig. 10. A tone burst generator can be very easily constructed with this mode of operation. In a tone burst

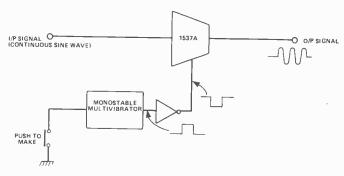


Fig. 10. A simple system enabling the construction of a tone burst generator.

generator, a rectangular envelope 50-500 uS long is formed around a single sine wave frequency of normally 1 kHz. Tone burst generators are useful for testing the transcient response of speakers, A push to make switch is used to provide the trigger to fire the multivibrator, producing the correct length pulse which in turn is inverted to form the control voltage pulse, applied to the control port of the 1537A.

The previous applications have all used automatic waveform control of the applied signal to produce the required attenuation characteristics, but this is not a necessary trait. The control voltage can be simply tapped off a variable resistor having the maximum control voltage range (ie 10 volts) across it. In this way, altering the position of the wiper alters the attenuation of the applied signal. The pot acts quite simply as a volume or level control. Ordinary non-DC volume controls can suffer from pick-up problems because the signal itself is being rotated through the pot. As only DC is applied to the pot in this application no pick-up can occur and the control can be remotely mounted from the module with no screened cable being necessary. Figure 11 shows such a volume control.

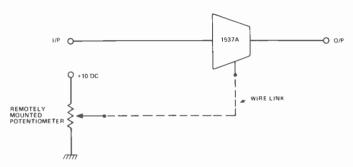


Fig. 11. Remotely (wire-linked) controlled volume control.

This remote control facility can be utilised in an audio mixer which includes remote faders for each channel. Figure 12 shows the general idea of such a circuit, An op amp is used as a summing amplifier into which the output of each channel's VCA is fed and mixed. The mix is relative to the control voltage applied from the remote faders to each VCA. The circuit allows for up to N inputs, where N to practical limits will probably be a maximum of about 12, but with careful layout techniques, there is no reason why this cannot be increased further.

Figure 13, shows an interesting outline to enable digital control of the VCA, say from a computer link. In order that the computer can operate in real-time, ie control of the VCA is not just its only job, it is necessary for the interface to provide a latch for the digital word. The output of this latch is changed to a linear DC voltage by the D/A (digital to analogue) convertor whose output is taken to the control port of the VCA.

The digital latch, once set by a strobe pulse, provides the facility that after the volume required has been found, the computer is free to perform other tasks, When the volume is to be altered, the latch is reset to the new digital input.

The last six applications of the 1537A VCA system have simply shown methods of providing a control voltage (automatically, manually or digitally) to control the module in its function as an analogue gate. The following section begins with the assumption that the control voltage is already present, perhaps by one of the previous methods.

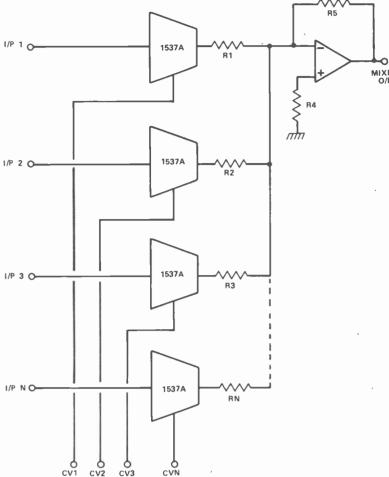


Fig. 12. High quality, remote fader controlled mixer.

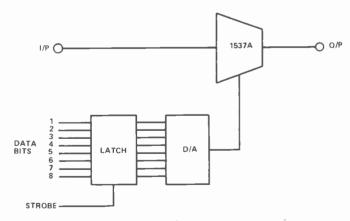


Fig. 13. Main components of a digitally controlled attenuator.

# **Applications**

Consequently the next few circuits show the system in a much more versatile role — not just as an analogue gate, but one in where the system itself becomes part of a larger system. Figures 14 and 15 give details of circuit in which the 1537A module is used in the feedback loop of conventional operational amplifiers to allow voltage controlled

amplifiers to be constructed. The resistance values used give gains of approximately 1 to 100 over the VCA control voltage range and an inverting VCAmp and a non-inverting VCAmp can be easily built as shown.

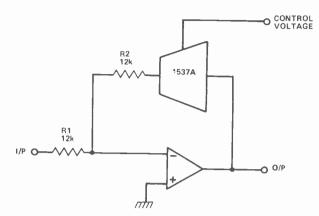


Fig. 14. A non-inverting controlled attenuator.

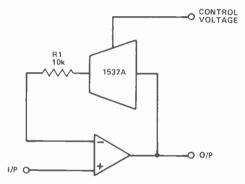


Fig. 15. An inverting voltage controlled amplifier.

A voltage controlled resistor is shown in the application of figure 16. The apparent resistance, R1, is given approximately by the formula

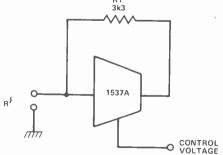


Fig. 16. A voltage controlled variable resistor.

where A is the gain of the VCA module (remembering that it has a maximum gain of unity). The value of R1 shown gives an apparent voltage controlled resistance of 7 k to 100 k over the ten volt control voltage range.

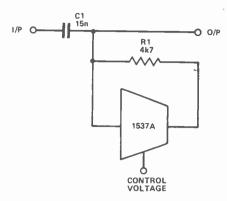


Fig. 17. A voltage controlled High Pass Filter.

The effect of a VCR (voltage controlled resistor) is used in the final two applications as the control element in filter circuits. Figure 17 shows a simple voltage controlled high pass filter. The component values shown filter out all frequencies below the variable limit of 1-2 kHz. Adjustment of the control voltage alters the lower cutoff point.

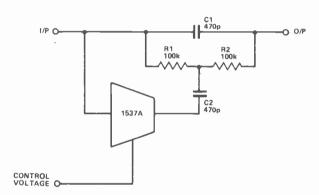


Fig. 18. A voltage controlled Band Reject (Notch) Filter.

Figure 18 consists of the circuit of a voltage controlled band reject or notch filter whose depth of notch is adjusted by the control voltage. The component values shown set the frequency at about  $300 \, \text{Hz}$  and depth of notch is variable from 0 dB to about  $-15 \, \text{dB}$ .

# **Conclusions**

The applications given in this article show the 1537A chip to be a very versatile device. It is remarkably easy to work with, a fact which is borne out by the quality (in technical terms) of the circuitry in the breadboarded fashion of our experimental design work, let alone in the modular fashion allowed by the use of our PCB layout. We can foresee many more applications of this device to come in the future. Thanks go to Aphex Audio Systems UK Ltd for their help in obtaining data on the 1537A. They are at present the only suppliers of the chip in this country and have kindly offered a 15% reduction in price to ETI readers quoting the code given in Buylines.

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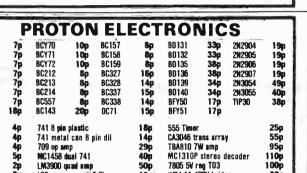
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## DESIGNER'S NOTEBOOK

### ETI's chief design engineer, Ray Marston, discusses the use of CMOS counter/divider ICs.

common task facing the electronics design engineer is that of producing simple digital counter/divider networks, which produce an output frequency or count rate that is some fixed fraction of the original input frequency or count rate. This month's 'Notebook' discusses the use of CMOS ICs in such applications.

#### 4013 and 4027 Flip Flops.

The two most basic counter/divider ICs in the CMOS range are the 4013 dual D-type flip-flop and the 4027 dual J-K flip-flop. Figure 1 shows the outlines and pin notations of these two devices, which each contain two independent flip-flop stages sharing common supply connections. Each of these packages can be used to give division ratios of 2, 3 or 4.



Fig. 1. Outlines and pin notations of the 4013 dual D and the 4027 dual J-K CMOS flip-flops.

A single 4013 'D' stage can be made to act as a divide-by-two counter by grounding its SET and RESET pins and coupling its DATA pin to its  $\overline{\Omega}$  output, as shown in Fig. 2a. A single 4027 J-K stage can be made to act as a divide-by-two counter by grounding its SET and RESET pins and connecting its J and K pins to the positive supply rail, as shown in Fig. 2b. Both of these circuits change state on the positive-going transition of the input clock signal, which must have rise and fall times of less than 5 uS. The 4013 is very fussy about the shape of its input clock signals and tends to be rather temperamental in operation. The 4027 is not too fussy about its clock signals and is very easy to work with.

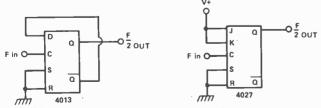


Fig. 2. Divide-by-two counters made from D-type (left) and J-K (right) flip-flop stages.

#### **Ripple Counters**

Figure 3 shows how two divide-by-two 'D' or J-K flip-flop stages can be wired in series to give an overall division ratio of four (22). Fig. 4 shows how three such stages can be

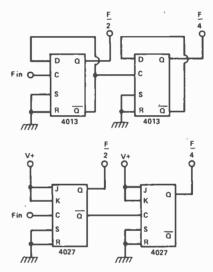


Fig. 3. D and J-K versions of divide-by-four ripple counters.

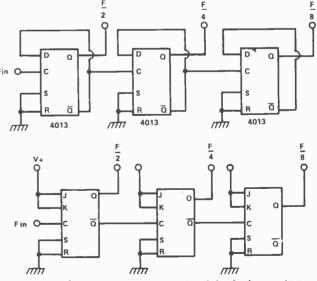


Fig. 4. D and J-K versions of divide by eight ripple counters.

wired in series to give a division ratio of eight (23). Note that' each counter stage is clocked at precisely half the rate of (an octave below) the preceeding stage, so that the clock signal seems to 'ripple' through the counter chain. Also note that, as is made clear in Fig. 5, the final division ratio is equal to 2n, where 'N' is the number of counter stages. Thus, four stages give a ratio of 24 = 16, five stages give 25 = 32, six give  $2^6 = 64$ , seven = 128 and so on.

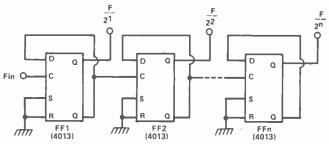


Fig. 5. D version of divide-by-2" ripple counter.

A detail not made clear in the above diagram is that, since the counters of a 'ripple' circuit are effectively wired in series, the propogation delays of the individual stages in the counting chain add together to give a fairly long total delay at the end of the chain. If each stage has a delay of 100 nS and there are ten stages, the total propagation delay is 1 uS. Consequently, the final output signal will not change state until 1uS after the arrival of the original input clock signal that initiates that change of state. The counter states of the 'ripple' type of counter are thus not in pefect synchrony with the original clock signal and this type of circuit is consequently known as an asynchronous counter.

4013 and 4027 counters can be cascaded to give any desired number of ripple stages. When more than two stages are required it is usually economic, however, to use a special-purpose MSI ripple-carry binary counter/divider IC. Figure 6 shows the outlines and functional diagrams of three popular ICs of this type.

The 4024 is a seven-stage ripple unit with all seven outputs externally accessible: it gives a maximum division ratio of 128. The 4040 is a twelve-stage unit with all twelve outputs accessible: it gives a maximum division ratio of

4096. The 4020 is a fourteen-stage unit with all outputs! except 2 and 3 externally accessible: it gives a maximum division ratio of 16 384.

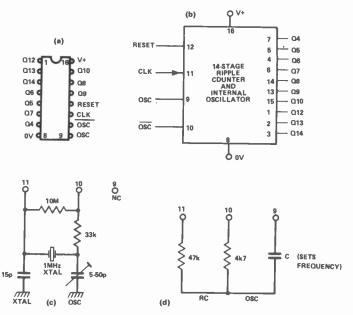


Fig. 7. Outline (a), functional diagram (b), and alternative oscillator connections (c and d) of the 4060 fourteen-stage ripple counter.

Fig. 7 shows the outline and functional diagram of a special-purpose ripple-carry unit, the 4060. This is another fourteen-stage unit, but does not have outputs 1, 2, 3 or 11 externally accessible. The special feature of the 4060 is that it incorporates a built-in clock oscillator circuit. The diagram shows the connections for using the internal circuit as either a crystal or an RC oscillator.

The 4020, 4024, 4040 and 4060 ICs are all provided with Schmitt trigger action on their input terminals and trigger on the negative transition of each input pulse. All counters can be set to zero by applying a high level on the RESET line.

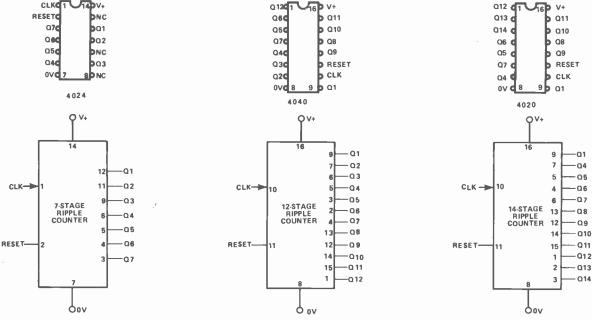


Fig. 6. Outlines (above) and functional diagrams (below) of three popular CMOS multi-stage ripple counters.

#### 'Walking Ring' or 'Johnson' Counters

An alternative to the ripple type of counter is the so-called 'walking ring' or 'Johnson' counter. In these counters, all counter stages are clocked in parallel and the stages are cross-coupled so that the response of one stage to a clock pulse depends on the states of the other stages. Fig. 8 shows the connections for making a divide-by-three counter from two J-K stages and Fig. 9 shows the connections for making a divide-by-five counter.

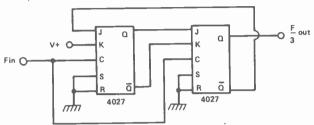


Fig. 8. J-K version of a divide-by-three 'walking ring' or 'Johnson' counter.

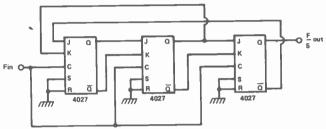


Fig. 9. J-K version of a divide-by-five 'walking ring' or 'Johnson' counter.

A major advantage of the 'walking ring' or 'Johnson' counter is that, since all stages are clocked in parallel, the outputs of the completed counter are subjected to only a single stage of propogation delay. Consequently, the system gives synchronous operation and outputs give glitch-free decoding.

#### **4018 Divide-by-N Counter**

When count numbers greater than four are required, it is economic to use MSI ICs such as the 4018, rather than the 4013 or 4027. The 4018 is a five-stage 'Johnson' counter that can be made to divide by 2, 3, 4, 5, 6, 7, 8, 9 or 10 by merely cross-coupling its terminals in suitable ways. The IC features a Schmitt trigger on its clock input line and clocks on the positive transition of the input signal.

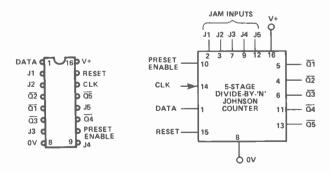


Fig. 10. Outline and functional diagram of the 4018 presettable divide-by-N counter.

Figure 10 shows the outline and functional diagram of the 4018. Fig. 11 gives methods of cross-coupling the IC to give division ratios from two to ten. On even division ratios, no additional components are needed. On odd ratios, a two-input AND gate is required in the feedback network. This gate can be a single 4081 AND stage, or can be made from two 4011 NAND stages.

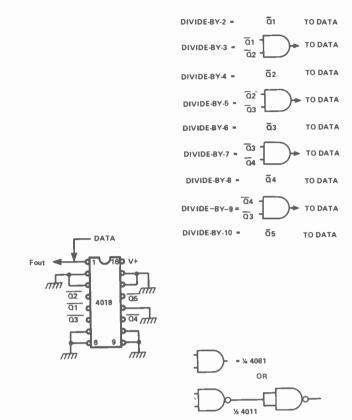


Fig. 11. Methods of connecting the 4018 for divide-by-two to divide-by-ten operation.

CONNECTIONS FOR DIVIDE-BY-N OPERATION

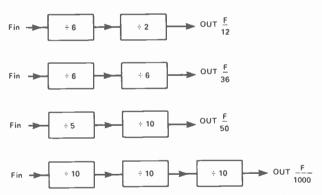


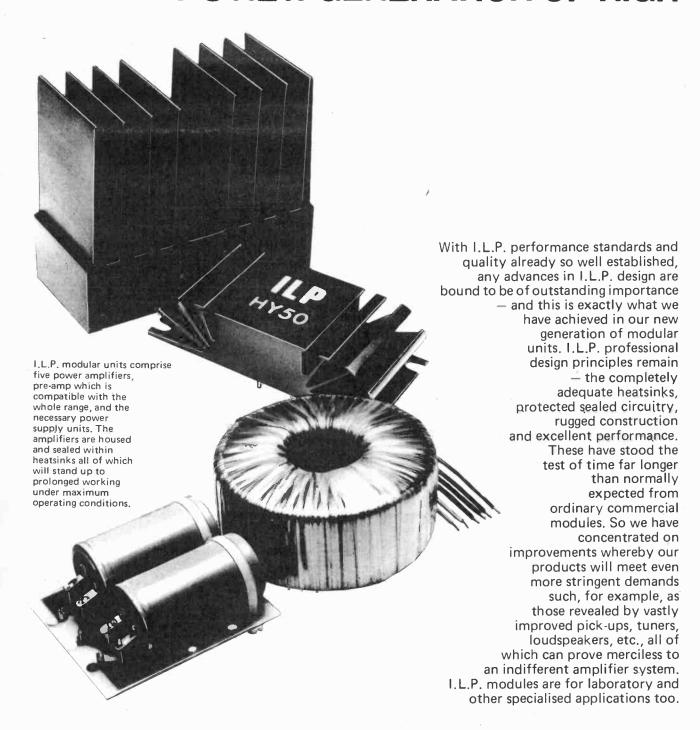
Fig. 12. Typical examples of division by numbers greater than ten.

#### **Greater-Than-Ten Division**

Even division ratios greater than ten can usually be obtained by simply cascading suitably scaled counter stages, as show in Fig. 12. Thus, a divide-by-two and a divide-by-six stage give a ratio of twelve, a divide-by-six and a divide-by-six give a ratio of 36 and so on. Non-standard and uneven division ratios can be obtained by using standard counters such as the 4018 and decoding their outputs to generate suitable counter-reset pulses on completion of the desired count.

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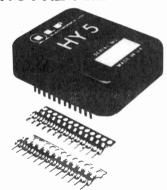
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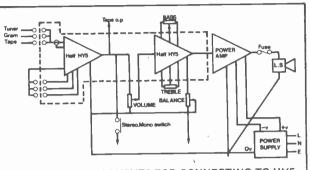
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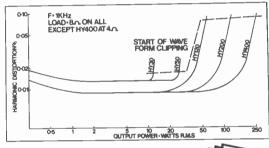


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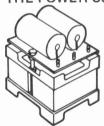


Model	Output Power R.M.S.	Dis- tortion Typical at 1KHz	Minimum Signal/ Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	80dB	-20 -0- +20	105×50×25	155	<b>£6.34</b> + 95p
HY50		0.02%	90dB	-25 -0 +25	105×50×25	155	<b>£7.24</b> + £1.09
HY12		0.01%	100dB	-35 -0- +35	114x50x85	575	£15.20 + £2.28
HY20		0.01%	100dB	-45 -0- +45	114x50x85	575	£18.44 + £2.77
HY40		0.01%	100dB	-45 -0- +45	114×100×85	1,15Kg	<b>£27.68</b> + £4.15

Load impedance - all models 4 - 16 12 Input sensitivity – all models 500 mV Input impedance – all models 100K.

Frequency response - all models 10Hz - 45Hz - 3dB

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## RAVEN ON...

## Dave Raven looks at the High Street discount war and suggests how you can spend £2500

igh street discounting is not a topic we normally discuss in the annals of a high technology magazine.

However, it does have a special relevance to ETI, since we are not against a bit of discount, but more important, the discounting of electronic goods is directly related to the subject of high technology. With 17% inflation, in what other field can you predict with confidence that prices of certain manufactured goods will fall. This ironic contradiction of market forces is brought about by the rapid development of micro-chip technology. Products which contained two components are quickly reduced to one, assembly operations are halved producing double the output, which effectively reduces the price.

This is clearly very confusing to consumers of these goods, but conserve your energy worrying about it, since the customer is on a winner. The man to spare a thought for is your local High Street retailer of electrical goods and, of course, the local jeweller. Cast your mind back to 1964 before the end of retail price maintenance. For years it was simple to place an order with a firm of reputable wholesalers who promptly deliver a mixed variety of stock items which are marked up with the usual standard profit margin and proudly displayed in the window, end of selling job. Customers came streaming in, picked up the goods and paid him his profit, thank you kindly. No point in the customer shopping around, since everything costs the same in all the shops.

Then, at a stroke, Mr Heath removed retail price maintenance, making it illegal for a manufacturer to dictate at what price his goods must be sold. In addition, our membership of the common market introduced further legislation forbidding any form of price rigging by a manufacturer. This resulted in one recent case where a company was fined nearly £200,000 by the EEC for its part in a breach of these regulations.

The effect of discounting on small traders was severe. However, they were afforded some protection by manufacturers who have blatantly broken the laws, but now, in addition to the normal type of discounting which usually works by operating on a smaller profit margin, cutting out the wholesale operation and going for a high turnover, we have the introduction of a fast moving technology which causes discounting of a new kind. This threat protects no one including the large multiple suppliers, as it takes them so long to select a product and

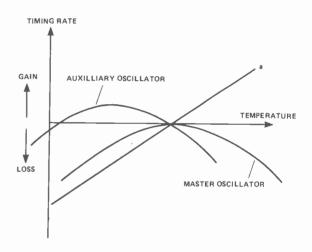


Fig. 1. The difference in oscillating frequency between the master oscillator and auxiliary oscillator is computed line (a).

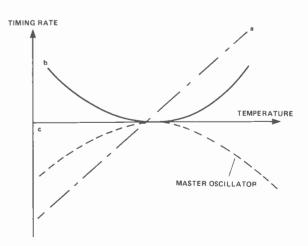


Fig. 2. The straight line (a) obtained by computation is squared and compensated for through a microprocessor in the circuit curve (b). The sum of curve (b) and the characteristic curve for the master oscillator is computed to form a straight line, which is not affected by temperature change.

promote it. Also, their buyers are not up to date with the technological changes. We now have a situation whereby the large chain stores who have grown to fame on the bulk purchase of items which are then distributed throughout their retail outlets, suddenly find that the electronic clock, watch, TV game, etc. selected for promotion in May or June is out of date and over priced by Christmas.

The effect of this during Christmas 1979 was clear to see. Apart from brand leaders such as Casio in the watch field there was little choice in the multiple stores. The shops that I did see selling unknown brands of electronic watches were grossly over priced and the product was out of date. It is obvious that buyers have been very cautious in their purchases of electronic products, probably hoping that soon there will be some sort of price stability.

The future for the small retailer in all of this looks very bleak. First he suffers a loss of trade due to discounting and now he suffers further losses because his wholesaler supplies him with out of date products at too high a price. The only way around this one, I am afraid, is for him to get his jacket off and run round to the wholesaler/importer and see what is going on. Probably he should travel wider for his purchases (even to Hong Kong if necessary).

For the big retail chain more misery is on the horizon, since the price rigging and cartel type operations which have been in existence are soon to crumble. The relevant government department has already invited companies which practice discounting such as Argos, Comet and Tesco to submit evidence of manufacturers that are refusing to supply them, because they discount. With an impending retail trade depression it seems certain that big battles lie ahead in the High Street and of course Mr. Consumer is smiling all the way to the Bank.

The loss of small local dealers for consumer electronic goods is obviously not to be welcomed, since their small size and flexibility usually provides an efficient after-sales service. In the case of jewellers selling quartz watches I think they have already shown that these are not suitable places from which to buy. Their profit margins are much too high for a product which thrives on low profit margin and a fast turnover. The servicing is minimum and a central service centre can service a large group of stores very efficiently and batteries, etc. can always be fitted at local level.

To try and forecast the future for the retail trade in consumer electronics is not easy, but it looks certain that the large multple stores will have to look closely at their buying methods and probably work closer with the very companies that are setting the price structure for microchip goods in the UK.

One company I know, whose name I would not divulge even if you inserted hot watch batteries up my nails, has increased its turnover by 20 times in three years and is all set to start discounting on the discount, so watch out Woolies.

#### **Slimming Time**

If you are not worried by the news that the Japanese are predicted to be big in making aero engines then you should be, since that is about the last major piece of technology we are still any good at. In addition to this, the sight of the latest Seiko version of an electronic watch is enough to make you give up and go home if you happen to be a watch designer. Styled in their usual superb way, these latest slimline models are as thin as some watch bracelets, which makes them look almost tasty enough to eat, let alone wear

on your wrist. The 18 carat gold digital man's watch measures a total of 1.79mm in thickness overall. The watch module is a mere 1.38mm thick including battery.

The analogue version is 18 carat gold and also only 1.79mm thick overall. The price for both models is slightly thicker than average, a real snip at £2500 each. Accuracy of Seiko watches has been improved using a traditional electronic technique of twin quartz oscillators for a temperature compensating circuit. The pair of crystal oscillators have different temperature characteristics and each of the crystal oscillators are oscillating independently. The temperature change is detected and this is then compensated for using a microprocessor which in turn corrects the watch accuracy, thus achieving an approximate accuracy of plus or minus 10 seconds a year.



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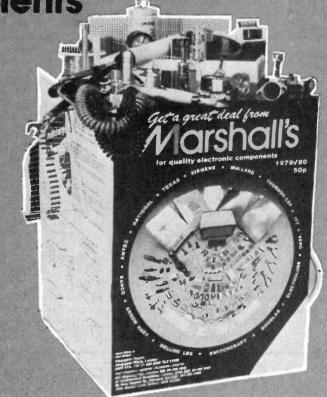
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# Month

## Hobby Electronics

### MOBILE MICROELECTRONICS



We have managed to "persuade" one of the country's leading motoring journalists into writing a feature for us. He will be taking a look at the impact electronics has been making on the world of automotive engineering and some of the advances we can expect in the next few years.

Already we have cars (if you can afford them) like the Aston Martin Lagonda that are almost completely computer controlled, is this the shape of cars to come? We think so, find out all about it next month.

#### SHORT WAVE RADIO

Have you ever wondered why there are so few designs around for really simple SW radios? We think it's because most designers are a bit afraid of RF circuitry. After all digital equipment is so easy to design, most of the hard work has already been done by the IC designer.

So, we at HE have girded the loins, put our noses to the grindstone and come up with a really first-class design for a SW radio. We won't promise it'll cover 27 MHz (after all, there's not much to listen to, is there?) on the other hand it just might. Miss next month's copy and you will never know.

#### PETTING IT TOGETHER



Rick Maybury's latest report from the west coast of America comes from the Commodore factory in Silicon Valley California where the famous PET computer is assembled. The PET is probably the best known of all the minicomputer systems and Commodore have lost no time in carving out for themselves a very large slice of the market, find out why next month.

#### TOUCH SWITCH



How would the world of amateur electronics exist without the ubiquitous touch switch? How have we got the nerve to publish another? Simple, they are easy to build and are a really great introduction to electronics.

Add a touch of class to your projects with next month's super design. Featuring novel circuitry and using only two inexpensive ICs with genuine capacitative operation we feel sure this one is going to be a winner. Ten channels are available and any one may be selected under fingertip control. Full constructional details next month. We know that you won't want to miss it.

#### **PSU MODULE**

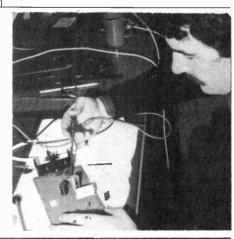
To complement the 25 watt power amplifier module we have designed a purpose-built PSU. The power supply to be described next month will happilly drive two 25 watt modules (with some to spare) and will still be relatively cheap and easy to build.

#### **25 WATT MODULE**

Here we have Keith Brindley putting the finishing touches to the prototype of the 25 Watt modular Amplifier for next month's HE. The final design will be built on a PCB and should set a new standard in medium power amplifiers. This project should be ideal for use in a home-built stereo system. Although we haven't published a purpose-built pre-amp it will happily work alongside the Tantrum pre-amp and virtually any other design, depending of course how far you want to go.

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- 1	4035 (1000ns)	1.07+	UARTS		CA3160E	1.00	MC1327P	0.95	TBA651	1.80	74LS20		74LS160	1.09	74LS373	0.78
- 1	4045 (250ns)	6.15	AY-5-1013	3.65	CA3600E	3.69	MC1330P	1.00	TBA750Q	2.84	74LS21		74LS161	0.89	74LS386	0.36
	5257 (TM\$4	8.93	MM5303	5.04	ICL7038A	3.67	MC1350P		TBA800	0.83	74LS22		74LS162	1.16	74LS393	0.84
	6810		TMS6011NC	4.30	ICL8038BC	8.82	MC1351P	1.20	TBAB10S	1.10	74LS26		74LS163	0.89	74LS668	1.17
-1	0010	3.03			ICL8038CC	3.40	MC1352P	1.35	TBAB10AS	0.80	74LS27	0.18	74LS164	1.06	74LS670	1.71
ı	20110	1	2708		ITT 7120	1.90	MC1375P		TBA820	0.70	74LS28		74LS165	0.72		
	ROMS				LF351N	0.40	MC1445L		TBA920Q	1.75	74LS30	0.18	74LS186	1.65	THE RESERVE OF THE PARTY OF	and the last
- [	2513 (U.C.)	6.25	only	T-17 3	LF356N	0.80	MC1456CG		DOGEABL	1.50	74LS32	0.26	74LS168	1.71	8 x 411	6
- 1	2513 (L.C.)	6.25	£6.25		LM301AH	0.36	MC145BCP1		TCA270Q	1.00	74LS33		74LS169	1.71		U
- 1	MM5230	4.62		155	LM301AN	0.25	MC1495L		TCA730	3.97	74LS37		74LS170	1.72	only	
-1	CPU		+VAT	5 00	LM307H	0.66	MC1496P		TCA740	3.97	74LS38	0.23	74LS173	0.81	£49.50	1200
- 1	6800	6.01	10	. 7	LM307N	0.43	MC3302P		TCA940	1.60	74LS40	0.18	74LS174	0.97		400
-	8080	5,08	Integrated Circu		LM 30BN	0.95	MC3340P		TDA1054	1,20	74LS42	0.85	74LS175	0.97	+ VAT	
-1	9900	28.05	703 (8 pin)	0.95	LM308	0.55	MEM 780		TDA 1327	0.95	74LS47	0.81	74LS181	2.77		
1	Z80	9.00	709 (8 pin)	0.35	LM318N	1.95	NE531N		TDA1352	1.38	74LS48		74LS188	0.44		
- 1	6502	9.50	709 (14 pin)	0.38	LM319H	2.25	NE540L		TDA2020	3.20	74LS49		74LS189	2.08		
1		3.00	709 (T099)	0.45	LM322N	3.87	'NE555N		TL072CP	0.95	74LS51		74LS190	0.88	041.00	0.00
п	E-PROMS		710 (8 pin)	0.36	LM324N	0.50	NE556N		TL074CN	1.50	74LS54		74LS191	0.88	21L02	40.00
н	1702AQ .	5.16	710 (14 pin)	0.38	LM339N	0.50	NE560N		TLO81CP		74LS55		74LS192	1.04		7 3
-1	2708	6.26	710 (TO99)	0.45	LM348N	0.90	NE561N		TLOB2CP	0.95	74LS73		74LS193	1.04	8 for	- 11 3
-1		24.00	711 (14 pin)	0.40	LM370N	2.90	NEB62N		TL083CP		74LS74		74LS194	0.86		- 107
			711 (TO99)	0.87	LM371H	2.05	NE565N		TLOB4CN		74LS75		74LS195	0.97	£8.50	• TIG-
	T.V. Controller		739 (14 pin) 741 (8 pin)	1.80	LM 373N	2.90	NE566N		UAA170		74LS76		74LS196	0.97		ANTON
		14.59	741 (8 pin)	0.18	LM 374N	2.90	NE567N		UAA180		74LS78		74LS197	0.97	404	11 50 5
-			741 (14 pin) 741 (T099)	0.35	LM377N	1.75	SAA 1024		ZN404		74LS83		74LS221	0.92	16 for	. 1
	Buffers		741 (1099) 747 (14 pin)	0.42	LM378N	2.05	SAA1025		ZN414	0.80	74LS85		74LS240	2.08		100000
	74365		747 (14 pin) 748 (8 pin)		LM379S	3.76	SL414A		ZN 4 1 7 E	1.90	74LS86		74LS241	2.08	£14.50	100
1	74366		748 (8 pin) 748 (14 pin)	0.33	LM380N8	0.85	SL440		ZN423T	1.05	74LS90		74LS242	2.08		8.70
1	74367		748 (T099)	0.48	LM380N	0.78	SD6000V		ZN424E	1.15	74LS91		74LS243	2.08	00.6	
	74368		753 (8 pin)	1.50	LM381N	1.45	SN75491N		ZN424P		74LS92		74LS245	2.50	32 for	THE R
-	81LS95		AY-10212	5.80	LM381AN	2.50	SN75492N		ZN425E	3.75	74LS93		74LS247	1.09		
п	81LS96		AY-1-5050	1,90	LM382N LM386N	1.20	SN76001N		ZN458A		74LS95		74LS248	1.09	£26.50	-6
п	81LS97		AY-1-5050		LM385N	0.78	SN76003N		ZN459CP		74LS96		74LS249	1.09		- 40
П	81LS98		AY-18721/6		LM389N	0.95	SN76008K		ZN1034E		74LS107		7.4LS 251	0.98	Terror of	- 1016
	8T26		AY-3-8500		LM 725CN	0.95	SN76013N		ZN 1040E		74LS109		74LS253	0.92	64 for	
	8T28		AY-5-1224		LM 1303N	2.25	SN76013ND		ZN 1066E		74LS112		74LS257	0.92		
	8T95		AY-5-3507		LM1808N	1.00	SN7601BK		ZNA116E		74LS113		74LS258	0.92	£49.50	
1	8T96		AY-5-4007		LM1812N	5.40	SN76023ND		ZNA 134J	26.95	74LS114		74LS259	1.39	All excluding	
1	8T97		CA3036		LM 1820N	1.00	SN76033N	2.00			74LS122		74LS261	4.50	An excidenty	
	8T98		CA3045F		LM1830N		SN76532N	1.55			74LS123		74LS266	0.37		
7			UA3045F	1.90.1	FIN LO 3 O M	1.98	SN76544N	1.25			74LS124	1.391	74LS273	1.70		-

1.57. CA3045F 1.40. LM1830N 1.98. SN76544N 1.25. 174LS124 1.391.74LS273 1.70.

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## AUDIOPHILE

## Ron Harris brandishes his safety raiser at a dust bug and has news for Audiophile Amp fiddlers

is a strange thing but the higher quality record deck you have, the more attention needs to be lavished upon it to keep it happy and operating. Not for the *real* hi-fi enthusiast the arm that raises itself from the groove after a hard side's tracking, thus liberating the ear from the repetitive click with which all composers, modern or baroque, somehow seemed to end every recorded piece. Oh no, it's not that easy.

It is only, apparently, upon the semi or totally automatic machines which populate the foothills surrounding peak-fi that such cantilever bending mechanisms are to be found. To be sure in the past couple of years' operation has moved ever more toward a gentleness suitable for the most compliant of stylus carriers.

Alas, though, noses still head rapidly skyward at a sniff of automation.

Not that there have not been devices marketed to add a refined touch of convenience to the first division decks before. There have. Never successfully enough, though. Anyway, wanting both my cake and digestion of it, I purchased myself the latest of this line, the Audio Technica "Safety Raiser".

Before we go ANY further, I absolutely refuse to make so much as a single pun around that name. Whatever blade at AT thought it up can keep his giggles to himself! I will simply applaud the sharp edge of his wit.

With anything resembling justice this beautifully engineered little device would sell a million. It looks superb and the action is so smooth and gentle that even the most hidebound purist must begin to question the value of listening to the run-out groove.

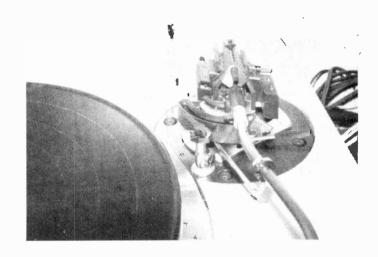
#### Lift-off

The trip lever is positioned so that it lies in the path of the pickup arm as it swings across at the end of the side. Once touched it leaps back out of the way, magnetically releasing the damped action platform to rise up and take the stylus away from all this, so to speak.

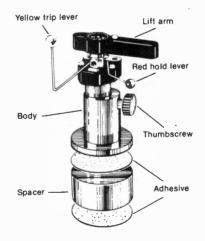
The required force on the trip lever to achieve this is so minute that it could not possibly be said to interfere with the arm anymore than would a passing butterfly breathing on it. Before fitting it I spent a good half-hour with the thing in the middle of my desk trying to touch the trip lever, without triggering the arm lift.

One thing's for sure — I ain't no butterfly, passing or otherwise. A big kid maybe, but butterfly no. Ah well, mine is not to do and fly . . .

In use the Raiser is a delight, although positioning it could prove a problem in some cases. I had a devil of a time persuading it to sit under an SME I I I such that it avoided the edge of the turntable, but reached the arm when it went for it.



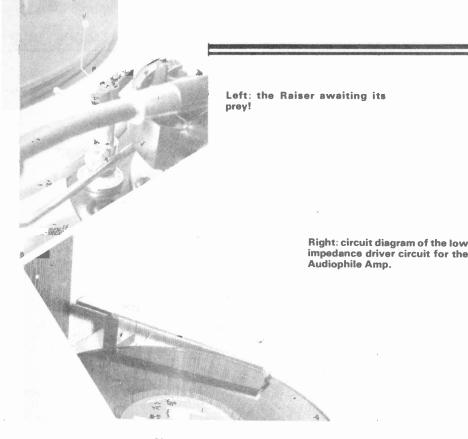
The little safety raiser in situ, i.e. stuck under the SME III, and what all the bits are for! The yellow lever is the one which the arm contacts on its way across the LP. thus triggering the action.



The height adjustment must be tightened up solidly, since you have to push the platform down after every operation and if you haven't tightened the screw enough . . .

Anyway, it's not often you can spend as little (circa £11) on the hi-fi and get such a welcome return. After all — admit it, oh ye followers of the holy musicality, there are times when you simply cannot get to the deck at once — aren't there?

No? Hmm . . . you're more dedicated to this hobby than I thought. Didn't Daddy ever take you aside for a little talk . . .?





#### Brush Up On Carbon

While I was meandering around the local audio emporium in search of the Raiser, I promised myself I'd finally replace my ageing Dust Bug — which is now so old it has a good claim to have kept the Magna Carta records clean.

After a deal of bewilderment in the face of the veritable horde of appliances vended to trail a brush across an LP, I settled on the Decca version as potentially the most useful.

Despite the varying claims for all these contraptions, their aim is usually identical. The purpose *should* be to sweep the grooves just ahead of the stylus, picking out any debris lurking therein to prevent it gathering around the diamond and suffocating its tracking ability.

Decca claim a static removal ability too, as do droves of the others. The bristles of the brush are conductive carbon fibre and an earth return lead is provided to attach to the deck earth. The scheme is that any local static charge will be grounded by the passage of the brush before the pickup reaches it.

Besides all this I simply thought the Decca was a nice looking little device and a bit more individual than most.

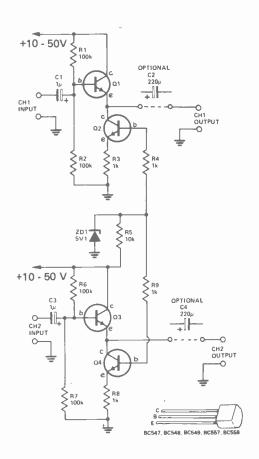
Since I've been using it I can report a definite drop in perceived surface noise, quite dramatic at times in fact. It seems that earth path *does* lead somewhere after all.

The device has been around a while I know, but has probably been buried under a mound of similar offerings from beyond the edge of the Empire in a lot of shops.

It deserves better! It works very well indeed — at least give it a look over next time you're browsing around, the brush-off would be un-just!

#### **Audiophile Amp**

Amongst the many bits of paper with stamps on that that funny little man with the flat cap (and head?) keeps dropping all over our floor every morning has been some correspondence on the Audiophile amp.



#### PARTS LIST

Resistors — All ½W, 5% R1,2,6,7 100k R3,4,8,9 1k0 R5 10k

Capacitors

C1,3 1u0 35V tantalum C2,4 200u 35V electrolytic

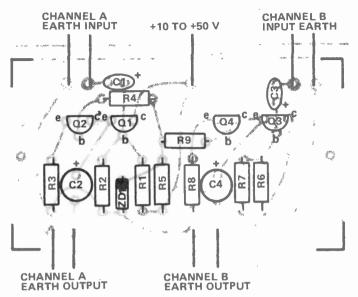
Semiconductors

ZD1 5V1 400mW zener Q1-Q4 BC547, BC107 etc.

It seems that some fickle fiddlers out there are using the power amps of this superb design, but not the pre-amp. Tsk, Tsk terrible people. Anyhow this may just cause problems. Our pre-amp was designed as a low impedance driving source for the power amps, the input impedance of which varies with frequency from a few kilo-ohms at extreme LF to hundreds of ohms at the top end.

If you go driving this with a high impedance output, the amplifier will load down the driving current at HF, causing distortion. With a low output impedance pre-amp (50R) no symptoms need be expected. However it is for the rest I speak these words of doom.

As there is no chance of anyone out there abandoning the idea of separating the Audiophile system, it falls to us to do the decent thing and provide a low impedance driver which will allow greater compatibility with the universe in general. The circuit given here will do just that.



Above: component overlay for the low impedance driver circuit. The PCB is to be found hiding with the rest of its kind.

It consists of two emitter followers, Q1 and Q3 with constant current generators in their emitters. Both the latter share a common reference, ZD1, which feeds the bases of Q2 and Q4, setting their emitter voltages at 4V4.

These transistors will always pass the exact amount of current required to maintain that emitter voltage, regardless of supply voltage. The constant current generators are to limit supply current and dissipation of the emitter followers when used with a high supply rail. It also lowers output resistance.

Output is derived via the optional blocking capacitors C2 and C4, which can be omitted if our modules are ALL you're driving with this buffer, but as we don't trust you . . . . Fit them if any other equipment at all is to be linked to the circuit. Replace the C1 capacitor in the power amp with a 220u (35V), with positive lead towards the input, if you leave out the blockers.

We've provided a PCB layout which we would advise using, and be careful with earthing arrangements — use the signal earths wherever possible.

#### **Trailing Trailers**

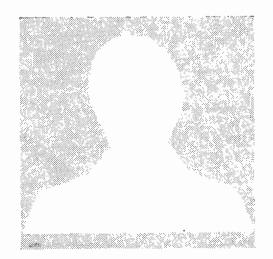
Next month I'm taking a look at some of the best of budget hi-fi. A heated conversation arose here some little while ago about just what level of fidelity could be obtained for £300 or less.

Everyone had their own ideas and tastes. Trouble is some of the combatants showed a deplorable *lack* of taste — would you believe not all of them had the sense to see that Felicity Kendal is the most beautiful woman in creation. Given that obvious blind spot in their make-up how can one possibly listen further?

I went ahead and assembled my £300 system despite the heathen howling hereabouts, and am presenting the results next issue.

I must confess there is one component I am not entirely happy about, but the amp and cartridge are real gems and together barely cost £100.

## ETI NEEDS YOU!



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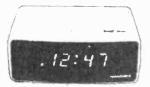


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1st-2nd place times.
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per month.
Battery 12 months. M24



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M36

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M30

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M33



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## **ELECTROMYOGRAM**

ETI's latest biofeedback box converts the electrical impulses associated with moving a muscle - any muscle - into observable outputs. Either audio output or a meter reading can be obtained and if you can't relax with this, try reading ETI again!

he design and construction of an electromyogram presents some unique problems. The object is to detect the minute electrical signals produced by the 'firing' of muscle fibres in a particular muscle. For our purpose metal electrodes of some sort are attached to the skin over the muscle(s) of interest. For a relaxed muscle, these signals are fractions of a microvolt in amplitude. That's a small enough signal to detect on its own without having to find it amongst volts of 50 Hz hum that will be present in the body — induced from power and light wiring.

When the body is grounded, this hum will drop to typically one volt peak-to-peak, but trying to see one microvolt in one volt of unwanted noise (50 Hz hum here) isn't easy.

The overall block diagram of the unit is shown in the drawing.

Battery operation is essential as, with any device connected directly to the body, the possibility of accidental contact with mains potential from a mains-operated unit is very real — with lethal results.

The instrument is called upon to detect quite small signals in the presence of large amounts of noise. It should have variable gain control - adjustable by the user, a threshold control so that small variations of a large signal may be readily detected, a visual indication (a meter) and an audible output that follows the convention of rising pitch or pulse rate for increasing muscle activity, and vice versa. Also some form of bandpass filtering to sort out the predominant muscle signal which is in the 100 Hz to 500 Hz range, and selectable integration of the feedback response was considered desirable.

Biasing the differential input stage is important and this is discussed in the "How it Works" section. One trimpot is used to set up the input stage for correct operation. Once set up, any of the component values may be varied by +/- 10% without affecting the CMRR.

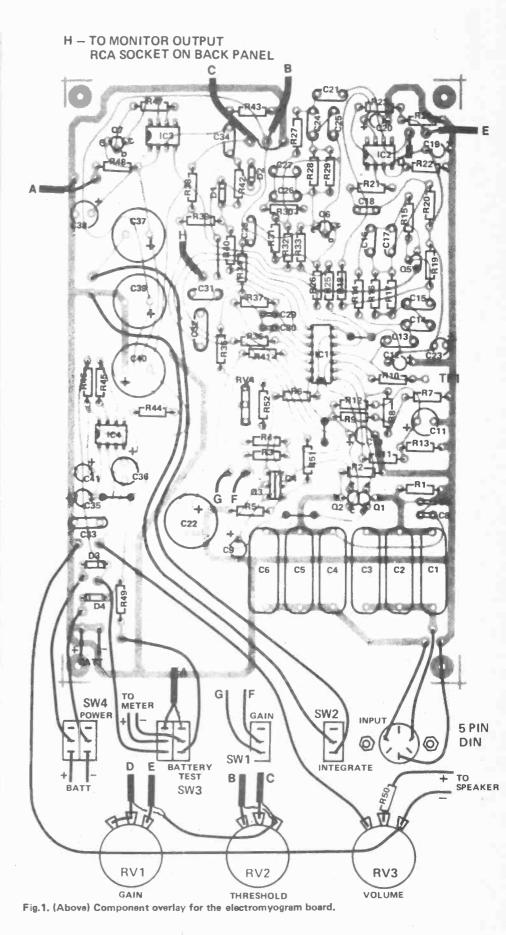
The choice of this type of first stage has resulted in a very low noise figure. The prototypes (we built two) had measured noise figures close to 150 nV at the input. This equals the performance of the best commercial units we have seen.

To provide some integration of the muscle activity level, so that the meter and audible responses are not too rapid (as researchers have found undesirable in some instances), switched capacitors are provided to provide integration times of about 0.5 second and 4 seconds — selected by a front panel switch.



#### PARTS LIST

PAR	TS LIST
Resistors Al	1 ¼W, 5%
R1,2,18,	220k
31 R3.7.9	4k7
R3,7,9 R4,25,26	100R
R5,6	2M2
R8,10,11, 22,23,40,41	1M0
R12,45	1k0
R13 R14-17,	8k2 47k
27-30	
R19,32	270k
R20,24,33, 38,39,42,47	10k
R34	330k
R35	560k
R36 R37	5M6 3M3
R43	390k
R44 R46	470k 680R
R48	2k7
R49	18k
R50	27R
Potentiomete	
RV1 RV2	1M0 linear
RV3	5k0 linear 1k0 linear
RV4	1k0 trimmer
Capacitors	
C1-C6	1u0 polyester
C7,8,29,30	1n0 polyester 33u 16V tantalum
C9,10,12, 19,20,23,35,	350 TOV tantatum
41	
C13,31,34,	100n polyester
C14-17,	68n polyester
24-17 C11,36	100u 25V
C18	22n polyester
C22,39,40 C28	1000u 25V 47n polyester
C32	220n polyester
C33 C37	150n polyester
C38	470u 25V 47u 25V
C	
Semiconduct D1,2	ors 1N914
D3,4	1N4004
Q1,2 Q3,4	BC559 BD140
Q5-7	BC549
IC1	LM3900
IC2,3 IC4	741 555
Switches	CDCT



SPST

**DPDT** 

SW1,2

SW3,4

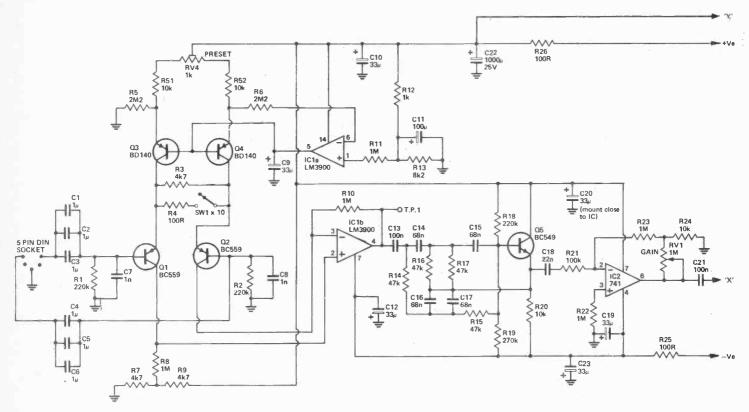


Fig.2. (Above) Circuit diagram of the unit. Note the battery connections carefully.

Since the circuit is fairly complex, a detailed analysis of its operation is best tackled by looking at the individual stages in turn,

from input to output.

Input signals from sensors on the body drive Q2 and Q1 which are arranged as a differential pair. Emitter current, and thus collector current, for Q1 and Q2 is derived from a precision constant-current source comprised of Q3, Q4 and IC1a. Transistors Q1 and Q2 share the current supplied by the constant-current source. If Q1 (for example) is driven harder, by an input signal, than Q2 then, while the collector current of Q1 increases, there will be a corresponding decrease in the collector current of Q2.

Now, the collectors of Q1 and Q2 are each connected to the input of IC1b, one amplifier in an LM3900 (a quad op-amp package). The amplifiers in the LM3900 package have the special feature that they amplify current differences applied to the

inputs.

To ensure a high common-mode rejection ratio, the quiescent (no signal) collector currents of Q1 and Q2 must be held very close to a fixed amount. Hence, the preci-

sion constant-current source.

To derive this constant current source for Q1 and Q2 the two bases of Q3 and Q4 are driven by the output of IC1a. The non-inverting input (marked +) of IC1a is driven by a fixed voltage derived from a voltage divider (R12, R13) from the positive supply rail. C11 is a bypass capacitor to prevent supply rail variations modulating this reference voltage.

The inverting input (-) of ICla is coupled to the emitter of Q4 placing this transistor in the feedback loop of ICl. The

op-amp (IC1a) will attempt to maintain the current flowing through its inputs at a constant level, thus maintaining the base-emitter current through Q4, and therefore the collector current, constant at nominally, 100 mA. Assuming Q3 has similar gain to Q4, its collector current will be the same. The 1k preset, RV4, allows adjustment of the two collector currents to offset any slight differences in gain.

The input stage gain is determined by the value of the resistance between the emitters of Q1 and Q2. The lower this resistance, the higher the gain. The 'x 10' switch simply connects a 100 ohm resistor in parallel with R3, increasing the gain.

Capacitors C7 and C8 ensure high fre-

Capacitors C7 and C8 ensure high frequency stability through by passing the bases of Q1 and Q2 at frequencies above the range

of interest.

To ensure good common-mode rejection ratio, it is essential that the bases of Q1 and Q2 each receive the same level of input signal. As the input is AC-coupled the characteristics of the input coupling capacitors must closely match each other. If stranded 10% capacitors are used the slightly different impedances of each will limit the common mode rejection. The solution we adopted was to use several capacitors in parallel so that the slight capacitance variations, and corresponding impedance variations, average out. It is important therefore that these six capacitors, C1-C6, are all the same type.

Supply rail decoupling for the Input stages is provided by R25, R26 and C22, C23

Two 50 Hz hum filters are employed, as can be seen in the block diagram, one

immediately following the differential input stage, the other between the variable gain stage and the band-pass filter.

Both 50 Hz filters employ a 'twin-T' circuit — as used in our Hum Filter project, ETI 451.

In the first hum filter, Q5 is connected as an emitter follower, the twin-T components connected to provide feedback at 50 Hz. In order to obtain a high circuit Q and thus good rejection at 50 Hz, the value of the resistance formed by R16 and R17 (parallelled) must be as close as possible to half the value of R14 and R15. As the latter are 47k resistors, the best way to obtain a value of half that is to connect two 47k resistors in parallel.

Similarly, for the second hum filter, Q6 is the active component and the filter consists of C24, 25, 26, 27 and R27, 28, 29 and 30. Resistors R28 and 29 form a resistance half that of R27 and 30 to provide good resisting at the patch forgus at th

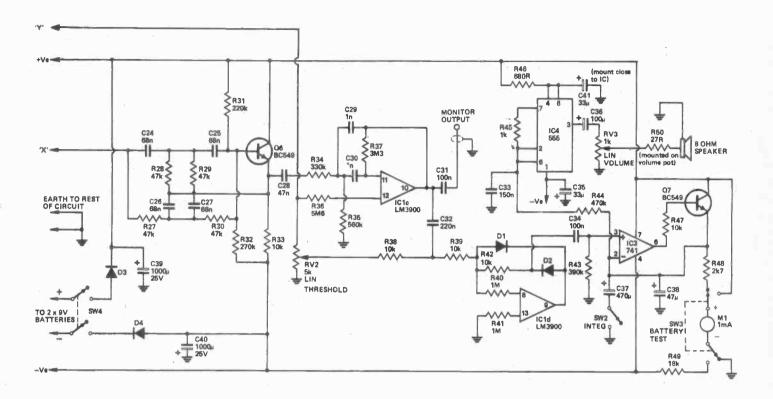
rejection at the notch frequency.

These stages provide a total of 20 dB

rejection at 50 Hz.

Following the first hum filter is a variable gain stage employing a 741 op-amp. This is quite a conventional amplifier, gain variation being provided by RV1, a 1M potentiometer connected in the feedback path of the 741. RV1 is a front panel control. Gain is variable between 10 and 1000.

To avoid problems arising from large output offset voltages and unstable gain settings, the feedback for the 741 has been arranged via a voltage divider consisting of R23 and R24, the gain potentiometer being connected between the op-amp output and the junction of these two resistors.



#### HOW IT WORKS

The gain of the circuits is given by the equation:

GAIN = 
$$\frac{R_{23} + \frac{R_{23} RV1}{R_{24}} + RV1}{R_{21}}$$

Signal levels at the output of the variable gain stage are around 1 V. Any hum exceeding this level could easily cause clipping in succeeding stages and the purpose of the second hum filter is to prevent this.

The bandpass filter employs one op-amp from the LM3900 package, IC1c. A filter network, consisting of R34, R35 and R37 and C29 and C30, is connected around a feedback path between the op-amp output and its inverting input. This provides a bandpass extending from 100 Hz to 500 Hz which encompasses the range of interest for the muscle fibre signals. At midband (250 Hz), the gain of this stage is roughly four.

A monitor output is taken from the output of IC1c so that the muscle activity waveforms (filtered) may be viewed on an oscilloscope if desired.

This consists of a precision rectifier that passes only the positive peaks of the signal that are greater than a presect DC voltage—determined by potentiometer, the theshold control on the front peak.

determined by potentiometer, the theshold control on the front panel.

The output of the bandpass filter is mixed with a DC voltage derived via the positive supply rail by the potentiometer RV2. The resultant signal — the AC muscle activity signal superimposed on a DC voltage

— is then applied to the input of the precision rectifier. This involves IC1d, D1 and D2 and resistors R39, 40, 41 and R42. The latter two resistors convert the current-differencing input of the LM3900 into a conventional voltage-input op-amp.

Positive-going signals of less than 0.6 V above the voltage present on the junction of R39 and R40 will be amplified by the full open-loop gain of IC1d. The output of this stage increases rapidly until D2 conducts, the stage then has only unity gain (x 1), determined by the ratio of R42 and R39.

Output from the precision rectifier is taken from the cathode of D2 and will consist of the amplified, positive-going part of the muscle fibre signals that are above the positive voltage set by the threshold potentiometer, RV2.

Diode D1 ensures that the gain of the stage remains at unity gain for the negative-going portions of the muscle fibre signals from the output of IC1c.

This consists of an op-amp (IC3) with an emitter-follower stage (Q7) connected in the negative feedback path. The emitter of Q7 drives the meter.

The threshold stage output is coupled to the input of IC3, a 741, via a 100n capacitor, C34. Resistor R47 limits the base current of Q7 to a safe value as the 741 will provide much more current than the transistor will stand! A signal from the output of the threshold circuit will be amplified by IC3, causing Q7 to turn on, charging C38.

The meter is connected to 'read' the charge on C38, via R48. The more signal that appears above the threshold, the longer Q7 will be turned on, increasing the charge in C38, thus increasing the meter reading. The circuit will respond quickly to increasing input signals, showing a corresponding increase in the meter reading. As the signal decreases, with decreasing muscle activity, the meter reading decays at a rate depending on the capacitance between the emitter of Q7 and ground. This provides for some integration of the signal level variations.

The integrate switch, SW2, connects a 470 u capacitor C37) in parallel with C38 (47 u). With this in circuit (integrate switch 'on'), the meter takes some four seconds to drop from full scale to zero.

This provides an audio output, consisting of a series of pulses, the repetition rate being an indication of muscle activity.

The emitter of Q7 is coupled to IC4, a 555 timer, via R44. Current through this resistor charges C33 until the voltage on pin 6 of IC4 reaches 2/3 of the voltage on pins 4 and 8. At this point, pin 7 of the 555, previously appearing as an open circuit, will conduct discharging C33 via R45. Once the voltage on pin 2 drops below 1/3 of that on pins 4 and 8, pin 7 returns to an open circuit condition, allowing C33 to charge again. In this manner, the 555 oscillates providing pulses on pin 3 to the speaker, via RV1 which serve as a volume control. As the voltage at the emitter of Q7 varies according to the variation in muscle activity signals, the rate at which C33 charges will vary. This varies the pulse repetition rate of the 555 oscillator in sympathy with the variations in muscle activity.



The case will hold the PCB, batteries and the loudspeaker. Note the positions of the front panel controls.

The audible output is derived from the meter drive so that it corresponds with the visual feedback response provided by the meter. This consists of a voltage-controlled oscillator (VCO) that provides a series of pulses to drive a speaker. The VCO employs a 555 timer IC.

Originally, it was intended to use a tone for the audio output. However, battery consumption on the prototype was almost 150 mA — at best! Battery life would be very limited at this consumption. A class A audio output stage is necessary to provide a tone output, and these are quite inefficient. Using a pulse output enables us to reduce the total current consumption to 20 mA.

#### **Muscle Building**

Construction is best commenced with the board. This method of construction is recommended as layout of the various stages is critical to avoid feedback or interaction between stages as one LM3900 package does sterling service in several parts of the circuit!

Assembly of the board should start with the resistors and capacitors. We found it easier to leave the six 1u input capacitors until the input transistors (Q1-Q4) were mounted. Be sure to check the polarity of the electrolytic and tantalum capacitors.

Finish loading the baord by inserting the diodes, transistors and ICs. The input transistor pair, Q1 and Q2, must be mounted so that their flat faces are touching to provide thermal coupling. The best way to do this, to avoid straining anything, is to solder only the collectors and emitters of Q1 and Q2 at first. Smear some thermal paste on the two flats and then tie the two transistors together using a link of enamelled (coil) wire - this prevents the possibility of shorts to the transistor leads should the loop slip off at some time. Tighten the loop by taking the ends in a pair of pliers and twisting until the transistors are held tightly together. Once this is done, solder the base leads.

The two BD140s, Q3 and Q4, also need to be mounted together. As they are in TO-126 packages they may be bolted together. It is necessary to use an insulating washer between them to prevent the collector contacts touching. Use thermal paste to improve the thermal coupling.

Once these devices are mounted, six 1u input capacitors may be soldered into place.

If you use board pins, the external connections to the board may be made after it is mounted in the case, otherwise, now is the time to attach all the leads going to the externally-mounted components.

#### **Pinned Down**

As high gain stages are used in several places, the circuit is sensitive to noise or signals radiated from other parts of the board. The 555 VCO output can be especially troublesome, so use shielded cable to connect the output of the 555 to the volume control. The only resistor not mounted on the board (R50) is mounted between the wiper terminal of the volume control and one of the loudspeaker terminals.

There are a number of other connections that should be made with shielded cable and these are shown in the wiring diagram.

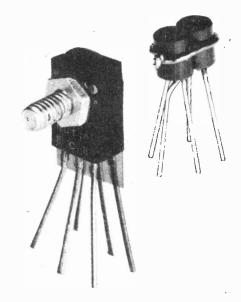
There is sufficient room inside the cabinet to accommodate a variety of 9 V batteries. The type of connection to the battery will depend on the particular style of battery used.

The speaker is mounted on one side of the cabinet and the monitor output (and RCA coax socket) is mounted on the back.

On the front panel, the switches should be mounted first, followed by the pots and the meter.

Although the common mode rejection of the input is better than 100 dB this will be degraded drastically if the contact to the skin is not good enough. To enable the input stage CMRR to effectively reduce 50 Hz hum it is necessary to ensure that the hum is exactly the same level on both inputs. For this reason the construction of the electrodes is very important.

The two input leads are made by soldering the centre conductor of the shielded cable to small metal discs about the size of 5p pieces. Cut the earth braid back enough so that it cannot touch the electrode. The braids of the two input cables are connected to pin 2 of the five-pin DIN plug (the grounded pin). This pin is also connected to the shield



Thermal stabilisation is achieved by mounting the input transistors together as shown and described in the text. Note the insulating piece between the BD140s.

#### **BUYLINES**

The design uses no unusual components, despite its complexity. The electrodes can be made at home easily enough, although commercial units, we believe, are available. Any of the bio-feedback firms, Aleph One. etc will be able to supply.

of the third cable which becomes the ground electrode. The centre conductor of this cable is not used and the other end of the braid is soldered to another metal disc. Use a slightly larger disc (about the size of a 10p piece) as this helps to ensure a good ground connection to he body.

Before powering up, check the board. Check the orientation of all the polarised components - electrolytic and tantalum capacitors, transistors, ICs and diodes. If everything is all right, switch the unit on with the battery switch in the test position. With 9 V batteries the meter should read about 9. If the battery switch is now switched off the meter should immediately fall to zero provided the gain control is turned fully down. If the volume control is turned to full on a slow clicking should be heard.

Now, measure the voltage (with respect to earth) at the test point (TP1) at the output IC1a (pin 4). With the x10 switch in the x1 position adjust the preset pot to obtain zero volts.

If the gain control is now increased, the meter reading will move along with the frequency of the clicks.

#### **Threshold Advances**

Now, advance the threshold control and the meter reading and click frequency should decrease. This threshold control works by varying the minimum signal required to cause a meter response. The higher the threshold control is set, the higher the input signal must be to cause a meter response. The threshold can be set just above the noise level so that even a very small input signal can be detected.

The electrodes can now be connected to the body and plugged in. The ideal way to secure the electrodes to your skin is to use a band of Velco tape, although we found Bandaids okay. If all three electrodes are placed reasonably close to each other along the inside of the arm (earth between the others) they can be secured in place all at once with a single wide band of Velco wrapped right around the arm. Some electrode paste may be used between the electrodes and the skin to improve the contact. This is available from some distributing chemists and medical suppliers, although it is relatively expensive. We found moistening the electrode to be a good alternative.

Once the electrodes are attached to the arm and plugged into the EMG monitor a reading should be easily obtained. Start with the gain and threshold controls set fully anti-clockwise, the gain switch in the X1 position and the

integrate switch off.

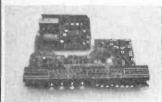
If the arm is tensed the meter should indicate muscle activity readily. With these settings the EMG is really acting as a strength meter. Relaxing the arm, the gain switch can be switched to the x10 position and the gain control slowly increased. With each gain increase, the threshold can be increased slightly to cancel any increase in noise that may have occured, although don't overdo the use of the threshold control until you are familiar with the unit as it is easy to cover up muscle activity as well as noise.

Eventually you should reach a stage such that the gain control can be set at maximum but with muscle activity held so low that the meter reads about 2 to

3. This isn't easy!

Some experimentation with electrode placement will indicate how to get good results on particular muscles.

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mv for rated output.

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## ELECTRONIC TRANSLATOR

lan Graham reports on his adventures with the Brainbank electronic information centre.

hilst phrase books are valuable little tomes for those of us with the 'why can't foreigners speak English?' syndrome, it can be infurating to have to thumb through the food, health and shopping sections to find out how to ask an impatient Parisian police person where their copy of Blackpool Tower is.

As I see it you have two alternatives. You could follow Jonathan Miller's observation of the British abroad. If you speak to a foreigner loud enough and sufficiently slowly, clearly enunciating every word, he's bound to understand you . . . eventually. The assumption is that all foreigners can speak English perfectly well, but are too bloody-minded to use it.

However, if you don't suffer from galloping xenophobia, you will accept that some of the onus of being understood abroad lies with you. Wouldn't it be simpler if you could select the word you want from hundreds of others without going through the others first? The Ami Memory System allows you to do that and a lot more.

#### **Multi-Access**

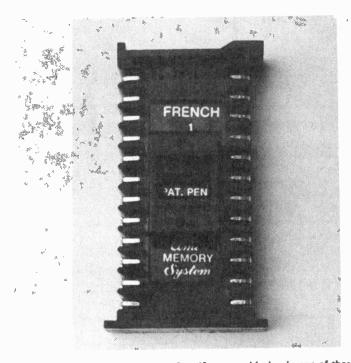
Although it can be used as a calculator and a desk diary, its chief use (and the reason why it's likely to be bought) is as an electronic translator. It can cope with single words and short phrases. You can also get at the words in a number of ways.

Four stores are accessible through the keyboard. Buttons L1, L2 and L3 permit access to plug-in memory cells. L4 is a general-purpose on-board memory. It contains common imperial/metric conversions, gallons to litres, etc and over twenty common words and phrases, available in French, Spanish and German.

#### **Button-Pushing**

On receiving the 'Brainbank', the first thing you must do is turn it upside down. Some of its capabilities are inscribed on its botty.

If you know the word you want to translate, you can punch in the English word. On the model I had, L1 was in English, L2 French and L3 German. So, to translate your word into French, just press L2, the screen blanks for a moment, then up comes your translation. It couldn't be simpler.



Schooldays might be a bit more fun, if you could plug in one of these to learn French. It's one of Brainbank's memory cells.

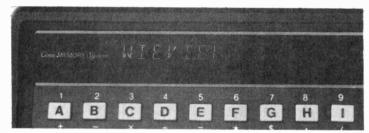
#### Re-Search

But what happens if the Box of tricks doesn't know your word? Let's take an example. Translate ABILITY into German. When you punch in ABILITY and press L3 for German, each letter is miraculously transformed into a dotless question mark. The Brainbank doesn't understand you. You can now press the SCH (search) key. The machine will then start taking letters off the end of your word until it recognises what is left and can compare it with words it knows. ABILITY is cut down to AB. Brainbank (or BB to its friends) will then go through its store of English words beginning AB. The first one is ABLE. So, you can now have a bash at forming your sentence a slightly different way.

If you're not a superb speller of the Queen's lingo, the search facility eliminates any difficulties arising from your own bad spelling. You can see the memory cycling through all the possible words on the display.







At the touch of a button you can translate straight from English to French or German and vice versa.

Although L1 is programmed in English, you don't have to swap the chips round in order to translate, say, from French into English. As you're strolling down the rue and you see an arrow directing you to the gare, switch BB on, press L2 (for French), punch in GARE and press L1 (for English) — Up flashes TRAIN STATION.

#### **Phrases**

If you want a well known phrase, the chances are that you won't have to enter the whole thing, letter by letter. Have a look at BB's botty again. You can press PHR (phrase) plus any one of 26 letters, each of which represents a word or a complete phrase. For instance, pressing PHR plus V will enter 'Do you change traveller's cheques?' Pressing PHR twice plus a letter will enter partial phrases eg PHR PHR D

will flash 'I am looking for . . .' on the display.

You can also access words by category eg pressing HOTEL plus LRN will make BB cycle through words relating to hotels. Pressing LRN again stops the cycling process and you can translate the word you want.

#### **Summing Up**

BB can also be used as a calculator, albeit a rather slow one. The calculation of two times four takes around three seconds, so BB is unlikely to be bought as a pocket calculator alone. However, it is convenient to have the simple four function calculation facility built in. It saves carrying an extra box around.

#### **Extras**

BB has one or two luxury extras. If you would prefer to see the words moving from right to left across the display instead of flashing up at the same end everytime, you can do just that with the ROT (rotate) key.

If you can soak up the words faster than BB's standard rate you can speed things up with the F/S key.

#### **Hardware**

Six plug-in language cells were available when we first heard about BB (English, French, German, Spanish, Italian and Portuguese) with Japanese and Arabic due in the following weeks. Each cell holds 1200 of the most common words, together with 25 complete and 25 partial phrases. Uprated cells containing 9,600 words should soon be available. That's good news, as even 1200 words is rather restricted.

Cells covering pronunciation, diet and nutrition, first aid, taxation and a thesaurus are already complete. A cocktail mixer guide, a spelling guide and word games and puzzles are on the way. Blank cells which the user can program through the keyboard are also imminent.

The Brainbank is powered by four HP7-size cells (giving ten hours of continuous operation) or by rechargeable nickel cadmium batteries.

Your cheque for £150 or thereabouts will buy you one Brainbank, complete with mains adaptor, battery charger and one free cell. Extra cells will cost less than £20. Brainbank is marketed in the UK by Ring Electric.

If you want to see Brainbank 'in the flesh', it is on display at the 'Challenge of the Chip' exhibition at the Science Museum in London until June.



One criticism of Brainbank is the keyboard layout. A QWERTY board would be much quicker to operate. You can use the superior symbols and numerals by using the shift button just as on a normal typewriter OR by pressing the EXT button, you can use Brainbank as a calculator until the next time you press the CLR button.

#### Greenbank

Greenbank Electronics (Dept T3E) 92 New Chester Road, New Ferry Wirrsl, Merseyside L62 5AG (Tel: 051-645 3391)

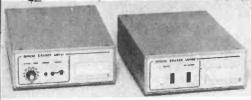


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#### **COMPUTER BOARDS**

The following is an extract from our leaflet ref. "MP4", which is evailable 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 ourchased.

development system is almost essential, nowever in the past to tribles and 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 combined store to combine the combination with a combined strobe called "valid memory address and phi-2". With some processors, the same address bus can be used in the processor of the processors, the same address bus can be used in phi-2". With some processors, the same address bus can be used in phi-2" with some processors, the same address bus can be used of both memory and input/output request control line. Naturally, if a development and takes advantage of any of the particular unique features of any particular microprocessor, this makes it more difficult to graft some other unrelate microprocessor onto the same bus at a later date. A Universal Micro are 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 of the same bus as the strong the data input (Keyboard) and output (VDU) in the memory space then such chips as the 8080 / 280 family, which normally use input/output ports, can now be used without any fundamental change to the bus (and as a bronus, users of these MPU's have all the ports entirely free for the constraints of the same and the same processor of the same processor.

bus (and as a boinus, 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 (4 ½" x 8") except for the larger power PSU A power supply card. This latter card is sized so that it can be bottled to the side of a standard 4"chassis module which is then compabile 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 connextions (42), against such standards as the "\$100 100-position bus. The \$5.100 bus, as it originated in America, is bigger and better. It's some way, a Ford 'Granada' is bygger and control of the position of the position with doesn't mean a Cortina isn't good value be better value!

The International Size of the position 
NEW! ISBUS-1.1

as it originated in America. Is bigger and better, life and was a cortinal soft good was better related. But it tows — it may own tows posterns. These modules — standard and a variety of modules — standard and a variety of modules — standard and a variety of use of was a computer is virtually with the control of the con

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## HEATER CONTROL

A hyper-efficient circuit that can be used to give automatic precision control of any electric heater unit with a power rating not exceeding 3 kW. The unit can maintain room temperatures to within 0.5 C of a pre-set value

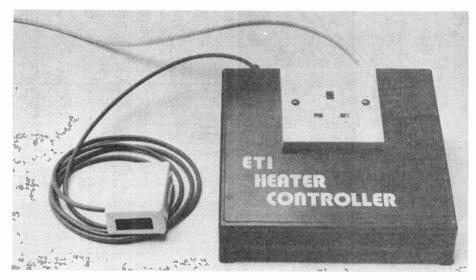
his unusual project is designed to impart automatic precision electronic control or regulation to virtually any electric convector or radiant bar heater with a power rating not exceeding 3kW. The heater is simply plugged into the electronic controller, which uses a remotely-mounted sensor/control unit to sense room temperature. The circuit can maintain the room temperature within 0.5° C of a pre-set value. Desired temperatures can be pre-set via the sensor/control unit.

The action of the ETI controller is such that, when first activated, it turns the heater on at full power until the room temperature rises to within a degree or two of the desired temperature and then progessively reduces the heater power output until the precise desired temperature is attained. From that point on, the controller maintains the room temperature within 0.5°C or so of the desired value and automatically adjusts the heater power output so that it exactly balances the thermal losses of the room: if an additional person enters the room, the controller reduces the heater output by an amount equal to that person's radiant body heat, thereby maintaining a thermal balance.

#### Zero RFI

Conventional thermostat-controlled electric heaters suffer from two major defects. First, their crude on/off electro-mechanical switching action gives poor thermal regulation and causes room temperatures to vary in a repeating series of thermal overshoots and under-shoots. Secondly, because the thermostat switching action is not synchronised to the mains frequency, the thermostat causes high switch-surge currents to be generated and generates a high level of RFI (radio-frequency interference).

The ETI controller, by contrast, uses a solid-state mains-synchronised triac to switch up to 2kW of mains



power to the heater. The switching action is synchronised to the 'zero crossover' points of the mains cycles and consequently causes virtually zero RFI generation. The triac is controlled via a thermistor proportional or 'burst fire' control circuit which enables the mean power output of the heater to be infinitely varied between zero and maximum and thereby enables the temperature to be regulated with negligible over-shoot or undershoot.

The complete control unit uses only a handful of components, including two ICs and the triac. It can be built in an evening, at a total cost of about £15, including the case and 13A output socket.

#### Construction

Construction should present few problems. The unit uses two PCBs. The small board holds the remotely-located RV1-TH1 sensor/control components. All remaining components are mounted on the larger board, which is housed in the main units case. The 2N5574 triac is fixed to a large (64mm x 100mm) heat sink which is bolted directly to the PCB. The two ICs are mounted in suitable holders. The completed PCB is bolted

to the case base-plate via stand-off

The remotely-located sensor/control board is mounted in a small (25mm x 50mm x 72mm) plastic Vero 'potting' box, which can be fixed in a suitable location via sticky-pads. The lower end of the box must be cut away to allow air to reach the temperature-sensing thermistor. A small hole should be drilled in the front of the case to allow screwdriver access to the RV1 'set temperature' pot.

On our prototype, we used a 3-pin DIN socket to connect the sensor unit to the main unit. You can use direct wiring if you prefer. When you complete the interwiring of the unit, remember to use adequately rated cables and plugs and sockets: the unit is intended to carry up to 13 amps of mains current!

Note that there is no need to fit the unit with fuses or on/off switches, as these should already be provided via your mains plug and socket. If the triac does short-circuit, the heater will simply lock on and no sigificant damage will be done.

#### **Using the Unit**

When construction is complete, plug >

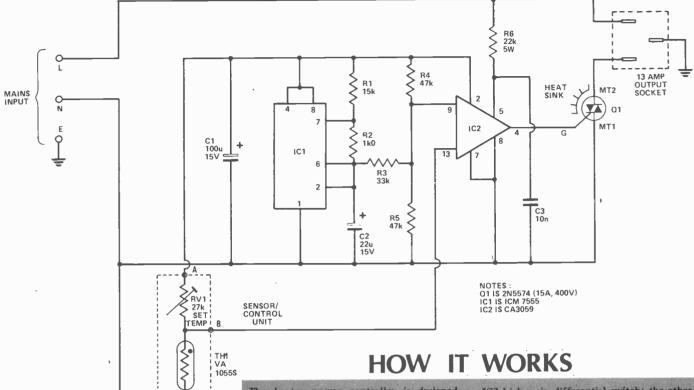


Fig. 1. Circuit diagram of the heater controller and remote sensor unit.

a heater into the unit, plug the unit into the mains and give the unit a functional check: if possible, temporarily wire a lamp in parallel with the heater, as this will give you a visual indication of the functional operation. Adjust RV1 and check that the heater/lamp load can be turned on and off via the preset pot. When RV1 is set to a value corresponding with the prevailing ambient temperature, power should pulse to the load at the timebase rate and the heater output should set to some value below maximum. If this action is obtained, the circuit is functioning correctly and you can complete the installation of the system.

When you install the system, be sure to fit the sensor/control unit in a position away from draughts and local sources of heat. Set RV1 by trial and error so that the heater produces a reduced output at the desired room temperature. If your heater is provided with its own thermostat, set the thermostat to maximum.

If your heater is fitted with a built-in lamp, you'll find that an annoying 'pulsing' action occurs as the heater power is regulated. You can overcome this problem by either disconnecting

The heater power controller is designed around a high power triac, plus a special-purpose IC known as a 'zero-voltage switch' and a CMOS version of the well known 555 timer IC.

The electric heater is wired in series with a high power triac, which acts as a solid-state high-speed bidirectional power switch which can be turned on via it's gate terminal: the triac turns off automatically at the end of each mains half-cycle. When the triac is turned on it self-latches for the remaining duration of the half cycle: the triac can thus be turned on via a very brief gate pulse. In our circuit, the triac is either not turned on at all or is turned on only at the very beginning of a mains half cycle (when the instantaneous mains current is near-zero), thus ensuring that very low switching (transient) currents are drawn from the mains, with consequently negligible switching RFI.

This switching action is obtained via IC2, which incorporates a mains zero-crossing detector which drives the triac via a 2-input AND gate/driver network which ensures that the triac is gated on only when the instantaneous mains voltage is close to zero and a GO signal is present on the other terminal of the AND gate. The GO signal is derived from a high-gain differential switch, which is also built into IC2. This IC also contains a DC voltage regulator that draws power from the mains and generates a stable 6 volt DC output that can be used to power internal and external circuitry.

over a ramp (timebase) generator, designed around a CMOS 555 timer (IC1), which has it's output fed to one side of the

IC2 high-grain differential switch: the other side of the switch is fed from the junction of potential divider RV1-TH1. TH1 is a carbon rod thermistor and is used to sense the room temperature.

When the room temperature is more than a degree or so below the pre-set value, the DC bias level (level 1) from RV1-TH1 is permanently above the ramp level. Under this condition the output of the differential switch is permanently high and a gate signal is fed to the triac at the start of each mains half cycle, thus causing the triac at the start of each mains half cycle, thus causing the triac and heater to be switched on for the duration of each ramp or timebase cycle.

As the room temperature rises, the DC bias level from RV1-TH1 interrupts the ramp waveform and the differential switch output goes low and cuts off the triac for part of each timebase cycle. Since the timebase period is short (a few hundred milliseconds) compared to the thermal time constant of the heater (several seconds), this action causes the mean output power (integrated over several seconds) of the heater to decrease linearly as the room temperature rises. In practice, a thermal negative feedback loop is set up by the circuit and eventually causes the heater output to adjust to a level that exactly balances the thermal losses of the room, thereby maintaining the room temperature within a typical accuracy of 0.5°C.

If the room temperature does rise above the pre-set level, the DC bias level falls permanently below the ramp level and under this condition the triac and heater are cut off for the full duration of each time-base cycle.

the lamp or providing it with an independent connection to the mains input terminal of the controller unit.

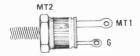


Fig. 2. Q1 outline

#### **PARTS LIST**

#### Resistors

R1 15k R2 1k0 R3 33k R4.5 47k

R6 22k 5W

#### Potentiometers

22k 0.25W horizontal

preset VA1055s

#### Capacitors

RV1

TH1

C1 100u 25V electrolytic C2 22u 25V electrolytic C3 10n polyester C280

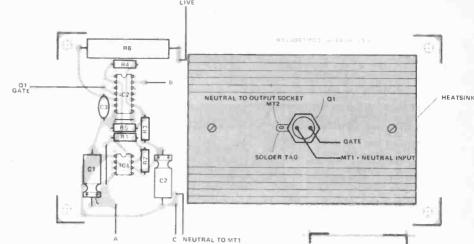
#### Semiconductors

IC1 ICM7555 IC2 CA3059

Q1 2N5574 (15A 400V)

#### Miscellaneous

13A MK socket, 3pin plug + socket, ½" grommet, ¼" grommet, Vero potting box order code 202-21025K heatsink 100mm x 65mm.



#### BUYLINES

The case chosen for the Heater Power Controller was obtained from CSC Ltd (see below for address), order as DMC-1.

The CA3059 IC can be purchased from Marshall's, all other components used are readily available from major stockists that advertise in this issue.

CSC (UK) Limited,

Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ Phone (0799) 21682.

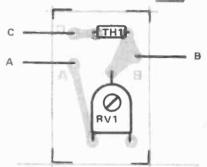
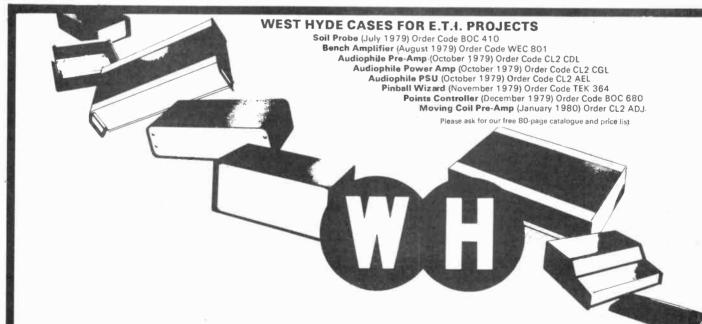


Fig. 3a (top) Component overlay of main control unit.

one (0799) 21682. Fig. 3b (above) Component overlay of remote sensor.



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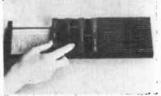
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## TELEVISION SOUND

### Rick Maybury takes the back off his telly (and his life in his hands)

#### for ETI to give a few hints on improving TV sound

here was a rumour some years ago that one of America's top Hi-Fi manufacturers was using old television loudspeakers instead of fancy new ones in their systems. That actually makes some sense when you consider the amount of use the average telly speaker gets. The cone tends to lose its stiffness and enables it to cover a greater range of frequencies. Whether you believe this or not, one fact is beyond dispute. The TV speaker is probably the most 'used' speaker in any piece of household audio.

It is, therefore, surprising to consider that the circuitry devoted to handling audio frequencies within a TV set and the speaker that produces the sound was up to only a few years ago (and still is with some manufacturers) actually considered a nuisance. In the ideal world of the TV set designer there would be no sound. This is perhaps best illustrated by the speakers used. They are deliberately shaped to take up the minimum space. Elliptical speakers on their own may not seem too bad but just consider where they are sited. One manufacturer (who shall remain nameless) actually put it at the back, unable to find anywhere it could be usefully placed. Side facing speakers are not uncommon (even one on the bottom of the cabinet). Within the last five years something of a revolution has been taking place. Tone controls have been spotted on some sets. The growing awareness of the set-maker to the interest in audio have stirred the advertising men, looking for new features to sell their boxes. This has led to some rather dubious claims for quality, so it is perhaps a good time to look at the transmitted signal which, unless someone has managed to do without it, remains the be-all and end-all of the sound that eminates from your telly.

Fig. 1. Twiddling points within the sound signal path. (a) 6 MHz intercarrier sound trap coil, L1. (b) Balance circuitry for setting up coincidence detector demodulator now widely found on sets using TBA120 sound and IF detector ICs. (c) Ceramic filter sometimes

The quality of the transmitted sound is relatively high. The main factor from the broadcaster's point of view is source. The video tape recorder is probably the worst in that respect. The tape used for VTRs is designed for just that. The oxide particles that make up the catering are aligned to optimise the helical scanning of the VTRs recording/playback head. The audio track is usually arranged on the bottom edge of the tape and nearly always recorded in a linear fashion. Because of this the best bandwidth that can be expected will be around 10 kHz.

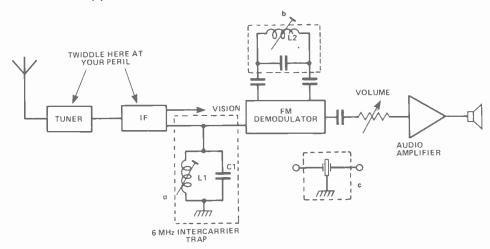
Live broadcasts and telecine material will do a little better, provided that the audio material is carefully handled something like 12 kHz can be expected.

The best quality undoubtedly comes from the 'simulcast' and separate synchronised audio recording. The audio material is recorded quite apart from the video on high quality studio tape recorders. At no time is this material ever allowed to come in contact with lesser machines and in theory at least, will have a bandwidth of something like 18 kHz. What it will be like by the time it comes out of your loudspeaker is another story.

At present there are two methods of transmitting a composite sound and vision signal used in the UK TV system.

The first and most obvious is to send the audio on a slightly different frequency or carrier to that of the video signal. This is the method used for domestic TV broadcasting at the moment. It has the rather glamorous sounding title of Intercarrier Sound. It involves transmitting the FM encoded audio on a carrier 6 MHz above the vision carrier. For instance, channel 21 on band IV — the video is

used in place of circuitry around trap L1, C1 — no twiddling possible! Please DO NOT attempt to twiddle anything before the intercarrier trap you will only regret it and that's a promise.



transmitted on a frequency of 471.25 MHz whilst the accompanying audio is to be found on 477.25 MHz. We will deal with Intercarrier Sound demodulation in more detail later on

The second, less obvious method rejoices under the name of Sound in Sync or SIS. This is not used for normal broadcast transmissions but for transmission of audio between studio and transmitter or relay stations. This is a rather cunning technique utilising the space 'inside' the line synchronisation pulse that occurs at the beginning of every TV line. This pulse is sited at a point on the TV waveform 'below black level'. This means it occurs below a pre-determined voltage at which the TV receiver will recognise it as picture information. The sync pulse lasts for approximately 4.7 microseconds and occurs at a repetition rate of 15.625 kHz (line timebase frequency).

Because SIS occurs in a synchronisation pulse it has to be removed if the signal is to be displayed. Within the studio environment a filter is used to remove SIS for insertion in studio monitors. It is removed at the transmitter prior to encoding into intercarrier sound for normal broadcast.

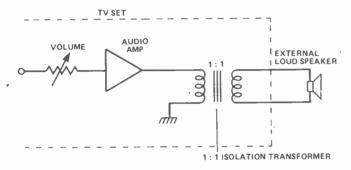


Fig. 2. Connecting an external speaker to a set with a live chassis (see fig. 4). Of course, if the set has an isolated chassis, the transformer is unnecessary and a direct connection may be made. Ensure the replacement speaker matches the impedance and power handling of the original.

# **Inter Sound**

The broadcast sound is FM modulated onto a carrier with an impressive 8 MHz bandwidth. The peak FM deviation, ie the amount by which the signal deviates around the centre frequencies, is 50 kHz. This compares with a 75 kHz deviation on FM sound radio. The sound and vision signals make uneasy bedfellows, even being 6 MHz apart. A variety of problems can arise with these two signals, sharing as they do a great deal of common circuitry within the TV receiver — not the least being intermodulation resulting in a loud irritating buzz, aptly called Intercarrier Buzz.

Those are the bare bones of TV sound. From a critical standpoint the signal that leaves the TV transmitter is rarely the same one as the one coming from the set's loud-speaker.

If it is your wish to improve upon what greets your ears every night you have a problem. Basically you are limited by the original design. You have two courses of action open to you. Firstly you can take it upon yourself to build a

complete tuner/IF/demodulator. This is not recommended for the faint of heart. To get round this a couple of enterprising manufacturers have got TV sound tuners on the market. You would be hard pressed to improve upon them, let alone do it as cheaply.

The second, more practical route is to make the best of a

bad job and improve upon what you already have.

The first and most obvious problem is perhaps the hardest to cure. That is the initial design. Modern receivers of the last few years have at least made some attempt to demodulate the sound responsibly. If your set is more than five years old — forget it. Proceed to step 2.

Step one. The aerial, the first link between the speaker and the incoming signal must be OK. As a general rule of thumb if the picture looks OK the sound will be. The colour TV is a very good indicator of signal quality being far less forgiving than a monochrome set. Look for noise or snow on the picture. If there is any, get a better aerial / move to an area with better reception / give up and proceed to step two.

The second principle of step one (confusing isn't it?) comes under the heading of alignment. Two symptoms to look for. Number one is intercarrier buzz. No big prizes for guessing how to recognise it. The second symptom of the second principle of step one (Prize for understanding that bit now available from the ETI offices) is called sound on vision. This is not necessarily detrimental to the sound quality but you might as well sort it out whilst you're at it.

Both these maladies point to one thing; poor alignment. The obvious remedy consists of whipping the back off your telly and twiddling the appropriate components. But hold on, which one. Most tellies have forty or fifty presets, coils, trimmers, etc just waiting for the eager, would-be twiddler. The answer here is arm yourself with a manufacturers' service sheet. You will be able to locate the audio section on the diagram quite easily. Just look for the loud speaker, amplifier section and decoder. On a modern colour TV just before the demodulator there will be a trap circuit. This usually consists of an LC network or a ceramic filter. For the sake of sanity DO NOT twiddle anything before this section. You will be entering the realms of IF alignment where only bold men tread, especially if you haven't got a wobbulator. If you have, then you have our deepest sympathy (and why are you reading this anyway because your set should be perfectly aligned?)

Now having located the demodulator/audio section take a deep breath. First thing to do is check up on your life insurance. Many thousands of volts run around the innards of tellies. Let them run up an errant finger and down your other arm, (the one clutching the gas pipe) and it won't really matter how bad your sound is on your TV set. The only noises you'll be hearing will be the strumming of heavenly harps (If you're lucky).

Start again, are you sound of wind, limb and brain. Yes? Then look for the vision signal trap. Does it consist of a LC network. If it does, mark the position of the slug relative to the coil, with one eye on a reflected image of the screen (use a mirror in front of the set) and the other on your shaking hand. Twiddle, no more than half a turn either way. Look for any striation on the screen (that's wavy lines). If they disappear back off and try the other way. If on the other hand the picture contorts with the sound coming from the set then go back to the starting point.

To make matters clear, if there is sound on vision this may cure it, it may also cure intercarrier buzz. If nothing changes or gets worse then return the slug to its original position.

Our next twiddle, or first, if you didn't have the first,

should be found around the demodulator circuit. As the sound is FM modulated you may be lucky and have a ratio-detector type decoder. If you have, chances are that there is another twiddle in store.

This time we will be setting up the decoder by ear. There is no practical way round it. Just twiddle and listen, keep looking at the screen, though nothing really terrible should happen. As always, make sure you know the starting point and NEVER twiddle more than half a turn either way. That way at least you should be able to get back to where you started without too much bother.

If neither of these exercises did anything for you, now is the chance for you to proceed to step two. It must be said however that if the sound is still really dreadful your II stage is probably in need of attention. The only really capable people are the manufacturers themselves. Have a word with your local (friendly) TV serviceman about doing a swap. Most sets in the last few years use modular construction so the IF strip and / or tuner might just unplug and easily substitute for another.

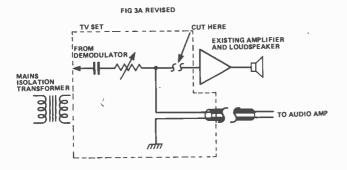


Fig. 3a. By isolating the set with a 1:1 mains isolation transformer, connections to the outside world should be safe. If your set has an isolated chassis, you should be OK.

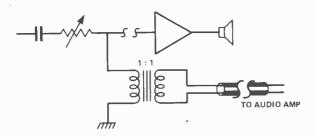


Fig. 3b. Using a 1:1 isolation transformer to prevent nasty shocks. The isolation transformer shown in fig. 4 is, however, the best solution for safe connection.

# The Famous Step Two

Step two exists for those of you who are either scared of rooting about in the backof 'live' TV sets or have tried step one without success.

This involves modifications to your set. Two things must be ascertained before you pick up that soldering iron. Firstly, the set must be your own. It's no good trying to tell the man from Radio Rentals that you were trying to improve his set. Be assured something nasty will happen if you do. The second thing to consider is, will I mind if the modifica-

tions I am about to make blow my set/house/self/cat up. If you can hold your hand on your heart and still pick up that soldering iron with an easy conscience, then proceed.

As we said earlier, the loudspeakers used in TVs can be particularly nasty items. Why not replace your one with a nice big 12in woofer? It won't fit in the case. Solution, disconnect the existing speaker making notes of impedance, power rating, etc and replace. Problem number one is likely to be the high voltages running around the speaker. Most modern colour sets have a metal chassis at around half mains potential. This is because of the types of power supply used do not employ mains transformers, or, if they do, they are of the auto type with no separate primary and secondary. You have been warned. Let not your fingers touch these wires or you will know all about it. Problem number two with this procedure is called visual/audio image separation. Be sure not to site the speaker too far away from the screen. You will have the disturbing effect of seeing the picture in front of you and the sound coming from one side or another. This is especially irritating when watching Crossroads, as it can appear that Meg Richardson is at the same time on telly and somewhere in your living room. To be avoided at all costs.



Fig. 4. Recommended method of isolating a TV set with a live chassis. Please note that the transformer should be rated at a minimum of 500 watts for a colour set.

# The Step Three Bit

Step three is for the intrepid only. Going back to your trusty manufacturers' diagram, try to locate the point of entry of the audio signal into the audio output stage. Most manufacturers do this around the volume control area. The trick we are about to play here is to take this point, sever the connection between the volume control and the audio stage and introduce it to your expensive hi-fi equipment. The proviso in step two still holds good, but this time add expensive Hi-Fi to the list of things that could be blown up.

Because we still have the live chassis situation, you must first rid the wires coming from your set of any high voltages. A1:1 mains isolation transformer is the only practical answer. Now you have to determine the impedance and level of the signal coming out of the demodulater. There is only one reliable way to do this. Measure the level on a 'scope. Use your judgement for the impedance. Safest bet (though don't blame us if it's not) is to assume it will be a fairly hefty signal and treat accordingly. All being well and nothing nasty happening, place your speakers either side of the telly and switch to Mono. You may be rewarded with a really rich sound, complete with a full set of tone controls. On the other hand you may be left with a smouldering mass of high technology that was the telly and the Hi-Fi. Seriously though, any of these methods outlined here should only be attempted if you have a very good grounding in electronics. Do not on any account muck around with your set unless you know what you are doing. If you don't then save up and buy yourself a TV sound tuner and you'll live to read all the complaints about this article next month from irate TV manufacturers.

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# METAL LOCATOR

For discriminating treasure hunters, we present the Shadow metal locator from Altek, featuring deep-seeking VLF and discriminating operation.

The design of professional quality metal detectors is a specialist field which up until now the commercial manufacturers have kept very much to themselves. This design incorporates many of the latest techniques in push button VLF discriminators which have hitherto been the subject of well guarded trade secrets. The detector performs as well as commercial models costing over £200

It uses a ready made search head, as a home-made one would have no hope of giving the results needed for a design of this nature (would you use a home-made speaker with your hi-fi?). The search head from Altek enables depths of over 12" for a single coin to be achieved.

#### Construction

The use of sockets for IC1 and IC5 is not recommended due to the increased risk of leakage currents in the push button circuitry. C12 is a very critical component. Its value is not too important but it must be of the highest quality, have low dielectric absorption and high resistance. Polycarbonate types were used, but polystyrene would be equally suitable.

To keep the design as tidy as possible 20 way ribbon cable is used to connect the board to the controls. As each colour appears twice they are differentiated by indicating from which side of the ribbon they come—either white or black (the colour of the wire at the edge of the ribbon). Circuit pins are used at all other connection points so that wires can be attached after the board is installed in the case.

# **Setting Up**

When construction is complete and the detector appears to function it is necessary to make sure that the Rx



coil has been properly connected. Due to the way the head is aligned it is not possible to check it until this stage.

Hold the head away from all metal and set the controls as follows: MODE and GROUND fully anticlockwise. ALL OTHERS at mid-rotation. Depress the tuning button and hold it in, rotate the TUNE control until the meter needle is approx mid scale. Release the button and bring the head close to a metal object — the meter should be deflected to the right. If it goes left, reverse the wires from the Rx coil (see diagram).

#### Use

Using the detector and interpreting the results is very much a matter of experience but the following notes will help.

# **Tuning**

To adjust, the push button must be depressed. When tuned to your satisfaction release the button. If the tuning point drifts then it can be brought back simply by pushing the button for a second or two. When first switched on the memory retune button will be needed every few seconds but as thermal equalibrium is established it will be needed less often.

# Sensitivity

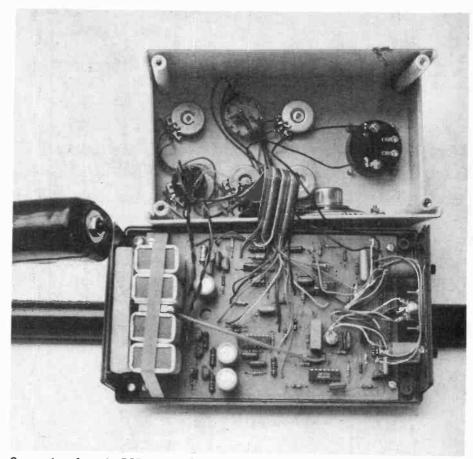
It is not necessary to set the sensitivity to maximum to achieve the greatest depth. Amplification is so great that a maximum setting may bring on instability. Experiment intelligently with it — mid-rotation is about right.

#### **Ground**

This only works in the VLF mode. Its setting is quite critical. First set the tuning with the head away from the ground. Move the head down to the ground and observe the meter. If it swings lett - rotate GROUND clockwise, if it swings right turn anticlockwise. Hold the head away from the ground and depress the button to reset the tuning. Repeat this procedure until the meter does not deviate when the head is lowered. A slight misadjustment is tolerable but if it is turned too far clockwise the detector will work in "reverse". When VLF is selected the detector is in its most sensitive mode

# Discrimination

It only functions when a TR mode is selected. The degree of discrimination

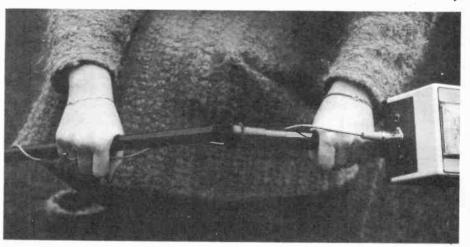


Connections from the PCB are taken to the top panel controls by 20 way ribbon cable.

is controlled jointly by the MODE coarse setting) and the DIS-CRIMINATION (fine setting) controls. Together they set the point at which the resistance of the target causes a left or right deflection on the meter. The circuit in this design is very good indeed. It is possible to differentiate between a can ring pull and a gold ring, for example. However, the discrimination control reduces sensitivity slightly. It is best to use a detector of

this type in VLF mode until a target has been found and then use discrimination to determine its likely value!

Finally we ought to point out that in the UK it is necessary to obtain a licence before using a metal detector. this is not necessary elsewhere. Application forms can be obtained from: Home Office, Radio Regulatory Dept., Waterloo Bridge House, London S.E.1.



No, we haven't broken it. The two-piece shaft is telescopic, accommodating varying altitudes of treasure hunter.

ELÉCTRONICS TODAY INTERNATIONAL — MARCH 1980

R20 100k

# **HOW IT WORKS**

L1 and L2 are the Tx and Rx coils in the search head. The signal to drive L1 is produced by Q3 and associated components which generate a sine wave of approx. 16 kHz. Part of this signal passes via C3 to the phase shift section which produces a reference signal for the phase comparator. When the VLF mode is selected, RV1 (ground control) and C4 provide a variable phase advance of 0-180.

The suitably modified signal is squared

The suitably modified signal is squared up by the precision voltage comparator IC4b and applied to the gate of the phase comparator IC1b. Meanwhile, the signal picked up by L2 passes through Q1 and Q2 which amplify, but do not distort or shift the phase, and meet the reference

signal at IC1b.

The signal emerging from IC1b is a DC signal upon which is superimposed an AC component corresponding to the phase coincidence of the reference and received signals. This is integrated by IC3d and a portion of the emerging DC signal is tapped off by the sensitivity control RV4. This is further amplified by IC3a and applied to the meter and, via D2, to the audio gate IC2b.

Audio is generated by an astable formed from the remaining half of the voltage comparator IC4a and, after being gated by IC2b, is amplified by IC2a, Q7, Q8 and Q9. RV5 is the volume control.

IC5 and IC1a form the heart of the push button tuning system. Part of the voltage from RV4 is added to a voltage

determined by the position of the slider of RV3 and applied to the source of ICla. When the tuning button is depressed, the normally high source to drain resistance falls and allows current to flow through the FET and build up as a voltage across Cl2. IC5 inverts and buffers the voltage to provide a DC bias for the phase comparator. The change of bias at IClb in turn affects the DC conditions at ICla (via IC3d and RV4). In other words a negative feedback loop is established whenever the tuning button is pressed. Within a second or two the new DC levels settle down and the button is released. The system is then maintained by the charge held on Cl2.

The power supply to the audio section is unstabilised, but due to the sensitive nature of the DC levels in the control section, stabilisation is required there. ZD1 provides a voltage reference for the differential amplifier formed by Q4 and Q5, which control the series pass element Q6. R52 allows a small current to Q4 and Q5 at switch on to ensure that Q6 starts conducting. The base of Q4 must always be at 50% of the stabilised supply (R48 = R49). This point is buffered by IC3c used in the voltage follower mode to source the V/2 supply. C21, C22 and C20 are decoupling components. Special attention has been given to cutting down the current consumption. The control section only takes 5.5 mA and the sudio section less than 2 mA when silent or when using headphones.

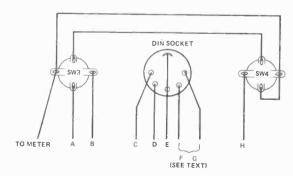
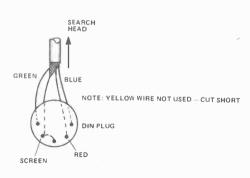
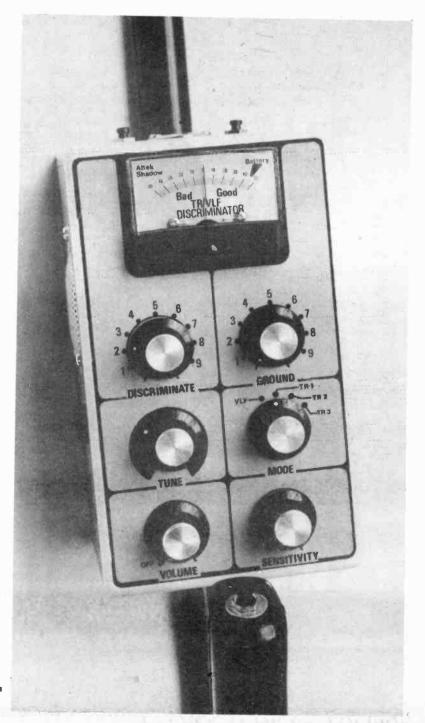


Fig. 2. Connection details for DIN plug and socket and SW3, 4. Note the tag lengths on SW3, 4.



You'll need a driving lesson before you commence twiddling with this control panel.



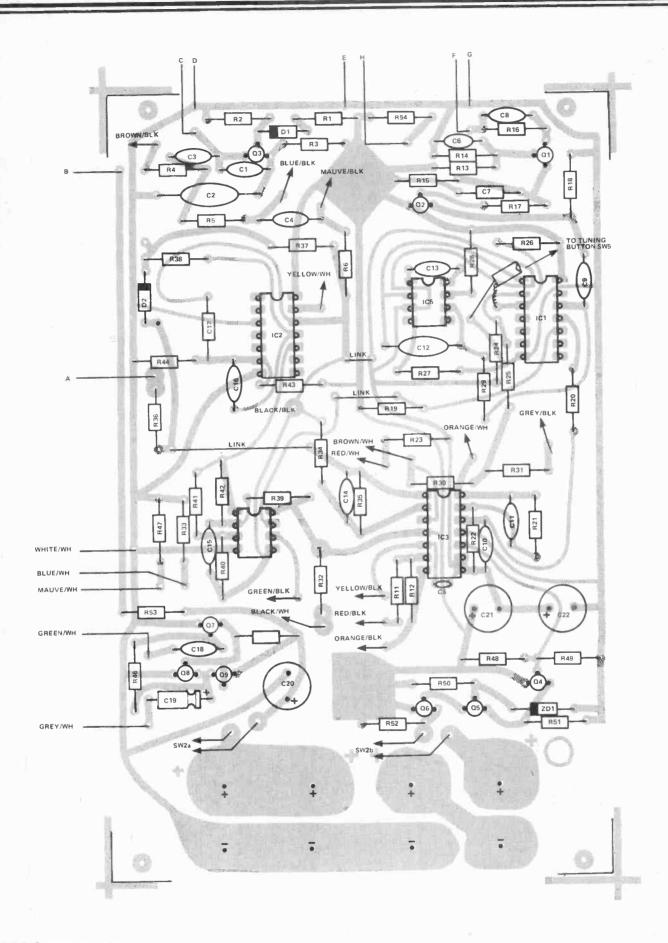
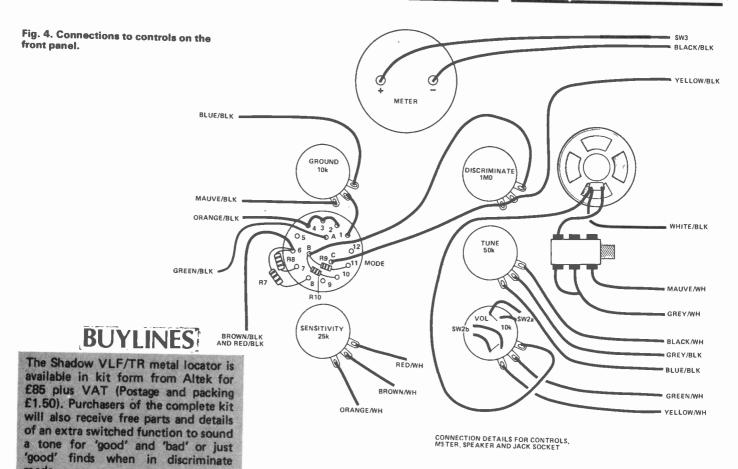


Fig. 3. Component overlay.



# **PARTS LIST**

RESISTORS All ¼W, 5%				
	R43	120k	C19	10u 25V electrolytic
	R47	470R	C20,21,22	470u 16V electrolytic
R2,16,34, 15k	R48,49	56k	,	rot circulotytic
52	R50	12k	SEMICONE	HICTORS
R3,5 2k2	R51	18k	IC1,2	4007
R4,51 18k	R53	68k		
R6,17,45 1k0	100	OOR	IC3	LM324
R7 82k	POTENTIO	VETERE	IC4	LM393
R8 27k			IC5	CA3130
R9,11,12, 100k	RV1	10k lin	Q1,2,4,5,	BC148
15,19,20,29,	RV2	1MO log	7,8	
22 22 27 40	RV3	50k lin	Q3,6,9	BC158
32,33,37,40,	RV4	25k lin	D1,2	1N4148
41,54	RV5	10k log	ZD1	5V6 400mW
R10,18,38 33k		The state of the state of		210 4001111
R13 180k	CAPACITO	RS	MISCELLA	NEOLIC
R14,22 22k	C1,6,8,14	47n polyester		
R21,25,26, 1M0	C2	470n polyester	30-0-30 UA	meter, 8R 24" speaker
30,39,44,46		10n polyester	% stereo	jack socket, 6 knobs,
R23 3k9	12 15 10	Ton polyester	double pole	c/o push buttons, single
R24,35 470k	13,15,18		pole make p	ush button, 3p 4W rotar
R27,28 4k7	C4,17	1n0 polystyrene	switch, 5 wa	y 180° latching DIN plu
R31 4M7	C5	220p ceramic	and socket,	PCB, search head, shaf
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	C7	22p polystyrene	and handle.	case to suit, 4 pairs PP3
	C12	470n polycarbonate	battery cor	meeting studs, 20 way
R42 3k3	C16	100n polyester	ribbon cable	way

mode.

Surrey.

£1.50) from Altek. Altek (ETI), 1 Green Lane, Walton-on-Thames,

A hardware kit is also available. It includes shell, search head, PCB and case and costs £44 plus VAT (P and P



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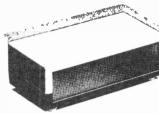


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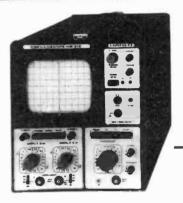
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		Price	
VA	Ref.	£	P&P
(Watts)		6.45	1.00
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100	150	10.95	1.25
200	151		
250	152	13.15	1.45

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# VOLTAGE CONTROLLED MIXER -A PROJECT 80 MODULE

This month we continue ETI's Project 80 with constructional details of the Voltage Controlled Mixer and Processor modules

ithin a synthesiser there are a variety of sound sources, for example, the waveforms from the voltage controlled oscillators and the outputs from the noise generator. In addition there are treated sounds obtained by filtering, modulation and so on. Incorporating mixers greatly increases the scope for generating complex wave-shapes by additive or subtractive synthesis as well as providing the normal mixer function of proportioning the various inputs. Furthermore, mixing within the synthesiser maintains a compatible signal level and a high signal to noise ratio. The synthesiser this month is a fourchannel mixer with pan control of the outputs. The unusual feature is that the input levels and pan have both manual and voltage control facility and some of their applications will be described.

# **Voltage Controlled Mixer**

The design is based on a custom IC, namely, the CEM 3330 Dual Voltage Controlled Amplifier produced by Curtis Electromusic Specialties. At first sight this may seem an expensive approach, but the device has the essential features required for a good mixer - namely, low distortion, low noise and wide bandwidth. Furthermore, it is directly compatible with the signal and control voltages employed and has a summing node control input. These features eliminate the need for additional op amps for buffering and control purposes. Additionally, the performance of the CEM 3330 is satisfactory for the present application



without employing trimmers and this is particularly useful to constructors having a limited amount of test equipment.

For synthesiser use, proportional (linear) mixing has been found simpler to use since the dial reading or control voltage is directly related to the proportion of each input being mixed. The input signal has been attenuated by a factor of four on each channel and maximum output is obtained with a 10V control signal derived from a rotary potentiometer, or from external sources. A manual master gain control has been provided for attenuating the output when required, or more commonly for maintaining signal level near to the standard 10V P-P. The output may be adjusted by a factor of ± 5. A visual peak level indicator has been included. After mixing, the out-

put passes to another dual VCA operated at unity gain and with a pan facility such that a 10V control voltage results in a full swing from left to right outputs. This arrangement gives a constant total voltage output, but its distribution may be varied between two speakers with the aid of a stereo amplifier. If only one output is used then the pan control facility will function as a fade control. Panel space has dictated the number of controls incorporated in the mixer and the pan system is considered to be the most versatile especially if the outputs are being subjected to further treatment.

The design is fairly flexible insofar as component values may be changed to suit other control voltages and so on. Nevertheless it is designed to operate with signal levels commonly found within synthesisers.

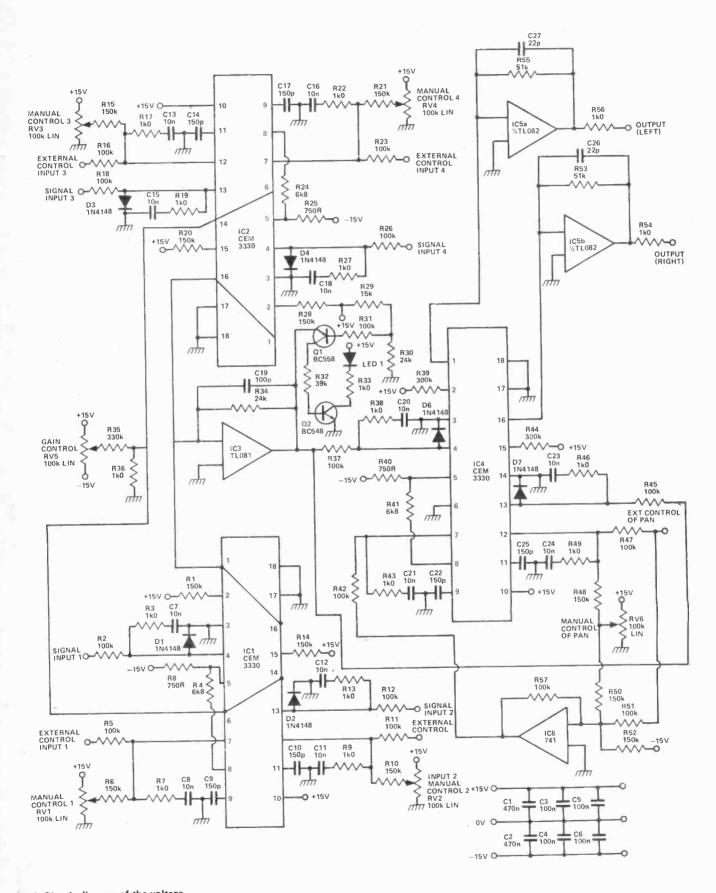


Fig.1. Circuit diagram of the voltage controlled mixer.

# **HOW IT WORKS**

The CEM 3330, from Curtis Electromusic Specialties, contains two voltage controlled amplifiers each of which consists of a variable gain cell and a log converter. The gain cell is the curren-in, current-out type and has simultaneous linear and exponential controls. The log converter generates the logarithm of the linear control input current while transmitting the exponential control input unchanged to its output.

Reference to the circuit diagram and Pins 1 to 9 of IC1 illustrate the basic principle of the design and some of the features of the CEM 3330. The signal input (Pin 4) is a summing node and can, therefore, accept multiple inputs. In this application where we require independent control over each input only one input has been provided and with R2 = 100k the signal level should be kept to ±10V. R3 and C7 are compen-sation components and the diode, D1, is to prevent latch-up problems. R1 connected to +15V provides a reference current to the gain cell and this current should be limited to 100 uA for best linearity. The design is based on proportional mixing of up to four signals and thus the linear control input is used to independently control the gain of each signal input. Again this is a summing node input at Pin 7 which allows manual control of gain via RV1 and R6 or external control via R5 without additional op amps. By using a 150k resistor for R6 the control pot can make use of the standard +15V external control signal applied to the 100k resistor, R5. R7 and C8 compensation network stabilise the log converter. C9 is for compensation of the gain cell. A master gain control is obtained by injecting a small voltage into the exponential control input (Pin 6). This voltage is derived from RV5, R35 and R36 and is common to the four input stages.

The overall gain of the VCA is given by
$$A_{V} = \frac{R_{F}}{R_{i}} \times \frac{I_{CL}}{I_{REF}} = \frac{-V_{CE/V}}{V_{T}}$$

where RF is the value of the output resistor (R34); R1 the signal input resistor (R2); ICL the linear control current developed across R5 (or R6); IREF the current input to Pin 2 via R1; and VCE the exponential control voltage. This equation indicates how the mixer may be altered to suit other signal

and control levels. One of the unique features of the CEM 3330 is that the operating point of the amplifiers may be set anywhere from Class B to Class A according to which parameters are most important in a particular application. The quiescent standby current of the signal carried by the signal-carrying transistors is varied by placing a resistor between the IEE pin (Pin 5) and the idle current adjust pin (Pin 8). In this application the amplifiers are run Class AB with the 6k8 resistor (R4) providing a standby current of about 7 uA

The four signal input and control stages are identical and their output currents are summed at IC3 and converted to a voltage across R34. This voltage is applied to Q1 which is turned on when the peak output voltage is about 9V5 (normal signal level for the synthesiser), which is set by the voltage divider R29, R30. Q2 is also turned on when this peak voltage is reached and the LED (D5) will then light up. At constant amplitude high frequency the LED will tend to glow dimly but intermittent peak voltages are clearly indicated.

The output voltage from IC3 also goes both VCAs in IC4 which is configured in a similar manner to ICs 1 and 2 except that the exponential output is grounded. The amplifiers and associated op amps (IC5a) and IC5b) are set to unity gain when a 10V control voltage is applied to R42 or R47. The panning effect is obtained through IC6 and associated components which provides a 10V output with zero volts at R47, or RV6, and 0V when there is 10V at R47, or when RV6 is fully clockwise. The left and right outputs are obtained by converting the current to a voltage across resistors R55 and R53 respectively. The use of op amp, IC5, provides low impedance

The CEM 3330 may be trimmed for precision control of gain and for use in high quality audio applications. The arrangement used in this design is entirely satisfactory for its intended use with high signal levels.

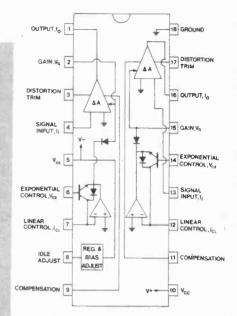
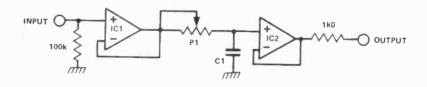
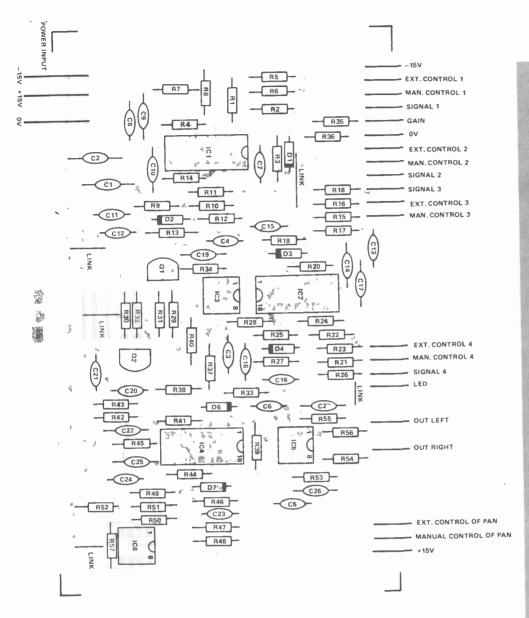


Fig.2. The internal structure of the CEM 3330 dual VCA.



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Fig.3. Circuit diagram of the simple processor.



# **Using The Mixer**

A few guidelines on use are given to demonstrate the versatility achieved by incorporating voltage control.

1. A simplistic view would be to consider the mixer as four voltage controlled amplifiers with a common output. One technique often applied to a VCA is amplitude modulation (tremolo). Usually, however, the VCA is one of the last stages and, if a number of signals have been combined in a conventional mixer prior to the VCA, then the total signal has to be amplitude modulated. Using the voltage controlled mixer only parts of the signal need be modulated and the resultant effect can be more pleasing.

2. One of the early works with a synthesiser was Morton Subotnick's "The Wild Bull," recorded in 1968. In this work extensive use is made of a sawtooth waveform (high harmonic content) which is separated into four octave bands to provide the signals for a four-channel voltage controlled mixer. Each channel was controlled by an ASDR envelope shaper gated from a sequencer. This arrangement allows the separate timbral characteristics of any sound to

Fig.4. Component overlay of the VCM.

be independently treated. Furthermore, by varying the speed of the sequencer the characteristics of the sound can be made to vary widely, for example, as the rate is increased the four bands begin to sound simultaneously. Only a simple digital sequencer is required for the above and the voltage controlled mixer becomes the heart of a useful music making instrument within the body of the synthesiser. This type of approach is particularly useful for those without access to multi-track recording equipment.

3. Adding and subtracting waveforms from two or more oscillators set to different pitches has not been widely used with synthesisers due to the tendency for the voltage controlled oscillators to track at different rates. The latter makes it impossible to maintain the same tone quality over several octaves. With the incorporation of synchronising facilities in modern VCOs this problem is overcome and additive and subtractive synthesis is a worthwhile field of exploration. Of course, subtractive synthesis already widely employed by filtering techniques but more subtle tones can be obtained by mixing techniques.

# PARTS LIST

RESISTORS	
R1,14,20,	150k 1% metal film
28,50,52	
R2,5,11,	100k
12,16,18,23,	
26,31,37,42, 45,47	
R3,7,9,13,	1k0.
17,19,22,27,	
33,36,38,43,	
46,49,54,56	40
R4,24,41	6k8 150k
R6,10,15, 21,48	LOOK
R8,25,40	750R
R29	15k
R30,34	24k
R32	39k
R35	330k 300k 1% metal film
R39,44 R51,57	100k 1% metal film
R53,55	51k
POTENTION	
POTENTION RV1-6	METERS 100k lin
RV1-6	100k lin
RV1-6 CAPACITOI	100k lin
RV1-6	100k lin
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12,	100k lin RS 470n polyester 100n polyester 10n polyester
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18	100k lin RS 470n polyester 100n polyester 10n polyester
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24	100k lin RS 470n polyester 100n polyester 10n polyester
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24 C9,10,14,	100k lin RS 470n polyester 100n polyester 10n polyester
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24 C9,10,14, 17,22,25 C19	100k lin  RS 470n polyester 100n polyester 10n polyester , 150p polystyrene 100p polystyrene
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24 C9,10,14, 17,22,25	100k lin  RS 470n polyester 100n polyester 10n polyester , 150p polystyrene
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24 C9,10,14, 17,22,25 C19 C26,27	100k lin RS 470n polyester 100n polyester 10n polyester 150p polystyrene 100p polystyrene 22p polystyrene
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24 C9,10,14, 17,22,25 C19 C26,27 SEMICOND	100k lin RS 470n polyester 100n polyester 10n polyester 150p polystyrene 100p polystyrene 22p polystyrene
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24 C9,10,14, 17,22,25 C19 C26,27	100k lin  RS 470n polyester 100n polyester 10n polyester 150p polystyrene 100p polystyrene 22p polystyrene 22p polystyrene CUCTORS CEM3330 TL081CP or equivalent
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24 C9,10,14, 17,22,25 C19 C26,27 SEMICOND IC1,2,4 IC3 IC5	100k lin  RS 470n polyester 100n polyester 10n polyester 150p polystyrene 100p polystyrene 22p polystyrene 22p polystyrene UCTORS CEM3330 TL081CP or equivalent TL082CP or equivalent
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24 C9,10,14, 17,22,25 C19 C26,27 SEMICOND IC1,2,4 IC3 IC5 Q1	100k lin  RS  470n polyester 100n polyester 10n polyester 150p polystyrene 100p polystyrene 22p polystyrene 22p polystyrene TLORS CEM3330 TL081CP or equivalent TL082CP or equivalent BC558
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24 C9,10,14, 17,22,25 C19 C26,27 SEMICOND IC1,2,4 IC3 IC5 Q1 Q2	100k lin  RS 470n polyester 100n polyester 10n polyester 150p polystyrene 100p polystyrene 22p polystyrene CUCTORS CEM3330 TL081CP or equivalent TL082CP or equivalent BC558 BC548
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24 C9,10,14, 17,22,25 C19 C26,27 SEMICOND IC1,2,4 IC3 IC5 Q1 Q2 D1,2,3,4,6,	100k lin  RS  470n polyester 100n polyester 10n polyester 150p polystyrene 100p polystyrene 22p polystyrene 22p polystyrene TLORS CEM3330 TL081CP or equivalent TL082CP or equivalent BC558
RV1-6 CAPACITOI C1,2 C3,4,5,6 C7,8,11,12, 13,15,16,18 20,21,23,24 C9,10,14, 17,22,25 C19 C26,27 SEMICOND IC1,2,4 IC3 IC5 Q1 Q2	100k lin  RS 470n polyester 100n polyester 10n polyester 150p polystyrene 100p polystyrene 22p polystyrene CUCTORS CEM3330 TL081CP or equivalent TL082CP or equivalent BC558 BC548

# BUYLINES

The voltage controlled mixer PCB and all the components shown on the circuit diagram are available for £24.62 including postage and VAT from Digisound Limited, 13 The Brooklands, Wrea Green, Preston, Lancashire PR4 2NQ.

4. A major application of the voltage controlled mixer is the ability to alter loudness and harmonic content with pitch. One of the criticisms of 'live' electronic music is the precise nature of its sounds and the initial excitement of a new sound turns to boredom as the brain adversely reacts to its repetitive nature. By applying the keyboard control voltage (or its inverse, or a proportion of either) to one or more of the mixer control inputs then the amplitude or harmonic content (often both) will vary with pitch and so provide a useful means of dynamically altering the timbral characteristics of the sound.

5. Applying a low frequency waveform to the pan control input can produce some interesting spatial and rotational effects, but for greatest impact this technique should be used sparingly.

6. Mention has been made of waveforms, envelope shapers and keyboard voltage for control of the mixer and in common with other voltage controlled modules any variable voltage source may be used. A foot pedal control adapted to provide a 10V output is particularly useful in conjunction with a mixer.

## **Processor Module**

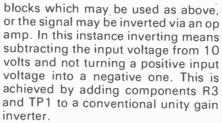
As discussed in Part 1, the low output impedance and high input impedance of the modules allows one output to drive several inputs without overloading or introducing appreciable errors. Thus attenuators should be on inputs rather than outputs so that their level can be independently adjusted. Likewise the modules should ideally have a number of commoned output sockets to facilitate distribution of the signal to other modules.

Additional attenuating potentiometers and jack sockets add to cost and also take up valuable panel space and so for situations where the controls are used infrequently a distribution panel was discussed last month.

A suggested configuration for the module (a 'processor') is two distribution blocks which allow one input to be distributed to three outputs with or without attenuation.

Secondly, there are a further two

The mixer PCB attached to its front panel.



Another addition is the so-called 'lag processor' which is simply a low pass filter and akin to the usual portamento circuit. This is useful for slowing down fast control signals and also for delaying control signals.

#### Construction

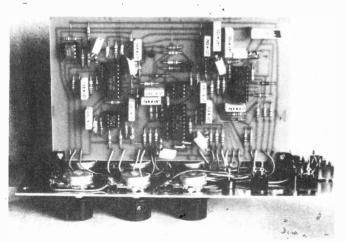
Because of the simple construction of the circuits no printed circuit board is shown but a few construction hints may be of value. For the inverter a BIFET type op amp (LF 351, TL 081. etc) should be used to prevent distortion of high frequency or fast signals. The main precaution is to keep the signal input resistor close to the inverting pin. A small capacitor (10 or 22p) across the op amp also reduces the likelihood of instability. Furthermore, if you decide to install more than two inverters on a board then 100n decoupling capacitors mounted close to the power supply pins of the IC will prevent the tendency of these devices to talk to one another. The circuit should be wired up so that the inverter stage is disabled when input jack socket 'B' is in use.

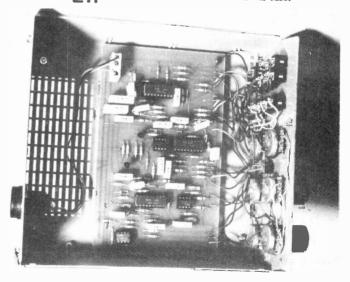
A LM1458 type op amp should be adequate for most applications of the lag processor. RV1 = 2M2 and C1 = 220n will provide sufficient delay and since short delays are the most useful a polyester capacitor may be employed.



Panel layout of the mixer.

The mixer PCB installed in its case.





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# TECH TIPS

Player 1

Example game of "Grand-Prix".

Winner is the first player to travel 1000 km. Pre-load store 3 with 0.25.

## **Grand Prix**

M. R. Harrison

Grand Prix can be played on the following calculators — Casio fx-201p and Casio Profx-1.

The game is played by the calculator explaining the conditions of the road by means of a skill factor. The conditions are as below:

- 1.5 + Excellent conditions and on a straight.
- 1.4 + Very good.
- 1.3 + Good.
- 1.2 + Reasonable road surface but bends in road. Take care.
- 1.1 + Greasy road surface due to water.
- 1.0 + Oil !!!! DANGER.

The player whose turn it is, decides how fast he dare travel without crashing. The faster the speed the further the distance the player's car will travel. The winner is the first person to travel a chosen distance.

The game is played as follows:

- Press start.
- 2. Skill factor is shown for player 1.
- 3. Player 1 enters his required speed.
- 4. Total distance player 1 has travelled will only be displayed if player 1 did not crash.
- 5. Skill factor is shown for player 2.
- 6. Player 2 enters his required speed.
- 7. Total distance player 2 has travelled will only be displayed if player 2 did not crash.
- 8. Go to stage 2.

The first part of the program is to obtain a random number between 0 and 1. This is done by multiplying another number between 0 and 1 again by —3.94. To the result, 1 is continually added until the result becomes positive. This result is used in obtaining the next random number in the same way and also in the next stage of the program, which is to obtain a skill factor. The skill factor is found by dividing the random number previously calculated by 2 and then adding on 1.021.

	Player	1		Player 2	
Skill Factor	Speed (kmph)	Dist Travelled (km)	Skill Factor	Speed (kmph)	Dist Travelled (km)
1.03 1.17 1.35 1.28 1.15 1.16 1.27 1.45 1.41 1.30 1.32 1.25 1.22 1.14 1.27 1.46 1.50 1.13 1.26 1.30 1.07	10.00 20.00 30.00 23.00 20.00 30.00 110.00 35.00 25.00 25.00 25.00 90.00 150.00 17.50 25.00 35.00 10.00 150.00 150.00	0.15 5.92 24.46 35.91 41.21 46.78 61.15 crash!! crash!! crash!! drash!! erash!! 80.86 92.16 101.14 107.94 119.92 189.52 crash!! 193.55 204.90 223.93 225.01 259.54 crash!! 262.25	1.49 1.44 1.21 1.49 1.46 1.03 1.30 1.46 1.45 1.34 1.09 1.23 1.34 1.04 1.28 1.12 1.08 1.07 1.38 1.31 1.09 1.13	100.00 90.00 20.00 110.00 120.00 15.00 35.00 100.00 80.00 37.50 20.00 25.00 44.00 10.00 33.00 15.00 20.00 20.00 45.00 17.50 20.00	80.81 crash!! 88.14 177.44 274.60 crash!! 275.08 293.68 crash!! 354.48 376.95 crash!! 387.13 crash!! 387.43 403.72 406.67 crash!! 407.96 441.47 crash!! 443.53 447.14 452.72
1.46	90.00	crash!!	1.27	30.00	

ETC

By keeping a record of one's attempts, the player can soon realise how fast he may go with certain skill factors.

For a new game, stores 7 & 8 have to be cleared.

GRAND-PRIX	Steps:-
ST*0: GOTO9: I=9: GOTO8:	13
GOTO9: I=K2: GOTO8: GOTO0:	27
SUB*9: 3=3x6:	36
ST*4: 3=3+9:	45
IF3=K0:4:5:5:	57
SUB*8: IM=3÷K2+0:	69
ANS IM:	72
2=9 10 <sup>x</sup> x IM TAN:	80
I=I3K3:	87
ENT IM:	90
1=IM: IF IM=2:1:1:3:	105
ST*1: I=I+K3:	115
IM=3SIN×1+IM:	124
ANS IM:	127

Pre-load memory stores as below: -

Store 3 . . . . . . . any number between 0 and 1.

Rad-Deg-Grad switch *must* bet set on "Radians". For a new game, stores 7 & 8 have to be cleared.



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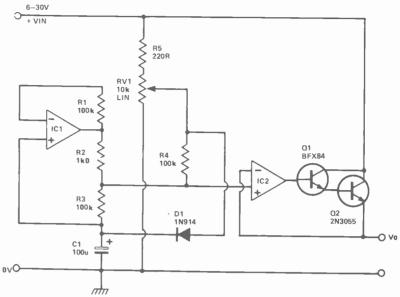
ELECTRONICS TODAY INTERNATIONAL - MARCH 1980

# **Gyrator Smoother**

J. P. Macaulay

Although this circuit was developed to supply a well smoothed supply to a stereo class A amplifier it is well suited to many other applications. The circuit is based on the dual op amp LM358. A1 is used as an gyrator, C1 being amplified by the ratio of R3 to R4, ie 1000X. The simulated capacitor thus formed between the output of A1 and ground is 100n.

R5 and RV1 set the output voltage whilst R4 in series with the 'capacitor' forms a smoothing network with a time constant of 10,000 seconds! In order to avoid protracted turn on times the diode, D1, rapidly charges C1 to within 0V6 of the nominal output voltage within two seconds. Ripple is not measurable with the prototype when supplying 3A into a load. A2 and the Darlington



output pair Q1 and Q2 form a voltage follower with an output current

capacity in excess of 10A, if Q2 is mounted on a hefty heatsink.

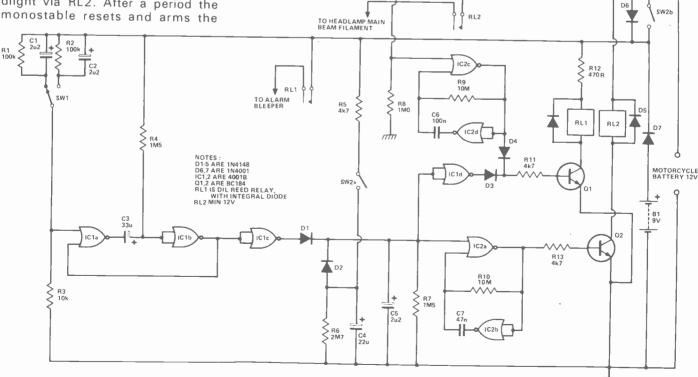
# Motorcycle Anti-Theft Alarm

C. R. Goble

IC1a,b form a monostable triggered by mercury switch S1.IC1c then provides a low output, allowing the charge on C5 to decay over a couple of seconds through R7. After this short delay IC1d allows RL1 to sound the alarm bleeper and the astable around IC2a,b flashes the bike headlight via RL2. After a period the

circuit once more. If the battery leads are cut then another astable around IC2c,d will switch the bleeper on and off continuously, via RL1, until disarmed by lockswitch S2.C4 discharging prevents the alarm from sounding for about 20 seconds after initial arming. RL2 contacts should be suitably rated and, ideally, RL1 should take only a low current to help con-

serve standby power. Current drain when untriggered amounts to that through S1.6V operation is possible with 6V relays although values may need altering to preserve timing. Mercury switch S1 can be formed either from one double switch or from two single switches, mounted across the 'bike and wired to give a changeover action.



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PSI Comp 80. Z80 Based powerful scientific computer Design as published in Wireless World, April-September,

The kit for this outstandingly practical design by John Adams published in a series of articles in Wireless World really is complete!

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2708 ROM (8 required) £8.00
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# **Solder Sucking**

A. D. Hextall

Here is a tip for those wealthy enough to possess a solder sucker. Those so fortunate will appreciate the cost of buying replacement nozzles. Great financial saving can be achieved by sliding a piece of rubber sleeving over the nozzle, extending it by about 4 mm. Not only is the sleeving heatresistant, but when worn can be replaced at a miserly cost.

#### **Car Alarm**

W. D. Solomon

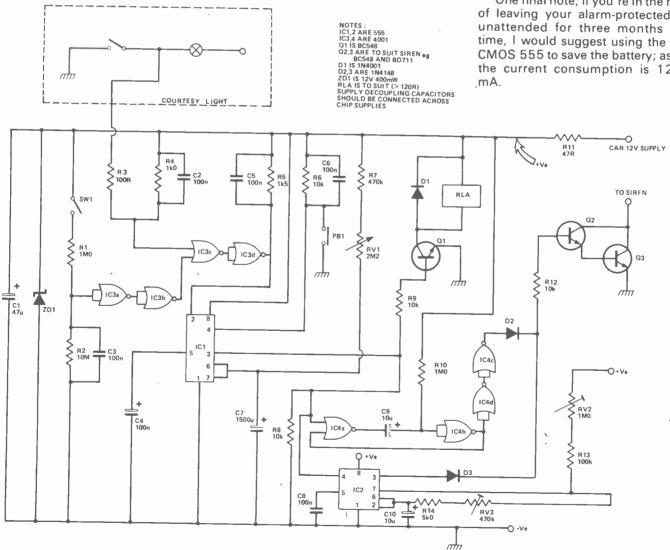
This circuit offers a greater degree of security than many of the designs previously published, in that there is absolutely no way of controlling, or resetting the alarm from inside the car. When triggered, a relay flips over, to be used for immobilising the car by, say, shorting out the points or disconnecting the solenoid. A siren is also turned on, winding up for a few seconds before an astable turns it on and off, thus producing an effective alarm sound. After a pre-selected time the system resets itself, to avoid draining the battery, or annoying the neighbours.

IC3 provides the trigger logic, the gates being arranged so that if the wire to SW1 (the enable/disable switch) is cut or damaged, the system will still be enabled. IC1 is a 555

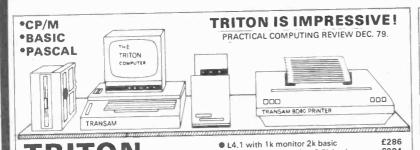
being used as a basic timer; the time period (before the system resets itself) is controlled by RV1. The output of IC1 turns on Q1 and thus the relay, while triggering the monostable (IC4a & b) and buffer (IC4c & d), which turns on the siren, via the Darlington pair (Q2 & 3). After a few seconds the astable 555 (IC2) takes over, bleeping the siren on and off. RV2, 3 are adjusted when the alarm is installed to vary the on and off times and produce the desired alarm sound. D2, 3 isolate the outputs of IC2, 4.

ZD1, C1 and R11 provide a stabilized 12V supply; C2, 3, 5, 6 and their associated resistors are a desperate attempt to protect the circuit from a noisy ignition! On the prototype, PB1 and RV1 were mounted on the alarm box, which was bolted inside the engine compartment; SW1 was hidden in the boot. although a key-switch could be used in a more prominent position.

One final note; if you're in the habit of leaving your alarm-protected car unattended for three months at a time, I would suggest using the new CMOS 555 to save the battery; as it is the current consumption is 12-15



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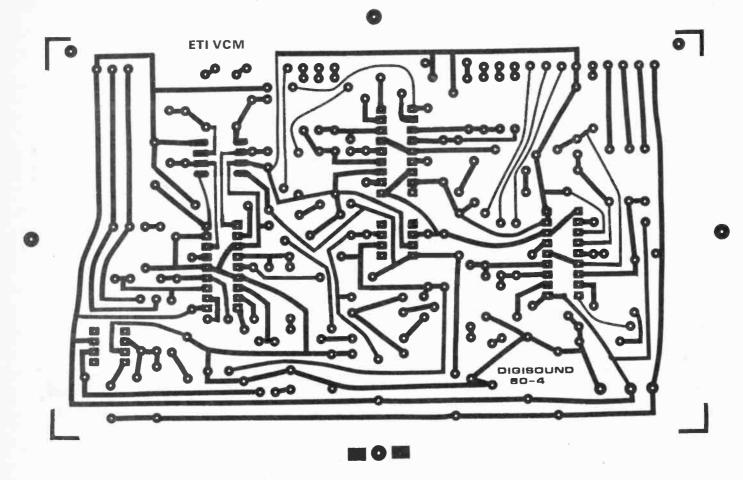
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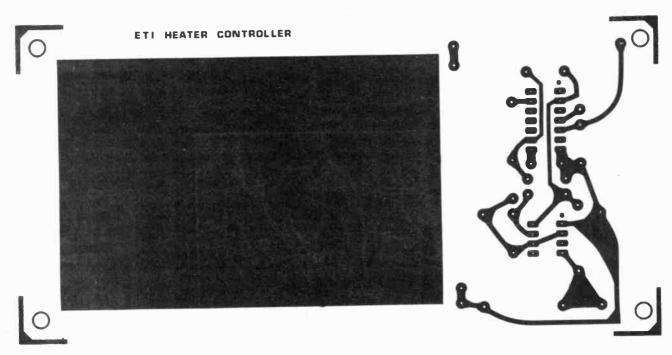


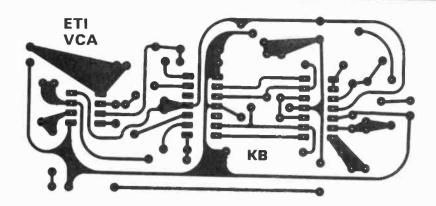
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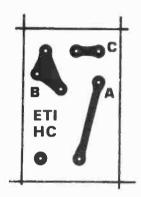


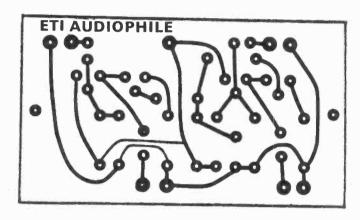
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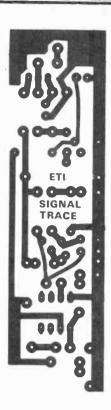


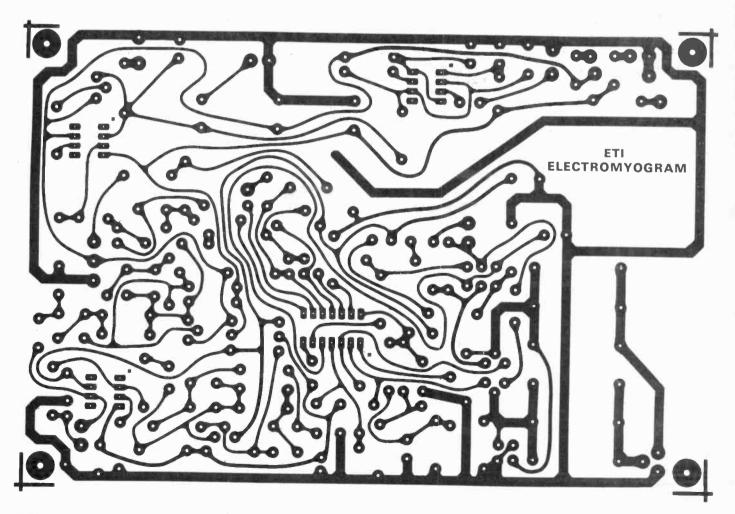












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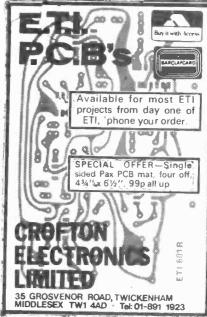
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# **ADVERT** INDEX

AJD DIRECT SUPPLIES	70
AUDIO ELECTRONICS	
BARINGLOCK LTD.	········ 38
BAYDIS	
BK ELECTRONICS	
CAMBRIDGE LEARNING ENTERPRIS	FS 102
OTTLE PRODUCT CONTRACTOR CONTRACT	
CODESPEED COMP. COMP. COMP.	102
COMP, COMP, COMP	106 8 107
COMP, COMP, COMP CRIMSON ELEKTRIK CROFTON FLETROMICS	84
HENRY'S RADIO	38, 85 & 94
L & B ELECTRONICS L & B ELECTRONICS LEYTHOMICS	
LEYTROMCS	
MARSHALL	
erit. Mintioffo	100
J. W. RIMMER	38
N. I. V. G.	
STEVE'S ELECTRONICS	
SURETRON	
1 COMMUNICATIO	
TRANSAM VIDEOTIME PRODUCTS	
VIDEOTIME PRODUCTS WATFORD ELECTRONICS WEST HYDE DEVELOPMENTS	
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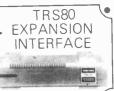


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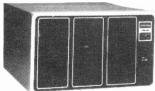
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