

electronics today

INTERNATIONAL

ISSN. 0142-7229

DECEMBER 1980 £0.95

POLYPHONIC SYNTHESISER PROJECT



Build it for a fraction of the cost of commercial units!

FOUR Circuit design features inside

How the Universe began?

An Alarming Clock design

Audio Mixer project

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

8K ON BOARD MEMORY!

5K RAM 3K ROM or 4K RAM, 4K ROM (link selectable) Kit supplied with 3K RAM, 3K ROM System expandable for up to 32K memory

2 KEYBOARDS!

56 Key alphanumeric keyboard for entering high level language plus 16 key Hex pad for easy entry of machine code

GRAPHICS!

64 character graphics option — includes transistor symbols! Only £18.20 extra!

MEMORY MAPPED

high resolution VDU circuitry using discrete TTL for extra flexibility Has its own 2K memory to give 32 lines for 64 characters

KANSAS CITY

low error rate tape interface.

2 MICROPROCESSORS

Z80 the powerful CPU with 158 instructions, including all 78 of the 8080, controls the MM57109 number cruncher Functions include +, -, *, /, squares, roots, logs, exponentials, trig functions, inverses etc. Range 10^{-9} to 9×10^{9} to 8 figures plus 2 exponent digits

EFFICIENT OPERATION

Why waste valuable memory on sub routines for numeric processing? The number cruncher handles everything internally!

RESIDENT BASIC

with extended mathematical capability. Only 2K memory used but more powerful than most 8K Basics!

1K MONITOR

resident in EPROM

SINGLE BOARD DESIGN

Even keyboards and power supply circuitry on the superb quality double sided plated through-hole PCB

PSI comp 80
Z80 Based powerful scientific computer design as published in WIRELESS WORLD



COMPLETE KIT NOW ONLY £225 + VAT

Cabinet size 19.0" x 15.7" x 3.3"

Television not included in price.

The kit for this outstandingly practical design by John Adams published in a series of articles in Wireless World really is complete. Included in the PSICOMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double sided, plated-through-hole printed circuit board, 2 keyboards PCB mounted for ease of construction, IC sockets, high reliability metal oxide resistors, power supply using custom designed toroidal transformer, 2K Basic and 1K monitor in EPROMS and, of course, wire, nuts, bolts, etc.

KIT ALSO AVAILABLE AS SEPARATE PACKS

For those customers who wish to spread their purchase or build a personalized system the kit is available as separate packs eg. PCB (16" x 12.5") £43.20. Pair of keyboards £24.80. Firmware in EPROMS £30.00. Toroidal transformer and power supply components £17.60. Cabinet (very rugged, made from steel, really beautifully finished) £26.50. P.S. Will greatly enhance any other single board computer including OHM SUPERBOARD for which it can be readily modified. Other packs listed in our FREE CATALOGUE.

PSI COMP 80 Memory Expansion System

Expansion up to 32K all inside the computer's own cabinet!

By carefully thought out engineering a mother board with buffers and its own power supply (powered by the computer's transformer) enables up to 3 8K RAM or 8K ROM boards to be fitted neatly inside the computer cabinet. Connections to the mother board from the main board expansion socket is made via a ribbon cable.

Mother board:

Fibre glass double sided plated through hole PCB 8 7/8" x 3 0/8" set of all components including all brackets, fixing parts and ribbon cable with socket to connect to expansion plug **£39.90**

8K Static RAM board

Fibre glass double sided plated through hole PCB 5 6/8" x 4 8/8" **£12.50**
Set of components including IC sockets, plug and socket but excluding RAMs **£11.20**
2114L RAM (16 required) **£5.00**
Complete set of board components 16 RAMS **£89.50**

8K ROM board

Fibre glass double sided plated through hole PCB 5 6/8" x 4 8/8" **£12.40**
Set of components including IC sockets, plug and socket but excluding ROMs **£10.70**
2708 ROM (8 required) **£6.00**
Complete set of board components 8 ROMs **£68.60**

★ ETI VOCODER ★



Panel size 9.0" x 5.25" Depth 12.2"

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NOISE GENERATOR!
LED PPM METERS!
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VOICED/UNVOICED DETECTOR!

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Like all our kits the ETI VOCODER really is complete — fully finished metal work, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc. — even a 13A plug! Kits also available as separate packs — See our Free Catalogue.

POWERTRAN

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!
POWERTRAN ELECTRONICS

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EXPORT ORDERS: No VAT. Postage charged at actual cost plus £1 handling and documentation.
U.K. ORDERS: Subject to 15% surcharge for VAT. No charge is made for carriage, or at current rate if changed.

SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.
SALES COUNTER: If you prefer to collect kit from the factory, call at Sales Counter. Open 9 a.m. - 12 noon, 1-4.30 p.m. Monday-Thursday.

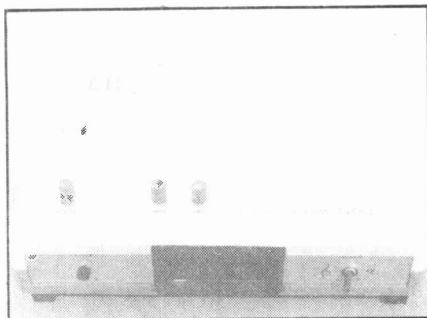
MANY MORE KITS ON PAGE 8



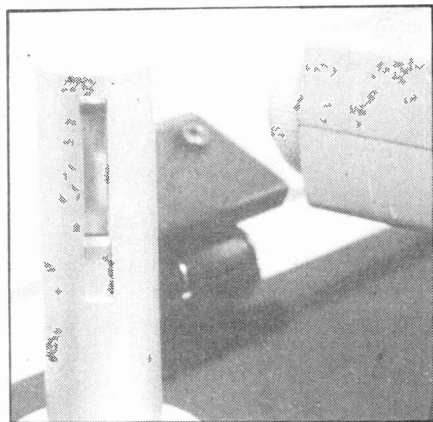
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Member of the
 Audit Bureau
 of Circulation



PUBLISHED BY Modmags Ltd, 145 Charing Cross Road, WC2
 DISTRIBUTED BY Argus Distribution Ltd. (British Isles)
 12-18 Paul Street, London
 Gordon & Gotch Ltd. (Overseas)
 PRINTED BY QB Limited, Colchester
 Covers printed by Alabaster Pressmore

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New Profile Amplifiers - Two New Series

MOSFET

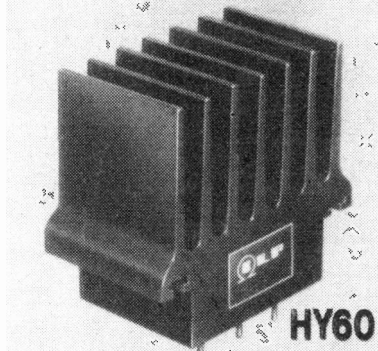
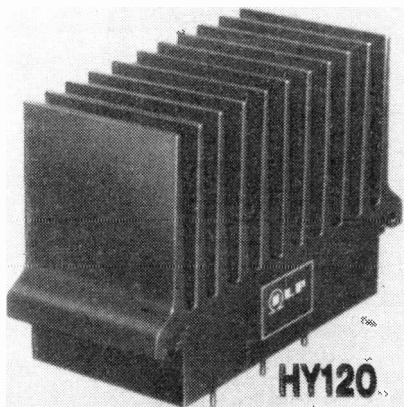
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MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

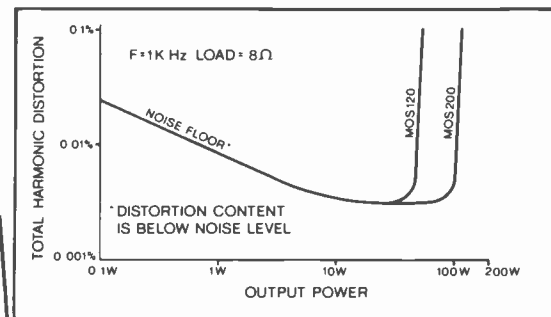
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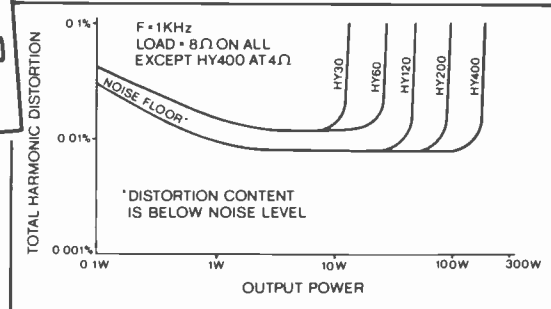
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£6.34 + 95p
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.24 + £1.09
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£15.20 + £2.28
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£18.44 + £2.77
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£27.68 + £4.15



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

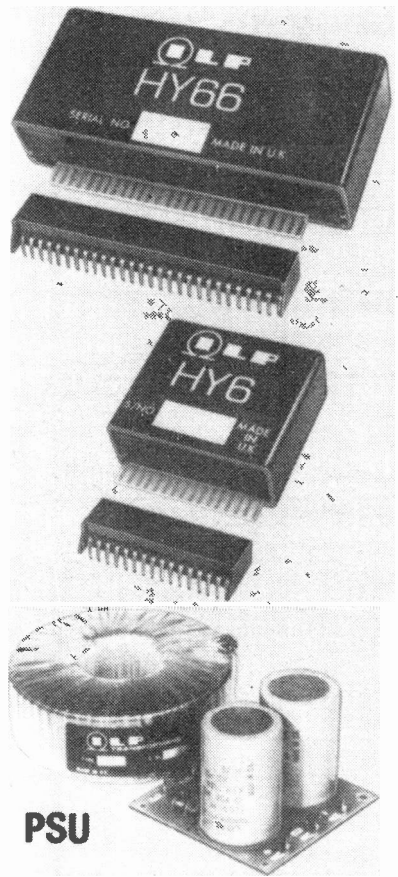


Load impedance all models 4Ω - ∞ Input impedance all models 100KΩ
Input sensitivity all models 500mV Frequency response all models 15Hz-50KHz - 3dB



THE NEW PROFILE EXTRUSIONS
The introduction of standard heatsink extrusion for all I.L.P. power amplifiers achieves many advantages: - Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for lower thermal conductivity. Extrusions vary in size according to module number.

NEW PRE-AMPS

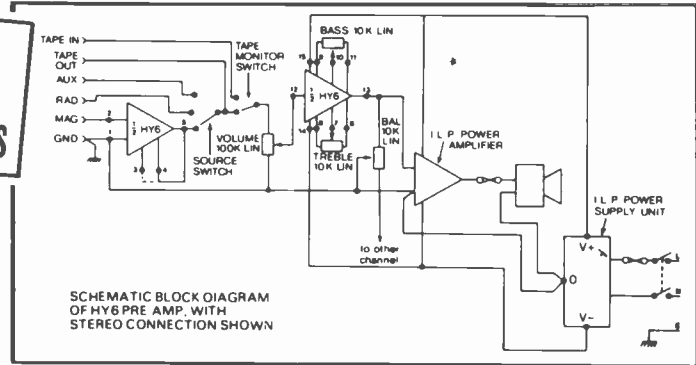


HY6 (mono) and HY66 (stereo) are new to I.L.P.'s range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P. power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.

Sizes - HY6 - 45 x 20 x 40 mm. HY66 - 90 x 20 x 40 mm. **Active Tone Control** circuits provide ± 12 dB cut and boost. **Inputs Sensitivity** - Mag. PU. -3mV: Mic - selectable 1-12mV: All others 100mV. **Tape O/P** - 100mV: **Main O/P** - 500mV: **Frequency response** - D.C. to 100KHz - 3dB.

HY6 mono £5.60 + 84p VAT Connectors included
HY66 stereo £10.60 + £1.59 VAT Connectors included
B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

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- PSU75** for use with 1 or 2 MOS120 **£13.61 + £2.04 VAT**
- PSU90** for use with 1 HY200 **£13.61 + £2.04 VAT**
- PSU95** for use with 1 MOS200 **£14.75 + £2.21 VAT**
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SUB-MIN TOGGLE SP changeover 59p SPST on/off 54p SPST biased 85p DPDT 6 tags 70p DPDT centre off 79p DPDT biased 115p	PUSH BUTTON DPDT Black Body Red, Blue, Grn., Yell SRL Latching 125p SRM Momentary 125p	'D' CONNECTORS (Cannon type) 9way 95p 128p — 15way 135p 195p 150p 25way 198p 284p 170p 37way 290p 398p 185p
	MINI, Non Locking Push to Make 15p Push Break 25p	
	D.I.L. SWITCHES (SPST) 4 way 85p , 6 way 95p ; 8 way 115p	

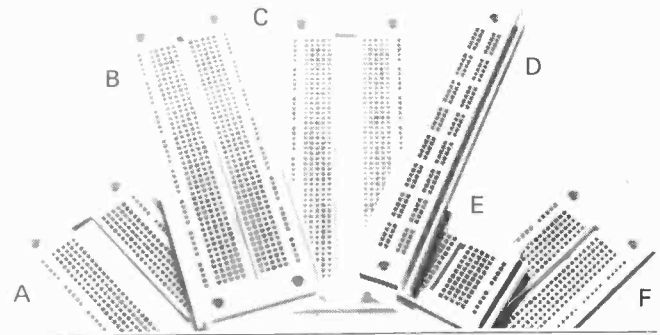
CRYSTALS 100KHz 323 455KHz 383 1MHz 323 1.008M 395 1.28MHz 392 1.8MHz 323 1.8MHz 323 1.8432MHz 362 2.4576MHz 362 3.2768M 323 3.57954M 195 4.000MHz 290 4.032MHz 323 4.433619M 135 5.0MHz 355 5.195M 323 5.24288M 425 6.0MHz 323 6.5536M 209 7.680M 323 8.0MHz 392 8.08333M 362 8.867237M 362 9.375M 323 10.0MHz 323 10.7MHz 323 12MHz 392 14.31818M 362 18MHz 323 18.432M 323 20.0MHz 323 27.648M 323 38.5667M 355 48.0MHz 323 100.0MHz 323	TRANSFORMERS (Mains Prim. 220-240V) 6.0-6V 9.0-9V, 12.0-12V 100mA 95p 3VA: 0-6V 0-6V (PCB mounting) 150p 6VA: 6V-5A 6V-5A, 9V-4A 9V-4A, 12V-3A 215p 12V-3A, 15V-2.5A 15V-2.5A 215p 12V: 4.5V-1.3A 4.5V-1.3A, 6V-1.2A 6V-1.2A, 20V-3A 235p (30p p&p) 12V-1A 12V-1A, 15V-8A 15V-8A, 20V-6A 320p (55p p&p) 20V-6A 320p (55p p&p) 50VA: 6V-4A 6V-4A, 9V-2.5A 9V-2.5A, 12V-2A, 12V-2A, 15V-1.5A 15V-1.5A, 20V-1.2A 20V-1.2A, 25V-1A 25V-1A, 30V-8A 30V-8A 365p (60p p&p) 100VA: 12V-4A 12V-4A, 15V-3A 15V-3A, 20V-2.5A 20V-2.5A, 30V-1.5A 30V-1.5A, 40V-1.25A 40V-1.25A, 50V-1A 50V-1A 695p (74p p&p). (NB. p&p charge to be added above our normal postal charge.)	ALUM. BOXES WITH LID 3x2x1" 5p 2 1/2x5 1/2x1 1/2" 75 4x4x1 1/2" 75 4x2 1/2x1 1/2" 75 4x5 1/2x1 1/2" 100 4x2 1/2x2" 80 5x4x2" 107 6x4x2" 110 7x5x2 1/2" 185 8x6x3" 185 10x7x3" 240 10x4 1/2x3" 228 12x5x3" 230 12x8x3" 275	PANEL METERS FSD 60x46x 35mm 0.50pA 0-100uA 40p 0-500uA 0.1mA 0-1mA 0.5mA 0-10mA 0.50mA 0-100mA 0.500mA 0-500mA 0.1A 0-2A 0.25V 0-20V 0.50V AC 0-300V AC
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VOLTAGE REGULATORS 1A TO3 +ve -ve 5V 7805 145p 7905 220p 12V 7812 145p 7912 220p 15V 7815 145p — 18V 7818 145p —	1A TO220 Plastic Casing 5V 7805 60p 7905 65p 12V 7812 60p 7912 65p 15V 7815 60p 7915 65p 18V 7818 60p 7918 65p 24V 7824 60p —	OPTO LEDs with Clips TIL209 Red 13 TIL211 Grn. 17 TIL212 Yel. 18 TIL220 2" Red 14 2 Green, Yellow or Amber 18 7 Segment Displays Square LEDs: Red TIL307 675 Green, Yellow 30 TIL312 3" CA 105 LD271 Infra Red 40 TIL313 3" CC 105 SRH205 Detector 90 TIL321 5" CA 115 TIL32 Infra Red 65 TIL322 5" CC 115 TIL78 Detector 75 DL704 3" CC 99 BARGRAPY Red 10 DL707 3" CA 99 segments 225 DL747 6" CA 180	ISOLATORS IL74 55 DVM176 1885 TIL111/2 85 LCD 3 1/2 Digits 775 TIL114 95 LCD 4 Digits 975 TIL117 110 LCD 6 Digits 950
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ETI Projects: Parts available for Digital Test Meter, DM900, 60W Amplifier System. Send SAE plus 5p for list.	LM300H 170p LM327 270p LM305H 140p LM723 38p LM309K 135p TAA550 50p LM317K 350p TBA625B 95p LM323K 550p TDA1412 150p LM325N 240p 78H05 + 5V/5A 595p LM326N 240p 78HG + 5V to +25V 5A 650p
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LS245 350 LS247 136 LS248 135 LS249 135 LS251 130 LS253 95 LS257 95 LS258 120 LS259 160 LS261 450 LS266 75 LS273 180 LS275 320 LS279 88 LS280 250 LS283 90 LS290 130 LS293 130 LS295 215 LS298 215 LS299 420 LS300 175 LS302 175 LS320 270 LS323 450 LS324 200 LS325 320 LS326 330 LS327 315 LS346 185 LS347 150 LS348 190 LS352 185 LS353 185 LS365 65 LS366 65 LS367 65 LS368 90	LS373 150 LS374 150 LS375 160 LS377 199 LS378 140 LS379 215 LS384 250 LS385 420 LS386 85 LS390 140 LS393 140 LS395 210 LS396 199 LS398 275 LS399 230 LS445 140 LS447 195 LS490 245 LS568 105 LS569 105 LS570 270 LS573 750 LS574 850	4015 85 4016 42 4017 82 4018 28 4019 48 4020 99 4021 105 4022 95 4023 25 4024 75 4025 25 4026 180 4027 48 4028 82 4029 105 4030 60 4031 225 4032 125 4033 175 4034 210 4035 125 4036 365 4037 115 4038 118 4039 360 4040 105 4041 80 4042 80 4043 95 4044 95 4045 175 4046 130 4047 98 4048 65 4049 45 4050 48 4051 80 4052 80	4053 80 4054 130 4055 135 4056 135 4057 2650 4059 575 4060 130 4061 1225 4062 995 4063 120 4064 58 4067 430 4068 26 4069 26 4070 30 4071 25 4072 25 4073 25 4075 25 4076 99 4077 48 4078 30 4079 118 4081 28 4082 28 4085 90 4086 90 4089 150 4093 89 4094 240 4095 105 4096 105 4097 350 4098 115 4099 190 4100 125 4101 125 4102 125 4103 125 4104 125 4105 125 4106 125 4107 125 4108 125 4109 125 4110 125 4111 125 4112 125 4113 125 4114 125 4115 125 4116 125 4117 125 4118 125 4119 125 4120 125 4121 125 4122 125 4123 125 4124 125 4125 125 4126 125 4127 125 4128 125 4129 125 4130 125 4131 125 4132 125 4133 125 4134 125 4135 125 4136 125 4137 125 4138 125 4139 125 4140 125 4141 125 4142 125 4143 125 4144 125 4145 125 4146 125 4147 125 4148 125 4149 125 4150 125 4151 125 4152 125 4153 125 4154 125 4155 125 4156 125 4157 125 4158 125 4159 125 4160 125 4161 125 4162 125 4163 125 4164 125 4165 125 4166 125 4167 125 4168 125 4169 125 4170 125 4171 120 4172 120 4173 125 4174 125 4175 120 4176 125 4177 125 4178 125 4179 125 4180 125 4181 125 4182 125 4183 125 4184 125 4185 125 4186 125 4187 125 4188 125 4189 125 4190 125 4191 125 4192 125 4193 125 4194 125 4195 125 4196 125 4197 125 4198 125 4199 125 4200 125 4201 125 4202 125 4203 125 4204 125 4205 125 4206 125 4207 125 4208 125 4209 125 4210 125 4211 125 4212 125 4213 125 4214 125 4215 125 4216 125 4217 125 4218 125 4219 125 4220 125 4221 125 4222 125 4223 125 4224 125 4225 125 4226 125 4227 125 4228 125 4229 125 4230 125 4231 125 4232 125 4233 125 4234 125 4235 125 4236 125 4237 125 4238 125 4239 125 4240 125 4241 125 4242 125 4243 125 4244 125 4245 125 4246 125 4247 125 4248 125 4249 125 4250 125	4521 250 4522 150 4526 150 4527 160 4528 120 4529 175 4530 89 4531 165 4532 140 4534 575 4536 395 4538 160 4539 135 4541 150 4543 175 4549 296 4553 440 4554 175 4555 85 4556 75 4557 425 4558 299 4559 290 4560 235 4561 95 4562 595 4566 190 4568 299 4569 250 4572 48 4574 595 4581 350 4582 150 4583 125 4584 64 4585 140 4586 140 4587 140 4588 140 4589 140 4590 140 4591 140 4592 140 4593 140 4594 140 4595 140 4596 140 4597 140 4598 140 4599 140 4600 140 4601 140 4602 140 4603 140 4604 140 4605 140 4606 140 4607 140 4608 140 4609 140 4610 140 4611 140 4612 140 4613 140 4614 140 4615 140 4616 140 4617 140 4618 140 4619 140 4620 140 4621 140 4622 140 4623 140 4624 140 4625 140 4626 140 4627 140 4628 140 4629 140 4630 140 4631 140 4632 140 4633 140 4634 140 4635 140 4636 140 4637 140 4638 140 4639 140 4640 140 4641 140 4642 140 4643 140 4644 140 4645 140 4646 140 4647 140 4648 140 4649 140 4650 140 4651 140 4652 140 4653 140 4654 140 4655 140 4656 140 4657 140 4658 140 4659 140 4660 140
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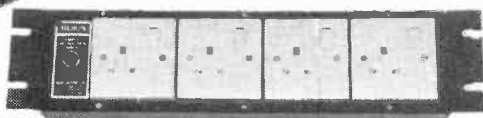
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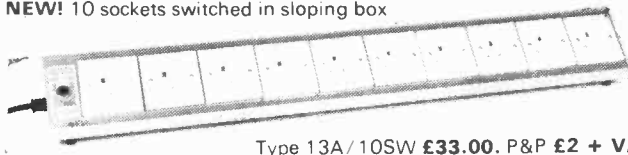


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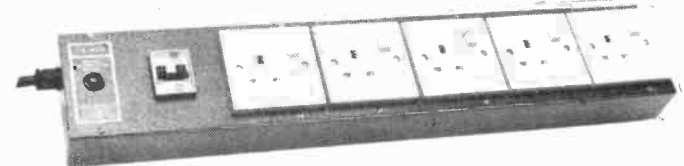
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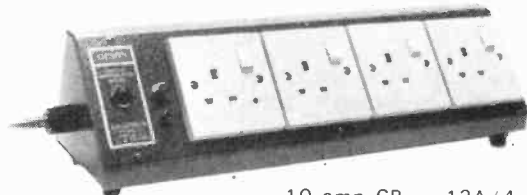


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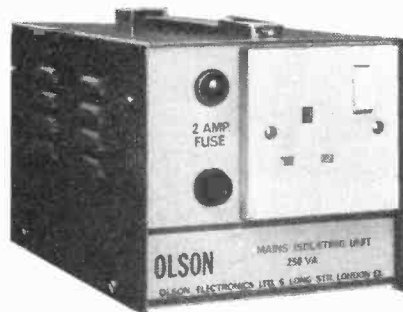
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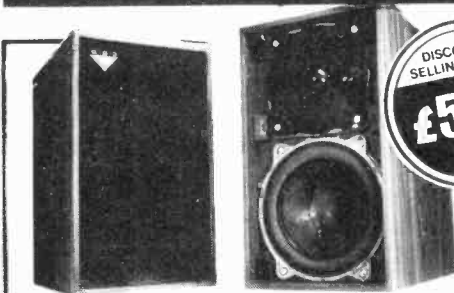
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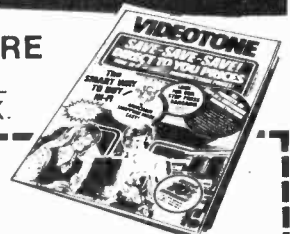
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TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

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

The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or 1/2% metal film), and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready-built units selling for many times the price.

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

**COMPLETE KIT ONLY
£168.50 + VAT!**



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

NEW! TRANSCENDENT POLYSYNTH

**EXPANDABLE POLYPHONIC SYNTHESIZER
AS FEATURED IN
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COMPLETE KIT from £320 + VAT

By brilliant design work and the use of high technology components the Polysynth brings to the reach of the home constructor a machine whose versatility and range of sounds is matched only by ready-built equipment costing thousands of pounds. This latest addition to the famous Transcendent family is a 4 octave (transposable over 7 octaves) polyphonic synthesizer with internally up to 4 voices making it possible to play simultaneously up to 4 notes. An add-on unit permits expansion up to 8 voices. Each voice is a complete synthesizer in itself with 2 VCOs, 2 ADSRs, 1VCA and 1 VCF. Being voltage controlled all voices can be adjusted simultaneously by master controls yet their own pitch and gate signals mean each voice can be operated independently from the keyboard.

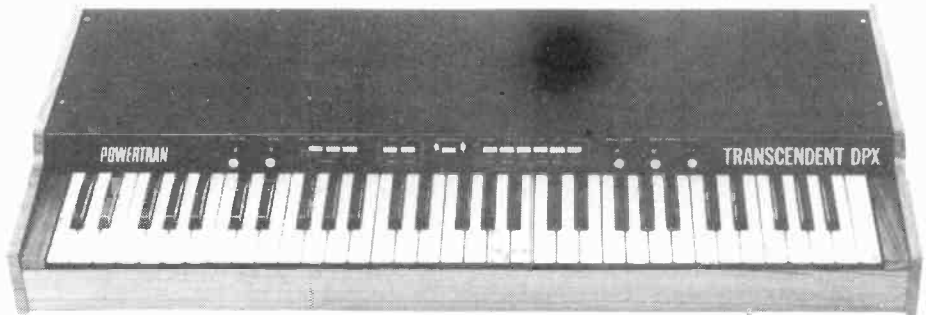
Although using very advanced electronics the kit is mechanically very simple with minimal wiring, most of which is with ribbon cable connectors. All controls are PCB mounted and the voice boards plug into PCB mounted sockets. The kit includes fully finished metalwork, solid teak cabinet, professional quality components (resistors 2% metal oxide or 0.5% and 0.1% metal film), nuts, bolts, etc. Complete kit with 1 voice £320, 2 voices £368, 4 voices £464, expansion unit to extend to 8 voices £275 (all prices subject to V.A.T.). A mere fraction of what you would have to pay for a ready-built comparable instrument!

TRANSCENDENT DPX

MULTI-VOICE SYNTHESIZER

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

**COMPLETE KIT
ONLY
£299 + VAT!**



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

The Transcendent DPX is a really versatile 5 octave keyboard instrument. 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 as a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass as the lower end (the keyboard is electronically split after the first two octaves) or vice-versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrator comes in only after waiting a short time after the note is struck for even more realistic string sounds.

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

As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing, etc., etc.).

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

The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug!

POWERTRAN

**MANY MORE KITS ON PAGE 115. MORE KITS AND ORDERING
INFORMATION ON INSIDE FRONT COVER**

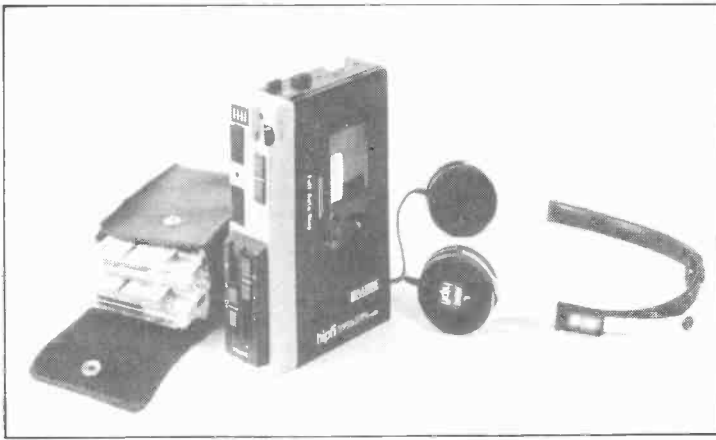
All projects on this page can be purchased as separate packs, e.g. PCBs, components sets, hardware sets, etc. See our free catalogue for full details and prices

DIGEST

Hi-Fi At Your Hip

Yup! It had to happen. Binatone have produced the cheap alternative to Sony's Stowaway portable cassette player. Called the HipFi, it will retail at £59.95. Backed by a nationwide advertising campaign, it has loads

of facilities: separate volume control for each channel, tone control, add-on headphones (optional extra), fast forward and rewind with cue and review, fold flat headphones for easy carrying and a direct talk line for communicating with the outside world. The three pencil alkaline batteries provide approximately eight hours playing time. See this month's Audiophile for further details.



IMPORTANT NOTICE

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

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

Multi Purpose

Further to our recent Digital Multimeter Survey, we have received details of Thurlby Electronics Ltd's new Model 1503 4 1/2 digit LCD Multimeter. It has an unusually long scale length of 32,768 counts (± 15 bits) and this enables it to monitor a 1 mV change in a 30 V power rail. Thirty measuring ranges are provided covering the five basic functions

of DC and AC voltage, DC and AC current and resistance. Diode test and frequency measurement functions are also included. Maximum voltage input is 1200 V and current can be measured up to 10 A continuous, 25 A short term. The 1503 is an entirely British design and sells for £139. For further information contact Thurlby Electronics Ltd, Suite 1, Coach Mews, The Broadway, St Ives, Huntingdon, Cambs, PE17 4BN.



Breadboard 80

Whatever aspect of electronics you're into, make sure you're in London in November for this year's Breadboard exhibition. From CB to home computing,

soldering to synthesisers — demonstrations, special offers — it's all at Breadboard 80.

The exhibition runs for five days — the doors open at 10.00 am on November 26th (watch the electronics Press for full details). Don't miss it.

Jaws — OK Style

OK Machine & Tool's new 'AD' wire dispenser comes complete with its own teeth. It's a heavy duty cutting and stripping wire dispenser with precision ground steel cutters and die stamped stripping blade. The strip length can easily be adjusted from 9 1/2-51 mm and the stripping blades can be changed to handle 24 or 30 AWG (0.5 or 0.25 mm) wire. 24 and 30 AWG dispensers are available with 15.2 and 30.5 m of wire respectively. Both offer a choice of insulation colour.

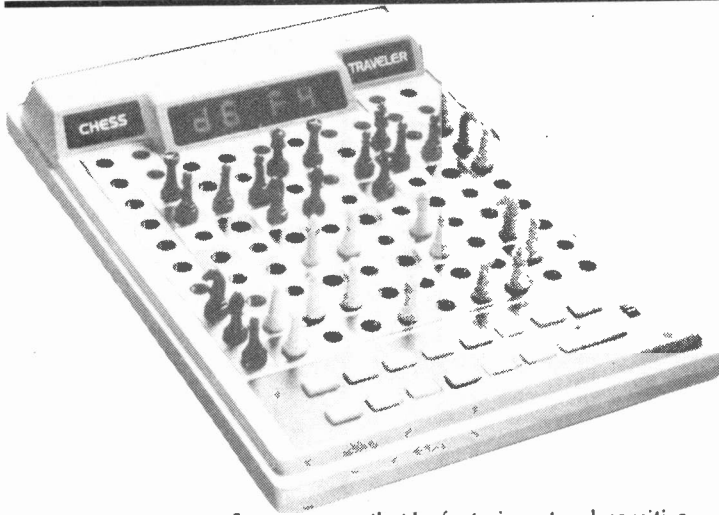
The transparent case nicely avoids that embarrassing situation when you sit down to do a job, pull out a length of wire and find that you're holding the last four inches of wire in your hand. You can see through OK's dispenser how much wire is left on the roll. Refill rolls are available and easily fitted.

For more information on the 'AD' cutting and stripping wire

dispenser contact OK Machine & Tool (UK) Ltd, Dutton Lane, Eastleigh, Hampshire SO5 4AA.



TTLs by TEXAS				93 SERIES				74S SERIES				TRANSISTORS				BFR40				TIP30A				2N3055				3N204				6A 50V			
7400	11p	74293	150p	4020	100p	9301	160p	74500	60p	745114	120p	AC126	25p	BFR41	25p	TIP30C	60p	2N3442	140p	3N204	250p	6A 100V	80p												
7400	60p	74298	200p	4022	100p	9302	175p	74504	60p	745124	300p	AC127/8	20p	BFR79	25p	TIP31A	58p	2N3553	240p	40360	40p	6A 400V	120p												
7401	12p	74365	100p	4023	27p	9308	316p	74505	75p	745132	160p	AC176	25p	BFR80	25p	TIP31C	62p	2N3665	30p	40361	2	10A 400V	200p												
7402	12p	74366	100p	4024	50p	9310	275p	74508	75p	745133	75p	AC187/8	25p	BFR81	25p	TIP32A	68p	2N3584	250p	40364	120p	25A 400V	400p												
7403	14p	74367	100p	4025	20p	9311	275p	74510	90p	745136	225p	AF116	50p	BFX29	40p	TIP32C	82p	2N3620	48p	40408	90p														
7404	14p	74368	100p	4026	130p	9312	160p	74520	60p	745139	225p	BFX43	70p	BFX30	30p	TIP33C	90p	2N3702	3	40409	100p														
7405	18p	74390	200p	4027	50p	9314	165p	74530	60p	745157	250p	AD161/2	45p	BFX85	5	TIP33C	114p	2N3704	5	40410	100p														
7406	36p	74393	200p	4028	84p	9316	225p	74532	90p	745174	250p	AU107	20p	BFX86/7	30p	TIP34A	115p	2N3706/7	14p	40411	300p														
7407	36p	74490	225p	4029	100p	9321	225p	74537	90p	745175	320p	BC107/8	11p	BFX88	30p	TIP34C	160p	2N3708	9	40412	100p														
7408	17p	74451	150p	4030	55p	9322	150p	74538	60p	745194	350p	BC109	11p	BFW10	90p	TIP35A	225p	2N3773	30p	40413	300p														
7409	19p	74450	14p	4031	200p	9324	360p	74539	90p	745211	450p	BC117	20p	BFX50	30p	TIP35C	290p	2N3819	25p	40414	75p														
7410	15p	74452	16p	4032	200p	9328	250p	74540	90p	745260	70p	BC147/8	9p	BFX51/2	22p	TIP36A	270p	2N3820	3	40415	90p														
7411	24p	74453	100p	4035	110p	9370	300p	74586	300p	745373	500p	BC149	10p	BFX56	33p	TIP36C	340p	2N3823	70p	40416	100p														
7412	20p	74454	16p	4036	295p	9374	200p	745112	120p	745374	500p	BC157/8	10p	BFX90	50p	TIP41A	65p	2N3866	90p	40417	100p														
7413	30p	74455	25p	4039	295p							BC159	11p	BFX39	45p	TIP41C	78p	2N3902	700p	40418	100p														
7414	40p	74458	22p	4040	100p							BC192	12p	BSX19/20	20p	TIP42A	70p	2N3903/4	18p	40419	100p														
7414	90p	74459	21p	4041	80p							BC192	12p	BU104	225p	TIP42C	82p	2N3905/6	20p	40420	100p														
7416	27p	744510	20p	4042	80p							BC177/8	17p	BU105	190p	TIP54	160p	2N4037	65p	40421	100p														
7417	27p	744511	20p	4043	90p							BC178	18p	BU108	250p	TIP120	120p	2N4058	9	40422	100p														
7420	17p	744513	40p	4044	90p							BC181	30p	BU109	250p	TIP122	130p	2N4060	12p	40423	100p														
7421	40p	744514	50p	4046	110p							BC184	11p	BU125	150p	TIP142	130p	2N4061	2	40424	100p														
7422	22p	744520	20p	4047	100p							BC187	30p	BU180A	120p	TIP147	130p	2N4123/4	27p	40425	100p														
7423	34p	744521	40p	4048	55p							BC212	3	BU205	200p	TIP2955	78p	2N4125/6	27p	40426	100p														
7425	30p	744527	38p	4049	45p							BC214	12p	BU208	200p	TIP4055	70p	2N4401	3	40427	100p														
7426	40p	744529	40p	4050	45p							BC237	16p	MJ3001	225p	ZTX300	145p	TIS43	45p	40428	100p														
7427	34p	744532	27p	4051	80p							BC327	16p	E300	50p	TIS93	30p	2N4871	60p	40429	100p														
7428	36p	744537	30p	4052	80p							BC337	16p	E308	50p	ZTX108	12p	2N5087	27p	40430	100p														
7430	17p	744538	38p	4053	80p							BC338	16p	E310	50p	ZTX300	13p	2N5089	27p	40431	100p														
7432	30p	744542	70p	4054	150p							BC461	36p	MJ2501	225p	ZTX500	15p	2N5172	27p	40432	100p														
7433	40p	744547	75p	4055	125p							BC477/8	30p	MJ2955	90p	ZTX502	18p	2N5179	90p	40433	100p														
7437	35p	744551	24p	4056	125p							BC516/7	40p	MPS402	45p	ZTX504	30p	2N5191	90p	40434	100p														
7438	35p	744555	30p	4059	60p							BC528	15p	MJ3040	50p	2N4574	250p	2N5194	90p	40435	100p														
7440	17p	744573	50p	4060	115p							BC546	9p	MJ2955	100p	2N695	35p	2N5245	40p	40436	100p														
7441	70p	744574	27p	4063	120p							BC549C	18p	MJ3055	70p	2N697	25p	2N5296	55p	40437	100p														
7442A	60p	744575	36p	4066	50p							BC557B	16p	MPF102	45p	2N698	45p	2N5401	50p	40438	100p														
7443	112p	744576	45p	4067	450p							BC559C	18p	MPF103	4	2N706A	30p	2N5457	8	40439	100p														
7444	112p	744583	70p	4068	27p							BCY70	18p	MPF05/6	40p	2N708	30p	2N5459	40p	40440	100p														
7445	100p	744589	40p	4069	20p							BCY72	22p	MPS442	50p	2N918	45p	2N5460	60p	40441	100p														
7446A	93p	744586	40p	4070	30p							BD131/2	50p	MPS6534	50p	2N930	18p	2N5485	44p	40442	100p														
7447A	75p	744590	40p	4071	25p							BD139	56p	MPSA06	30p	2N1131	236p	2N5875	250p	40443	100p														
7448	80p	744592	70p	4072	25p							BD213	56p	MPSA02	50p	2N1613	236p	2N6027	48p	40444	100p														
7450	17p	744593	60p	4073	25p							BD242	70p	MPSA13	50p	2N1711	25p	2N6041	160p	40445	100p														
7451	17p	744596	110p	4075	25p							BD189	60p	MPSA20	50p	2N1702	70p	2N6044	160p	40446	100p														
7453	107p	744597	10p	4076	10p							BD232	95p	MPSA42	50p	2N2160	350p	2N6052	30p	40447	100p														
7454	17p	744509	80p	4081	27p							BD233	75p	MPSA44	50p	2N219A	30p	2N6059	325p	40448	100p														
7460	17p	744512	40p	4082	27p							BD235	85p	MPSA56	32p	2N222A	30p	2N6107	65p	40449	100p														
7470	36p	744513	90p	4086	72p							BD241	70p	MPSA70	60p	2N2369A	25p	2N6247	190p	40450	100p														
7472	30p	744514	45p	4089	150p							BD242	70p	MPSU06	63p	2N2484	30p	2N6254	130p	40451	100p														
7473	34p	744522	60p	4093	70p							BDY56	60p	MPSU07	60p	2N2646	45p	2N6290	65p	40452	100p														
7474	30p	744523	80p	4094	250p							BF200	32p	MPSU45	50p	2N2904	30p	2N6292	35p	40453	100p														
7475	38p	744527	60p	4095	95p							BF200	32p	MPSU65	78p	2N2906A	30p	2N6293	72	40454	100p														
7476	32p	744528	50p	4096	95p							BF256	70p	OC28	130p	2N2907A	30p	3N128	120p	40455	100p														
7480	50p	744526	50p	4097	340p							BF257/8	32p	OC35	130p	2N2926	9p	3N140	120p	40456	100p														
7481	100p	744532	60p	4098	120p							BF259	36p	TIP29A	40p	2N3053	30p	3N141	110p	40457	100p														
7482	84p	744533	30p	4099	200p							BFR39	25p	TIP29C	55p	2N3054	65p	3N201	110p	40458	100p														
7483A	90p	744536	55p	4100	220p																														
7484	100p	744537	55p	4101	220p																														
7485	110p	744539	55p	4102	180p																														
7486	34p	744545	120p	4103	180p																														
7489	210p	744547	220p	4104	99p																														
7490A	30p	744548	175p	4105	120p																														
7491	80p	744549	10p	4106	90p																														
7492A	46p	744550	10p	4107	60p																														
7493A	36p	744554	200p	4108	470p																														
7494	84p	744555	80p	4109	100p																														
7495A	70p	744556	90p	4110	300p																														
7496	65p	744557	60p	4114	250p		</																												



Piece Work

With the two latest additions to the successful Chess Challenger series of games, the Challenger is moving away from the concept of a chess board with a computer tacked onto the side, towards the truly electronic board. If you're wary of computers and keyboards, you may have been put off buying a chess machine up to now because of the business of entering your move on the keypad. The Sensory 8 gets round

that by featuring a touch-sensitive playing surface, by means of which the computer can 'see' the pieces and automatically enter each move. A light on each square shows the 'from' and 'to' positions. Eight levels of play can be selected and skill level can even be changed in mid-move. All the usual Chess Challenger features (position verification, problem-solving, etc.) are featured.

Following on from the Voice Chess Challenger, you can now also buy a Voice Sensory Chess



Challenger. In addition to all the Sensory 8's features, it speaks its own moves, repeats yours, calls out captures and rattles off all the board positions on command. If this dedicated dalek's voice gets a bit too much you can switch it off (unlike human opponents).

The voice version also has a built-in chess clock showing the time left for you or the computer and the elapsed time for the game. You can buy a plug-in printer to provide a copy of every move in the game. Sensory 8 sells for £129.95 and Voice Sensory for

£279.95.

Aimed at chess players with itchy feet, Ingersoll Electronics have introduced the Chess Traveller, featuring eight levels of play. The pieces push into holes on the board (with spare holes for taken pieces) and can be covered by a perspex top at half time or between games. Through the keyboard you can select skill level, verify board positions, solve problems and set up specific openings. Power is from mains or batteries. Chess Traveller retails at around £50.

Oops

Space Invasion Game

In the Space Invasion Game main circuit diagram (November 1980, p.66/67) pin 12 of IC11b is shown connected to earth. It should be connected to pin 34 of the CPU, IC15. All new boards supplied by Tangerine Computers will have this modification, so check your board before making any changes.

On the same diagram, the ICs are identified in two ways. Our own IC1, IC2, etc. notation identifies the components as they appear on the Parts List. The circled legends (A1, A2, B1, H4, etc.) are the positions of the ICs shown on the PCB supplied by Tangerine Computers.

IC20 pins 20 and 21 should be swapped over. The label adjacent to IC7c was ringed in error — it is diode D2 not position D2.

The Inch War

Length may not be everything, but JVC want to know how important it is to video tape recorder owners. They are shortly to test market four hour VHS tapes in the UK. As it is a test exercise, the new E240 tapes will be in very short supply until the experiment is complete and demand is established.

Cassette Interface

In the component overlay of the Cassette Interface project (October 1980 p.65 Fig.5) the junction of R4-R5-R6-C4 is shown connected to pin 1 of IC6. Instead it should be connected to pin 2 of IC6. The circuit diagram is correct but the foil pattern on p.109 is incorrect. Simply break the track connecting the above components to pin 1 and solder a new link across to pin 2. The Buylines information omitted from this project was included in Digest in the November issue.

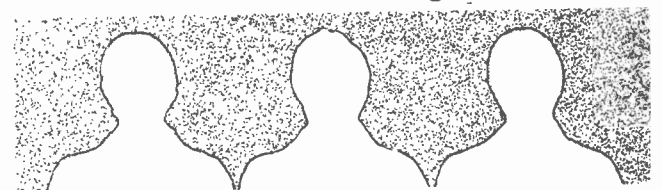
Radio Control

In the Radio Control Buylines section (October 1980) the prices quoted for the transmitter and receiver do not include PCBs, receiver case or SLM three-pin gold-plated servo connector block. Prices including these items are £8.57 for the transmitter kit and £14.26 for the receiver kit (including VAT) from Ambit International.

JVC expect the demand to come from owners of their new HR7700 recorder, with which every absentee landlord worth his salt can tape up to eight programmes from different channels in a fortnight.

So, if you like the idea of four hour VHS tapes, seek out the elusive JVC test retail outlets and form an orderly queue with piggy banks at the ready.

HELP! ETI NEEDS YOU!



Could you be a Project Engineer for ETI? — the person who fills this position will be able to design and build up projects to the standard of finish ETI readers are used to seeing in their magazine. This calls for someone with a good knowledge of circuit design and with the patience to carry the design through to a finished state. Existing staff are available to assist in all aspects of design work. The easiest part of the job will be writing up the project once it is completed. None of the present ETI technical staff were journalists previous to joining, and no-one has found the writing a difficult task.

We have no preconceived notions of age required.

Applications should reach us as soon as possible with C.V.

Apply in writing to:
The Editor,
Electronics Today International
145 Charing Cross Road,
London WC2H 0EE



Airwaves

Sony technologists have recently developed what they consider to be "the most advanced portable communications receiver in the world." The ICF-2001 receiver is no bigger than a hard-cover book and has the capability of capturing English-language short-wave programmes from Australia to Finland, foreign language

services from all four corners of the earth, ship-to-shore, amateur and Citizens Band as well as standard medium-wave, long-wave and FM broadcasting. It has a built-in minicomputer instead of a tuning dial, so instead of searching for the frequency of your favourite (or a new) station, with this model you simply punch in the frequency you require on a pocket calculator style keyboard, or instruct it to scan wave bands and stop automatically each time it reaches an 'on air' transmission. If it's a station you want to listen

to frequently, you simply enter it into the computer memory and recall it by pressing one of the six 'preset' buttons. And that's not all! Other features include dual PLL synthesiser circuit for stable reception, auto-scan tuning, manual tuning, preset tuning, liquid crystal multi display, electronic 90 minute sleep timer and powerful 6 W output. The ICF-2001 sells for a mere £150. For further information contact Sony (UK) Ltd, Pyrene House, Sunbury Cross, Sunbury on Thames, Middlesex, TW16 7AT.

Royal Award

On September 11th this year HRH the Prince of Wales launched a new award — a challenge to industry and people with new ideas. The Prince of Wales Award for Industrial Innovation will be presented in June 1982 following a competition promoted and organised by the BBC programme 'Tomorrow's World'. The aim is to encourage people with innovative ideas to get them accepted by an industrial backer, eventually to have their ideas taken into production. The first step will be to invite people to send their ideas to 'Tomorrow's World' for scrutiny. The competition is open to institutions and individuals

alike. The closing date for this first stage is December 31st 1980.

Certificates will be presented to the winners (who will be expected to have found a commercial backer to qualify) at the end of the current series of programmes. During the following twelve months those ideas will be developed and by June 1982 the judges will decide who has made the most promising, enterprising and exciting commercial development. The winner will be awarded the Prince of Wales Award for Industrial Innovation and Production for that year. For further details contact: Unit Manager, 'Tomorrow's World', BBC TV, London, W12 8QT.

Project 80

The number of inquiries we receive on the Project 80 modular synthesiser seems to be inversely proportional to the number of shopping days left to Christmas. Is it going to finish in the December edition? Will it be miraculously transformed into Project 81 as from the January 1981 edition? Are we going to continue to support it?

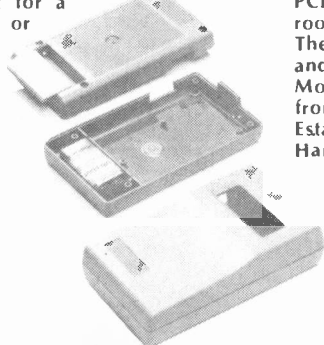
Well, it won't be finished in this issue and it won't be transformed into Project 81, but we certainly are

going to continue supporting this very, very popular series. We are going to bring together in one magazine all the Project 80 articles published to date (with new additions or amendments, where necessary) together with three new modules, the keyboard design, the keyboard controller, setting up procedures and a brand new section on module and whole-system applications written by the system designer, Charles Blakey.

Watch out for the Project 80 handbook on the bookstalls in January.

Pocket Box

A new pocket-sized, hand-held case is now available from Vero Electronics. With a 20 x 50 mm cut-out for a display or switch



panel and an integral battery compartment (PP3), it's ideal for remote control handsets and hand-held instruments. The top section will take a 71 x 107 mm PCB and the bottom section has room for a 56 x 105 mm board. The two sections snap together and are secured by four screws. More information is available from Vero Electronics, Industrial Estate, Chandler's Ford, Eastleigh, Hampshire SO5 3ZR.

Boffin Badge

The following is not to be mistaken for an ETI special offer. Address all your orders clearly to the Physics Dept. at Imperial College.

The Physics Dept.
Imperial College

Dear Sir,

This is an 'unsolicited Press Release to inform you of my latest, and rather wacky, entrepreneurial venture.

Available within the next fortnight, bona fide physicists will be able to have their very own badges with the legend:

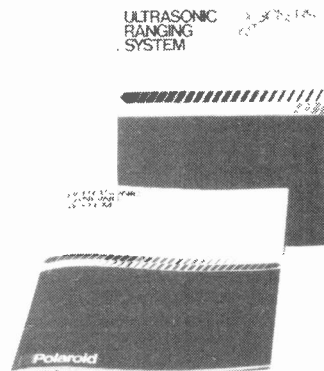
'I am A. S. Lipson'.

The wearing of the above artefact will, of course, raise the proud owner to the very pinnacle of his subject. It is sure to become the fashionable attire for discerning readers of this publication, so be advised — order today.

Yours faithfully

The Mysterious Physicist

P.S. Discounts are naturally available on large orders.



Sound Designing

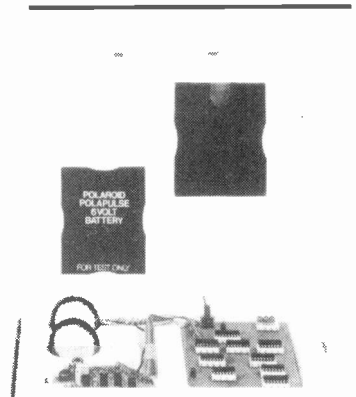
The ultrasonic rangefinding system used in Polaroid's SX-70 sonar focusing cameras since 1978 is now available separately as a designer's kit. Polaroid can supply an attractive kit containing two sonar transducers, the necessary circuitry to convert time into distance, two 6V Polapulse batteries, a LED readout and a technical manual. Both of the transducers emit and receive four-frequency ultrasonic signals.

Applications? The system has already been used in the unlikelyst of places. When Gossamer Albatross crossed the Channel by pedal power, it had to be flown at a precise height above the brine. However, none of the commercially available altimeters give accurate readings below about 20 m. Gossamer wave-hopping was achieved using a

custom-built altimeter incorporating the Polaroid system.

Ultrasonic rangefinding could be useful to a pilot of any aircraft manoeuvring in limited air space close to the ground or to a driver who doesn't have all-round vision from his cab. In fact, any situation where a measurement of distance has to be converted into an alarm signal or a control signal could put the Polaroid kit to good use. Several medical applications spring to mind immediately — automatic focusing glasses (especially for cataract patients), sonar cane for the blind, obstacle warnings for wheelchair-users, etc.

For more information on the Polaroid Designer's Kit, contact Polaroid (UK) Ltd, Ashley Road, St Albans, Hertfordshire.

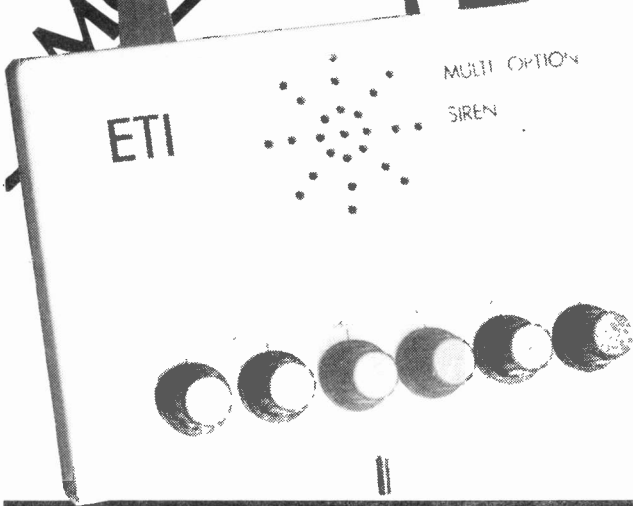


**NEXT
MONTH**

electronics today

INTERNATIONAL

Look out for the January issue on sale December 5th



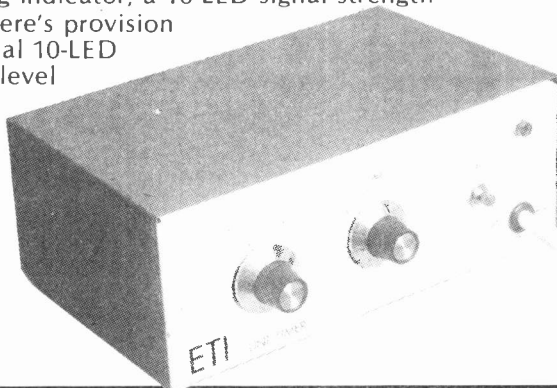
DIGITAL TACHO/OVER-REV INDICATOR

Keep track of your revs with the ETI Digital Tacho and Over-Rev Indicator. Watch the revs climb the LEDs in two ranges up to a maximum of 10,000 RPM. Set the rev limit of your choice. When you exceed it, the display flashes and continues to give a true read-out — suitable for most makes of cars with four, six or eight cylinders.

FM TUNER

This attractive FM Tuner, built around the 7254 tuner module from Ambit, has been designed to match the popular Audiophile 4000 Amplifier. It offers switch selectable muting, AFC and mono/stereo. The 200 mV output can be fed directly to the input of any stereo audio preamplifier. Tuning is selected by switch or by a conventional rotary control. The design also incorporates a search and lock facility to find strong FM broadcasts in the 87.5 to 104.5 MHz band.

And that's not all — the unit is fitted with a 20-LED tuning indicator, a 10-LED signal strength meter and there's provision for an optional 10-LED stereo audio level indicator.



MULTI-OPTION SIREN

You can build a circuit that sounds like Kojak on his way to the lollipop store; you can knock up a little black box to make a few sci-fi sound effects; you can probably even find a device to imitate a trimphone. But our Multi-Option Siren does it all. This versatile box of tricks gives you full control of tone, vibrato and shape modulation and vibrato depth and rate. That little lot offers almost limitless combinations of sounds. As if that wasn't enough, you can also select ramp or pulse output.

PULSE GENERATOR

Our battery operated delay/tone burst generator is an accurate and reliable piece of test gear, offering tone burst, pulse positive and pulse negative outputs. It features three clock generator ranges, six pulse delay ranges (from nanoseconds to milliseconds), six pulse width ranges (also from nanoseconds to milliseconds) and three tone ranges covering 1 Hz to 1 MHz in decade steps.

ELECTRONICS IN PHOTOGRAPHY

Microminiature electronic circuits and microprocessors — they've found their way into most aspects of work and play. Photography is no exception. Next month we look at what has happened to the humble 35 mm camera. You'll be amazed at what the manufacturers can pack into its compact frame.

GENERAL PURPOSE TIMER

Whether you want to time an egg or find out how long it takes to read ETI from cover to cover, our General Purpose Timer can solve your problem. There are two ranges — 1 to 10 minutes and 10 to 100 minutes. The relay output will handle up to 10 A. With the flick of a switch you can select timed make or timed break, with a neon indication of the output state — an economical project with a whole host of applications around the home and workshop.

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

FOUR INPUT MIXER



Four into one will go with this mini-mixer. Why not build one for your band today? Design and development by John Fitzgerald.

If you are in a band and your PA has a range of inputs you may wonder why you need a mixer. Well one of the advantages is that when your bass player thinks he is not loud enough to be heard over the rest of you, it's up to someone else to turn him up! Otherwise, you can so easily get that snowball effect where one musician turns up the volume only to be followed by all the rest and so on until every sentient being within earshot suffers premature deafness (pardon?).

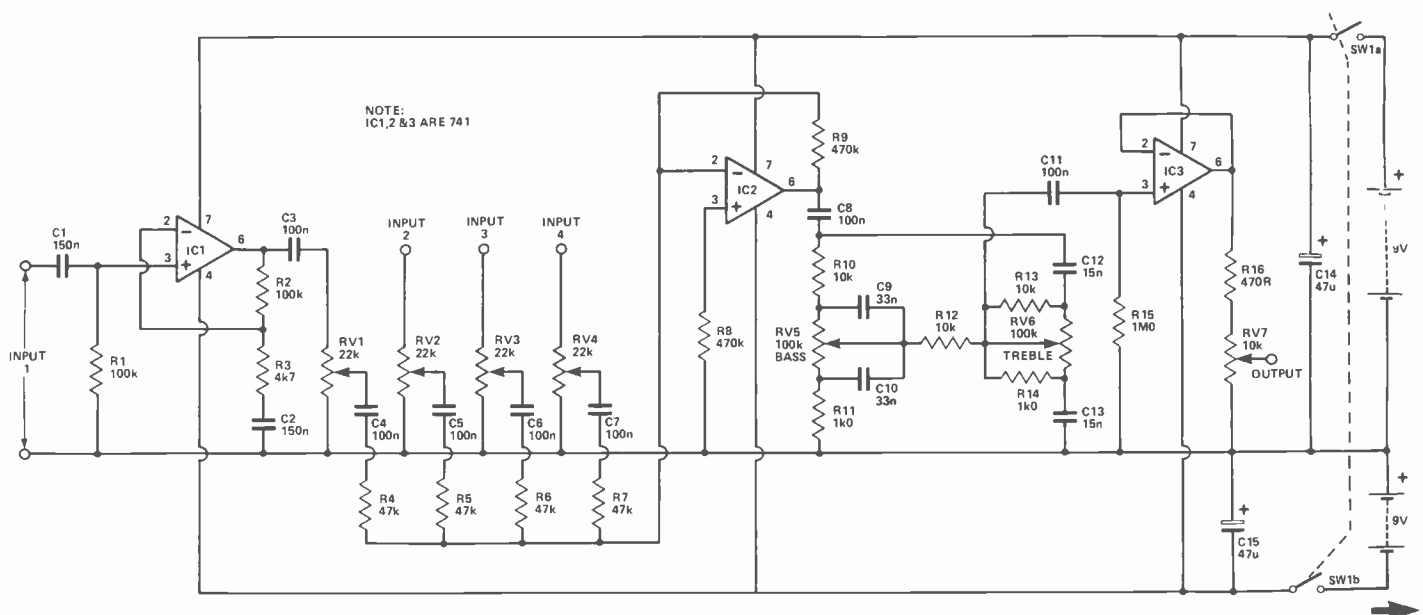
Many bands these days seem to have started on nothing and are maintained on a shoe string. If yours falls into this category, then this is the project for you. No-one is going to claim it's hi-fi but it is cheap. Using 741 op-amps will produce plenty of power versus cost.

HOW IT WORKS

The heart of the circuit is IC2, an op-amp connected as a conventional 'virtual earth' summing amplifier. This stage mixes the input signals and also has a gain of 10 to compensate for the insertion loss of the passive tone control network. There are three high level inputs and one low level which is input to IC1. This stage provides non-inverting amplification with a gain of about 20. Independent volume controls are provided for each input and the signals are mixed in IC2 before being passed to the tone control network. This provides a 40 dB range of control with an insertion loss at midband of -20 dB.

This output from the tone control is AC coupled to unity-gain voltage follower IC3. AC coupling avoids the problem of wiper 'track noise', which would result from the irregular capacitor charge and discharge currents. R16 is inserted in the output of IC3 to isolate the op-amp from the large capacitive load presented by a long length of screened cable. Potentiometer RV7 provides overall volume control and capacitors C14 and C15 decouple the power supply lines. Two 9 V batteries provide power for the unit and current consumption will be just a few milliamps.

Fig.1. Circuit diagram.



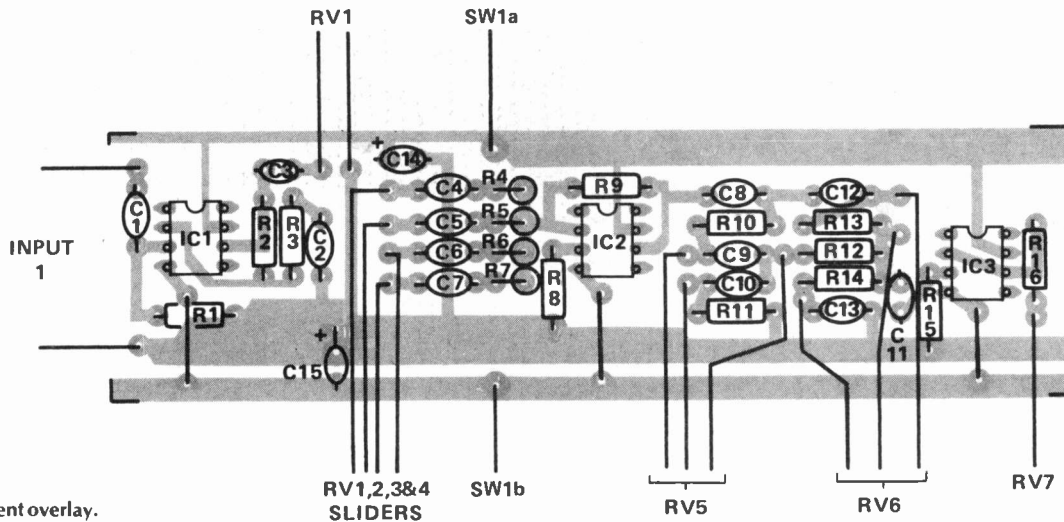


Fig. 2. Component overlay.

PARTS LIST

Resistors all ¼W 5%	
R1,2	100k
R3	4k7
R4,5,6,7	47k
R8,9	470k
R10,12,13	10k
R11,14	1k0
R15	1M0
R16	470R
Potentiometers	
RV1,2,3,4	22k logarithmic
RV5,6	100k logarithmic
RV7	10k logarithmic
Capacitors	
C1,2	150n polycarbonate
C3,11	100n ceramic
C4,5,6,7,8	100n polycarbonate
C9,10	33n polycarbonate
C12,13	15n polycarbonate
C14,15	47u 16 V tantalum
Semiconductors	
IC1,2,3	741
Miscellaneous	
Case, connectors, batteries, DPDT switch, etc.	

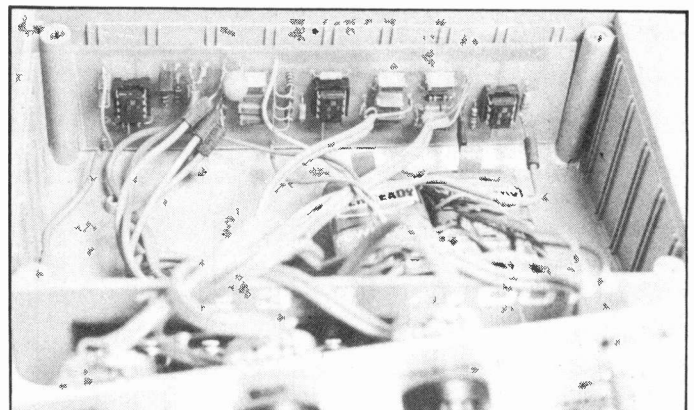
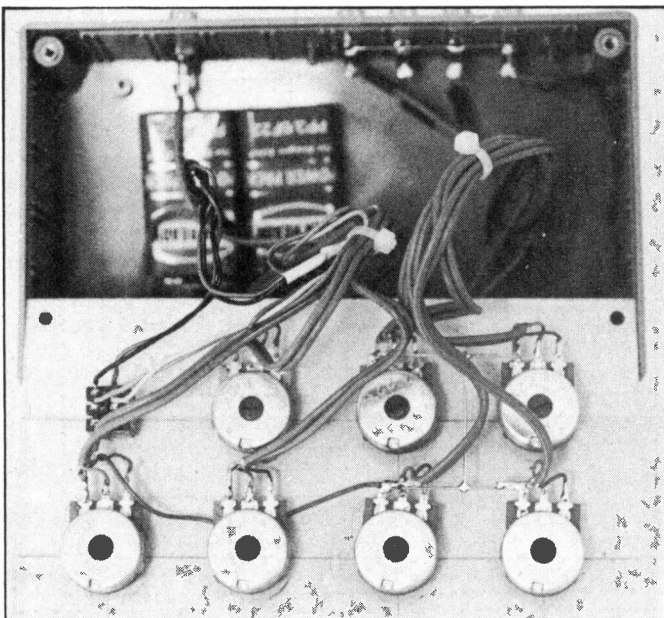
Construction

We built our unit into a small plastic case and mounted all the pots on the aluminium top cover, making the required connections with screened cable. Take care not to produce an 'earth loop' when connecting up. The remaining components can be mounted on our PCB; only three wire links are required to supply the op-amps' negative supply. We used polycarbonate capacitors mostly, taking advantage of their small size and good characteristics, though polyester types can be substituted. There are no special precautions to take. Just make sure you put the ICs in the right way up and get the polarity of the two tantalum capacitors right.

Remember, if you ever reverse-bias a tantalum cap by more than about 3 V it's dead certain that you'll have blown it up and it'll no longer be a capacitor; more a low-value resistor with the inevitable effect on circuit operation. No problems with this project, though. Simply build it, fix it and mix it!

BUYLINES

All the components for this project should be readily available. In case of difficulty, the polycarbonate capacitors are available from Watford Electronics or Electrovalue.



The PCB (above) tucks neatly away at one end of the case. Make sure the case is deep enough to allow clearance of the batteries and potentiometer bodies.

Front panel control layout (left).

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DORAM

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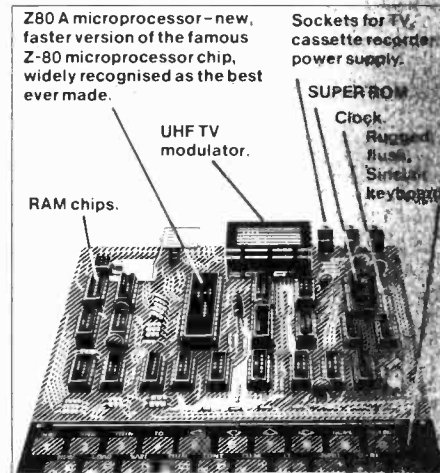
- **Single key touch key word entry:** the ZX80 eliminates a great deal of tiresome typing. Key words (FOR, PRINT LIST, etc.) are entered on a single key only.
- **Line wrap:** Only lines with correct characters are accepted into programs. A cursor displays characters late, and prevents you from entering complicated programs with only one hand when you try to fit them.
- **Excellent string handling capability:** takes up to 255 characters of any length. All strings can include special characters (e.g. comma). The ZX80 also has string input to make it easy to enter what is necessary. Strings do not have to be dimensioned.
- **10 x 20 matrix dimension arrays**
- **10000 x 1 characters up to 20**
- **Variable names of any length**
- **10000 Boolean expressions, etc.**
- **Fast, precise, power fed facilities,** allows a word of code to be written in 10 program lines.
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The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer - typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

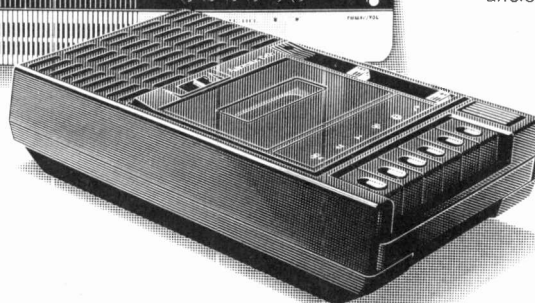
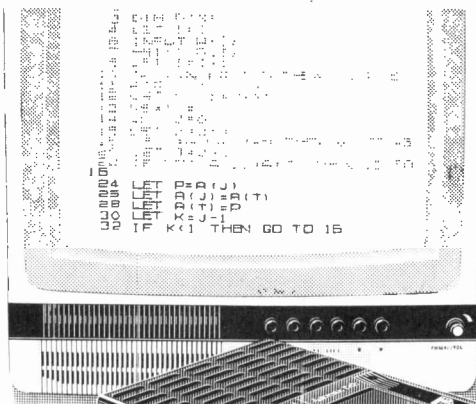
The display shows 32 characters by 24 lines. And Benchmark tests show that the ZX80 is faster than all other personal computers.

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BANDPASS AND BEYOND

Here's some more from Mr. Orr. Our circuit specialist looks at the development of bandpass design, switched capacitor techniques and some new ICs.

Many machines such as spectrum analysers and vocoders use analysing filter banks, these are often quarter octave devices extending over six octaves. If quarter octave filtering is to be successful then the bandpass filter responses must be very sharp, having almost flat tops and a fast roll-off slope at either side. A poor slope would mean that the filter bank would not be able to resolve incoming signals; for example a sinewave might give a high output in several of the channels. Also, a very peaky response would give large interfilter 'dips' in the overall response (Fig.1). An approximation to the square ideal response can be obtained by using multiple tuned filters. The response of a single pole bandpass filter is shown in Fig.2.

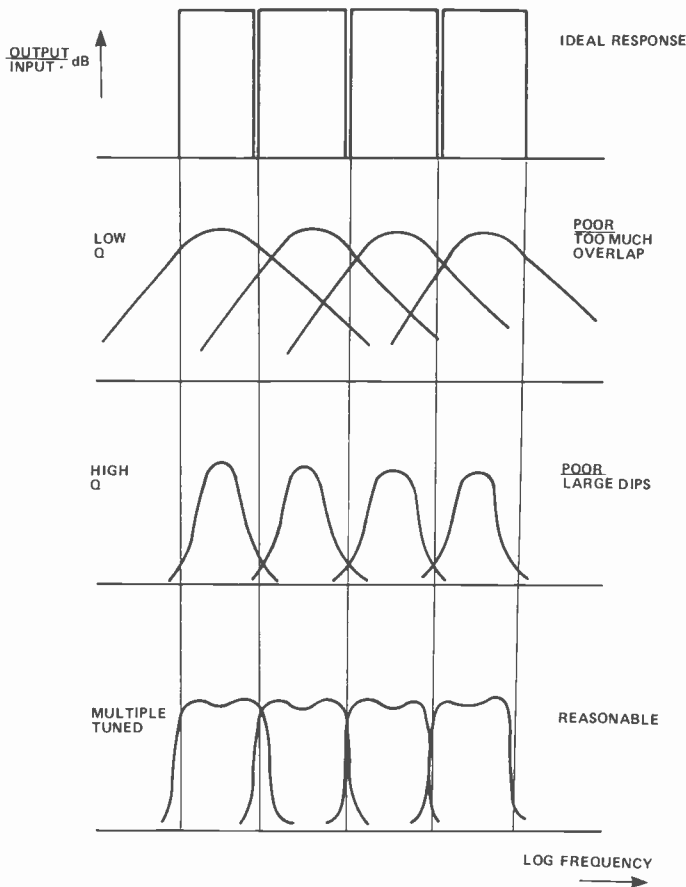
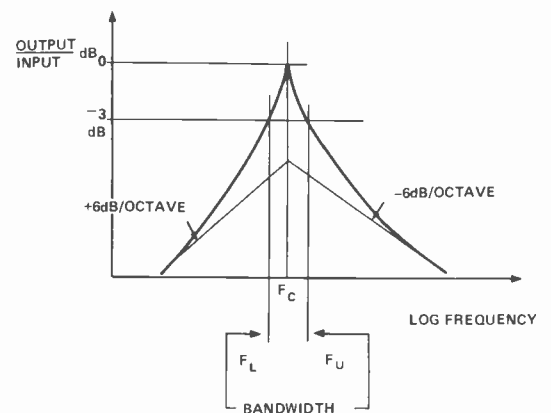


Fig.1. Various responses of an analysing filter bank.



$$3\text{dB BANDWIDTH}=(F_U-F_L)$$

$$Q \text{ FACTOR}=\frac{F_C}{(F_U-F_L)}$$

$$\text{ALSO, } F_C \approx \sqrt{(F_U F_L)}$$

$$\text{FINAL ROLL OFF SLOPES}=\pm 6\text{dB/OCTAVE}$$

Fig.2. Single pole bandpass response.

By Design

When designing bandpass filters it is important to decide what type of filters to use. Figure 3 shows two bandpass responses. Response A is a peaky filter, whereas B has a flat top to it, but still has the same roll off as A. One sensible design solution would be to use bandpass filters for A, and a highpass/lowpass structure for B. A rule of thumb for making this decision is to calculate the fractional bandwidth:-

$$\frac{F_U - F_L}{F_U \times F_L}$$

If this is greater than unity then use lowpass/highpass filters, if it is less than unity use multiple tuned bandpass filters. Some standard bandpass filter designs are shown in Fig.4. The multiple feedback circuit requires only one op-amp, but is limited to low Q operation (less than 5) and the centre frequency and Q are interactive.

R _A	R _B	C	F ₁	Q	R _C	R _D	C	F ₂	Q	
3k6	360k	15n	290Hz	5	5k1	510k	15n	205Hz	5	FILTER D
1k8	180k	15n	580Hz	5	2k55	255k	15n	410Hz	5	FILTER E

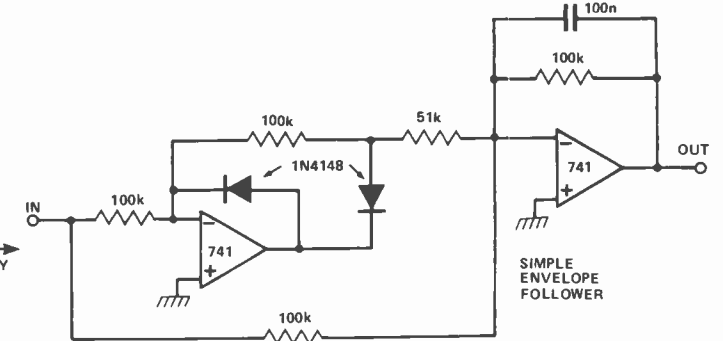
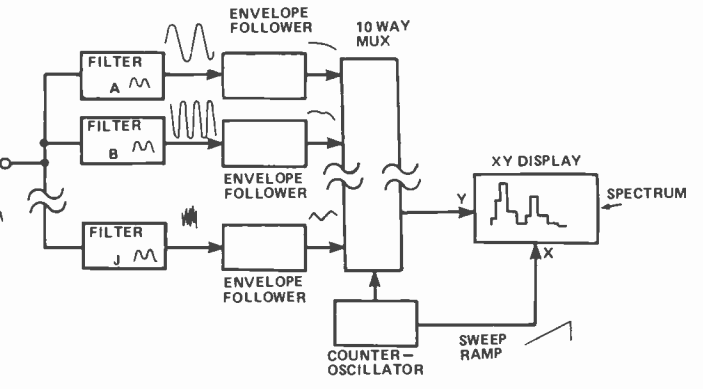
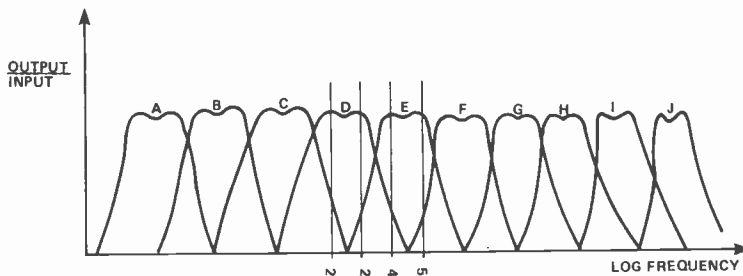
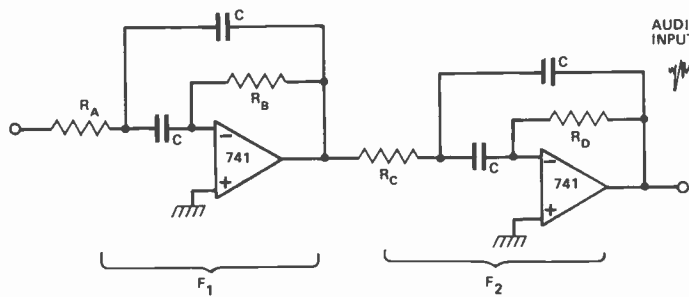


Fig. 6. An analysing filter bank suitable for a spectrum analyser. a) Circuit for each of the ten filter stages (A to J), and component values for two of the stages. b) Graph of the ten filter responses. c) Block diagram of the spectrum analyser and a suitable circuit for the envelope follower.

Other Design Applications

Figure 7 shows a design for a parametric audio equalizer. This device has variable cut and lift and a resonance and frequency control. The resonance control is arranged such that as the Q increases, the input signal is attenuated (RV2a), thus maintaining the same overall gain at resonance, independent of the Q setting. The filter is a state variable design which is situated in the feedback/feedforward loop of an op-amp. Thus RV3 controls whether overall response is a bandpass cut or lift.

The resonant frequency is tuned by RV1 and SW1 is used to switch frequency ranges. The Q factor is set by RV2.

The TCA580N (Signetics) is an IC that can be used to simulate an inductance and in doing so may be used to synthesize many conventional LCR filter circuits (Fig.8). The device has a pair of floating input terminals which generate the impression of being an inductor. This inductor is programmed by three passive components, R_{C1} , R_{C2} , C_2 . By connecting a capacitor (C_1) across the input terminals, a parallel resonant circuit (C_1L) is produced.

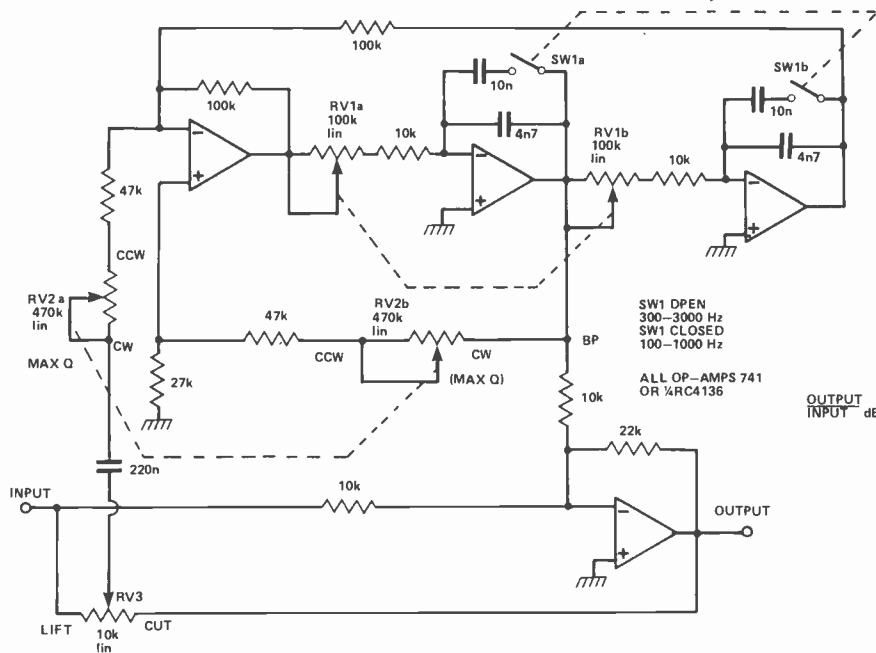
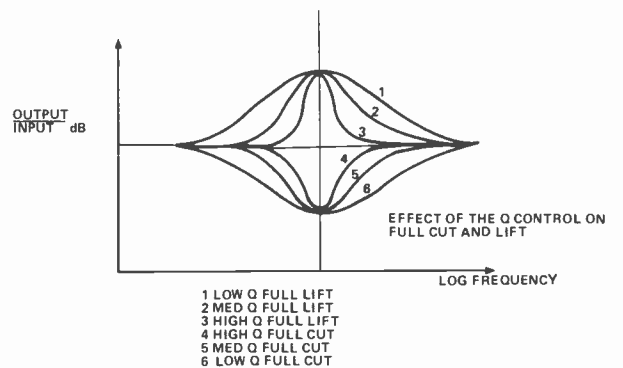


Fig. 7. A parametric audio equaliser with variable cut and lift and a resonance and frequency control.



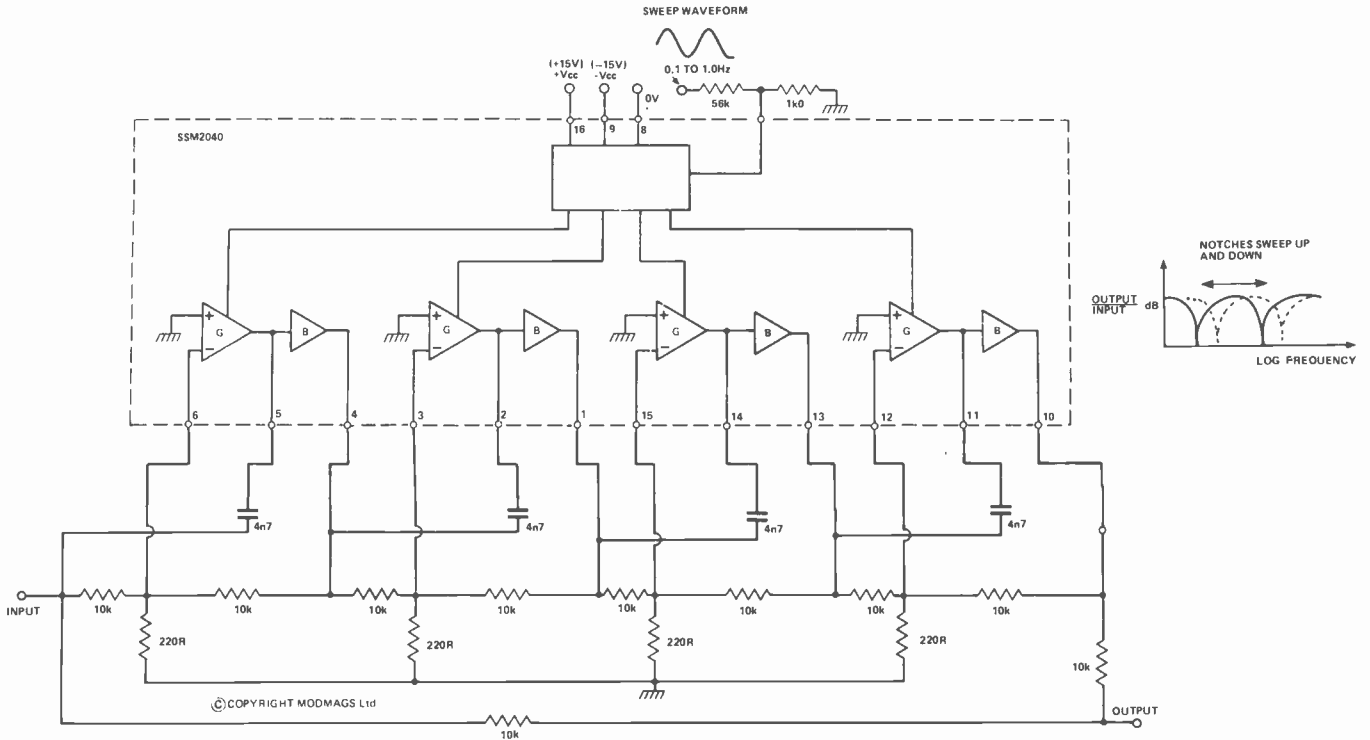


Fig.10. The SSM2040 connected as a two-notch phasing unit.

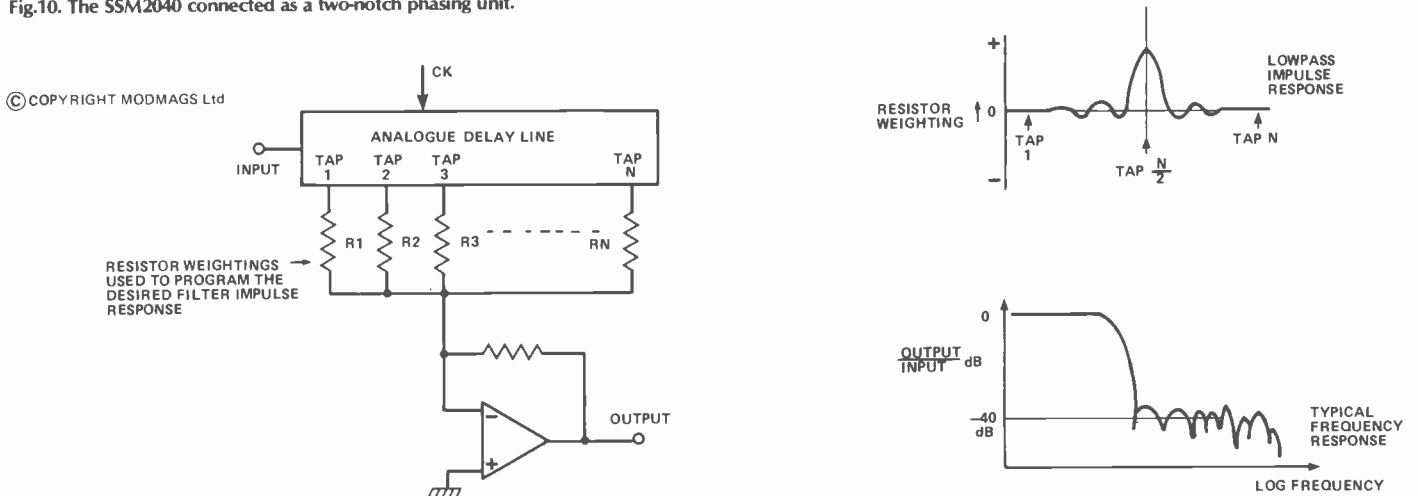


Fig. 11 The transversal filter, with graphs of impulse and frequency responses for a lowpass design.

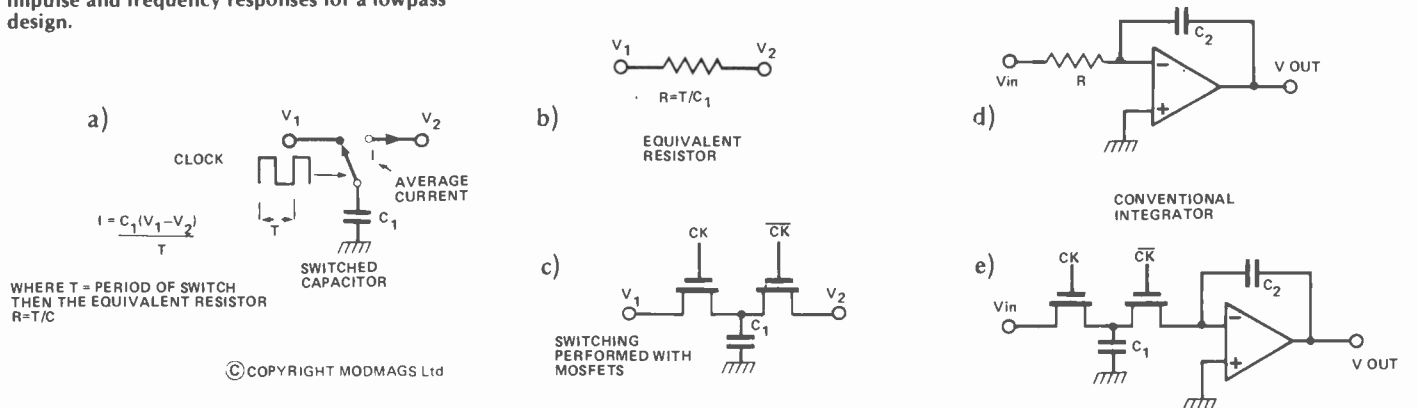


Fig.12. Switched capacitor filters. a) Basic circuit. b) The equivalent resistor. c) Practical design using MOSFETs. d) Conventional integrator. e) Replacing R with a switched capacitor enables a filter to be easily produced in IC form.

Recent Monos

A more recent monolithic device is the switched capacitor filter, which can be used to implement many standard lowpass and bandpass filter structures, Fig.12. The problem with producing monolithic recursive filters is that stable high tolerance components such as resistors and capacitors are very difficult to make, and the filter performance depends heavily upon these tolerances. However, it is possible to simulate resistors with switched capacitor techniques. With the switch as shown in Fig.12a C_1 is charged up to V_1 . When the switch is thrown to its other position the capacitor is discharged into V_2 . By continually switching the switch, a current I can be made to pass from V_1 to V_2 . This simulates a resistance R (where R equals the period of the switch divided by C_1). The switching is performed by two MOSFETs (Fig.12c) driven by antiphase clock signals. The simulated resistor can be used to construct an integrator (Figs.12d,e) which can then be used to build up conventional filter structures. For example a state variable filter would have a resonant frequency F_c , where

$$F_c = \frac{1}{2\pi RC_2}$$

but $R = \frac{T}{C_1}$

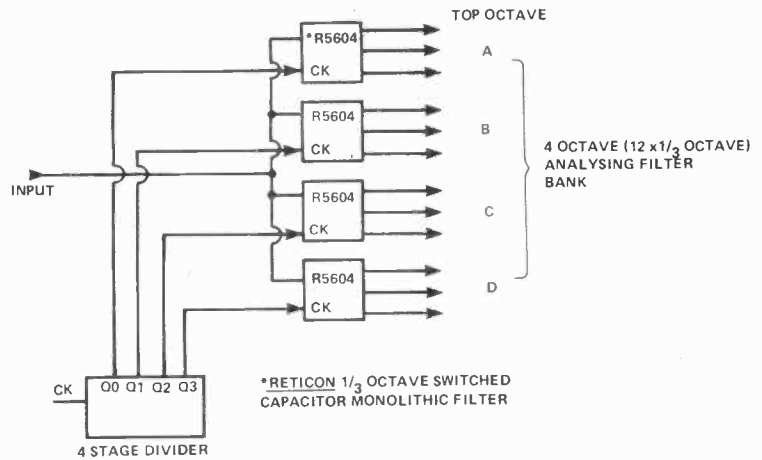


Fig.13. Switched capacitor filter bank using the R5604 from Reticon.

$$\text{therefore } F_c = \frac{C_1}{2\pi C_2 T}$$

Note that F_c is linearly proportional to $1/T$, which is the clock frequency.

Reticon make a switched capacitor bandpass filter which contains three filters at one-third octave spacing, thus making filterbank design relatively simple (Fig.13). Maybe in a few years time it will be possible to purchase a wide range of low cost monolithic filters. If that day comes, you won't need to learn how to design active filters!

ETI

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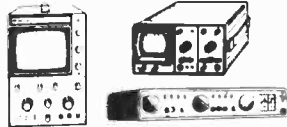
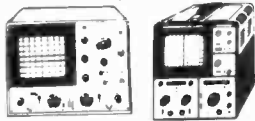
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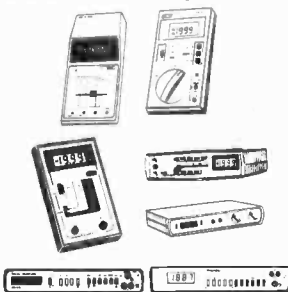


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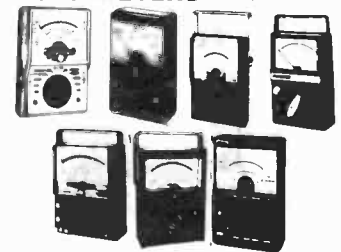
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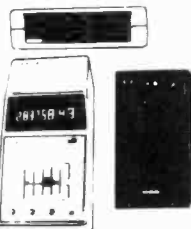
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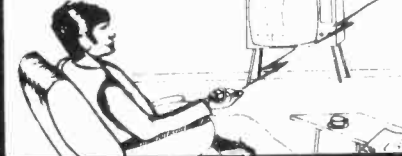
As with all our kits, these come complete with all components including RFI suppression, frontplate, a neon to help you find the switch in the dark and a neat box for the transmitter. The plastic frontplate has no metal pads to touch ensuring complete safety and enabling the plate to be covered with a decorative finish to blend with your room decor.



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In two years time everyone will be selling remote control dimmers but you can have your TDRK300K kit NOW for only **£14.30** for the dimmer unit and **£4.20** for the transmitter.

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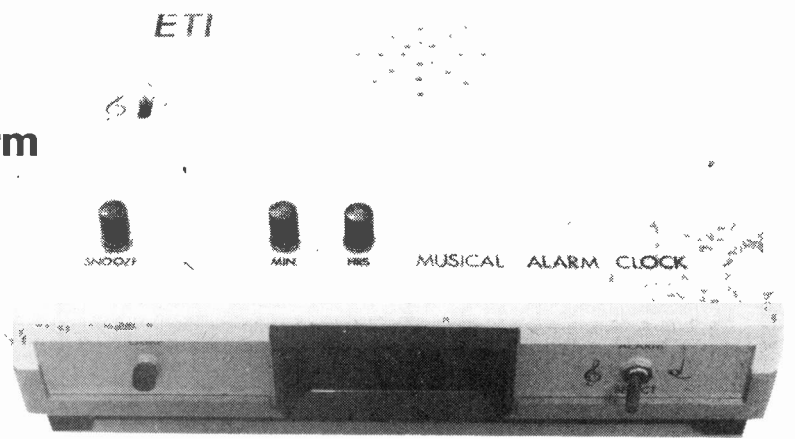
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MUSICAL ALARM CLOCK

This unique battery-powered alarm clock has all the usual facilities, but in addition it makes a tick-tock sound and plays a random selection of eight tunes under the alarm condition

Design by Ray Marston. Development by Steve Ramsahadeo.



This ETI alarm clock project has a number of unique features. First, the clock is based on a ready-built CM172 module that has a large liquid crystal readout and will give a year or two of continuous running from a single 1V5 cell. The module can be easily programmed for 'time set' and 'alarm set', remembers the 'alarm set' time indefinitely, has ten minute snooze facility, two alarm output terminals and a built-in backlight. The CM172 module forms the basis of the whole project.

The second feature of our clock is that we've provided it with a unique tick-tock sound generator circuit, so that the clock looks electronic but *sounds* like a mechanical device and can easily be located in a darkened room. The tick rate and volume are presettable, to suit individual tastes. The tick-tock circuit typically consumes a mere 9 uA of current and gives a couple of years of continuous running from a standard battery.

Finally, we've fitted our clock with a special and modestly priced microcomputer chip that, in conjunction with a handful of other components, generates a random selection of eight well known tunes under the alarm condition. The tempo, tone and volume of the tunes are variable via preset pots. The microcomputer chip is actually capable of generating a total of 24 different tunes in three selectable groups of eight tunes each (see Table 1).

In our circuit any one of the three groups can be manually selected via a switch. Electronic circuitry then randomly selects and plays complete tunes from that group, automatically inserting a random pause of up to several seconds between the end of one tune and the start of the next when the circuitry is active.

The tune-generator circuitry consumes virtually zero standby current, turns on automatically under the alarm condition, can be temporarily cancelled (for ten minutes) by a snooze button or can be disabled by either of two off switches. It can also be independently played at any time using the tune test switch. We've also provided the circuit with a switch that

gives you the option of selecting either the musical alarm or a more conventional pulsed tone alarm signal.

The complete alarm clock project uses a total of three batteries, there being a 1V5 cell for the actual clock module and two 9 V (PP3) batteries for the rest of the electronics. The 1V5 cell can be expected to give one or two years of continuous running. The two 9 V batteries should last about a year under normal usage conditions. The clock is fitted with a special switch-enable slide switch, which ensures that important functions and time settings cannot be inadvertently operated or changed by accidental switch operation at night or when the clock is packed away in a suitcase, etc.

Construction

Construction of the electronics of this project should present few problems. The basic CM172 clock module circuitry is quite independent of the alarm/tick-tock circuitry, so these two major units can be built and tested separately.

Start the construction by tackling the major mechanical problems. If you intend to use the same case as our prototype note that the front panel will need to be split into two and the upper and lower centre-front lips of the case will have to be cut away to accurately accommodate the clock bezel (a separate item, not supplied with the basic CM172 module). The bezel is then used to secure the module to the front panel.

Next, fit all the switches associated with the clock module (PB1, 2, 3, 4 and SW1, 2, 3) to the case and make the interconnections to the clock module solder pads as indicated in the circuit diagram, using a fine-tipped soldering iron. Now connect B1 (1V5) to the module (taking great care to fit it in the correct polarity) and give the clock a functional test as follows.

Turn SW1 on, press SW2 to TIME SET and use PB1 to set MINS and PB2 to set HOURS (when setting HOURS, check that the correct AM or PM indication is given at the left of the

display). Similarly, use SW2-PB1-PB2 to select the ALARM SET time, taking care to get the correct AM or PM indication. The alarm facility can be activated by turning SW3 on, in which case a treble clef musical sign will appear at the right of the display. PB4 operates a built-in backlight, for night viewing, and is intended for intermittent operation only.

Alarm/Tick-Tock Circuit

Proceed now to the construction of the alarm/tick-tock circuitry on the large PCB. Note that all ICs should be fitted in suitable sockets. The usual care should be taken to ensure that all semiconductor devices and electrolytics are fitted with the correct polarity. When construction is complete, temporarily fit speaker LS1 in place, together with SW4 and SW6. Connect B2 (9 V) in place, with its negative terminal to -ve and its positive to point A. Check that the tick-tock sound is generated and that its rate and volume are variable via presets PR4 and PR5 respectively.

Now connect B3 (9 V) in place, with its negative terminal to point A and its positive to +ve. Close tune test switch SW6 and check that the circuit randomly generates a selection of tunes, with the tempo, tone and volume variable via presets PR1, PR2 and PR3 respectively. The structure of the circuit is such that the musical alarm randomly runs through a selection of eight tunes, with an undefined pause between each tune. A total of three selections (24 tunes) are available and can be chosen by SW4 (see Table 1).

When you are satisfied that the circuitry is functioning correctly, remove all batteries (including B1), fit the speaker and switches SW4, 5 and 6 permanently in place in the case and complete the interwiring, taking special care over the connections between SW5 and the CM172 clock module. Finally, refit all batteries and give the musical alarm clock a functional check as follows.

Final Testing

Set the correct (real) time and the alarm time with SW2 and PB1-PB2, with the alarm time a minute or two away from real time. Turn the alarm function on via SW3. When the alarm

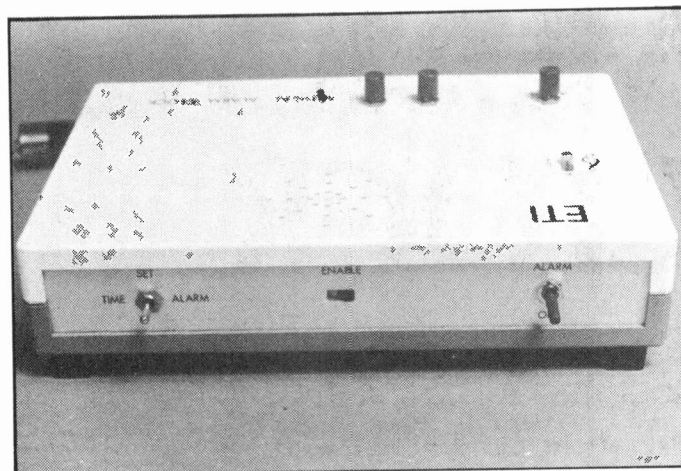
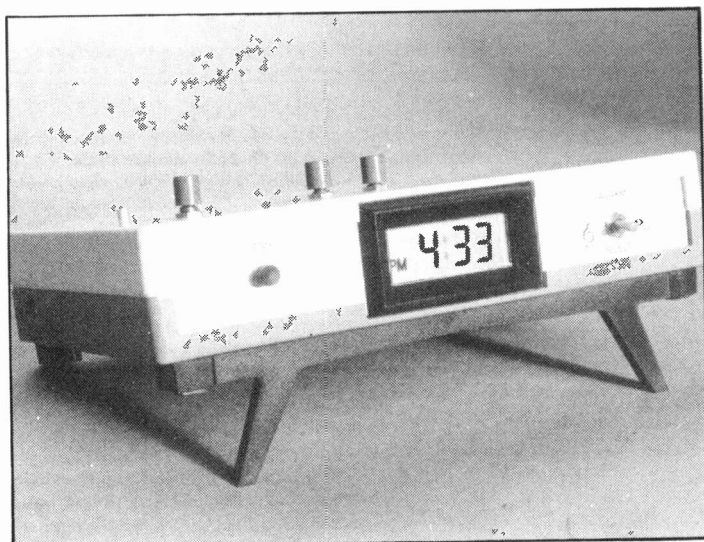


Fig.1. The back panel of the Musical Alarm Clock, showing the special switch-enable slide switch. This ensures that functions and time settings cannot be inadvertently changed.

time is reached, the alarm should be generated. The alarm will be musical with SW5 in the TUNE position or will be a pulsed-tone signal with SW5 in the TONE position.

Once the alarm has activated, it will continue to sound for about 12 minutes and then automatically turn off. If the snooze button is pressed when the alarm is activated, the alarm will immediately turn off and then automatically activate again after ten minutes. If SW3 is turned permanently off once the alarm has activated, the alarm will immediately turn off and remain off. If SW3 is momentarily turned off and then on again once the alarm has activated, the alarm will immediately turn off but will re-activate when the set alarm time is reached the following day.

IC OUTPUTS	TUNES
K1	R ₀ Greensleeves
	R ₁ God Save the Queen
	R ₂ Rule Britannia
	R ₃ Land of Hope and Glory
	R ₄ Sailors' Hornpipe
	R ₅ Westminster Chimes
	R ₆ Oranges and Lemons
	R ₇ Oh Come All Ye Faithful
K2	R ₀ Cook House Door
	R ₁ The Stars and Stripes
	R ₂ Beethoven's Ode to Joy (9th)
	R ₃ William Tell Overture
	R ₄ Red Flag / Maryland / Tannenbaum
	R ₅ Great Gate of Kiev
	R ₆ Twinkle Twinkle Little Star
	R ₇ Soldiers' Chorus (Faust)
K4	R ₀ Fate Knocking (Beethoven)
	R ₁ The Marseillaise
	R ₂ Deutschland Uber Alles
	R ₃ Toccatina in D Minor (Bach)
	R ₄ The Lorelei
	R ₅ Wedding March (Mendelssohn)
	R ₆ Colonel Bogie
	R ₇ Mozart

Table 1. Tune repertoire of the musical alarm clock.



Fig.2(Right): Circuit diagram for the ETI Musical Alarm Clock, showing alarm and tick-tock circuitry.

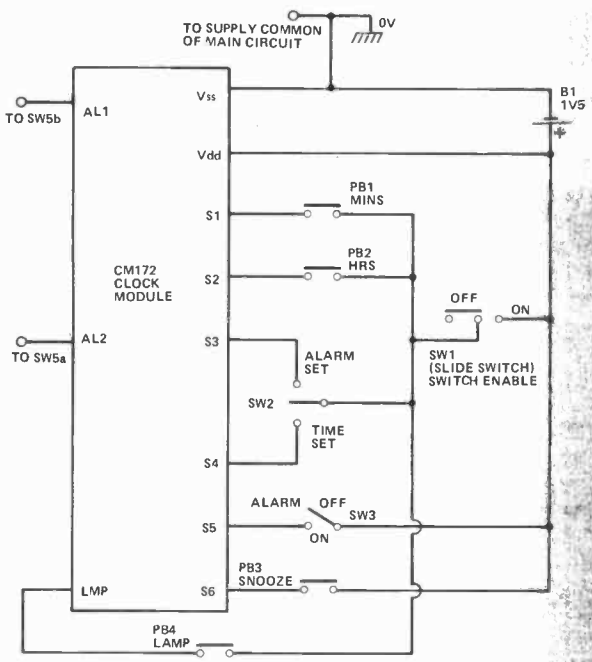
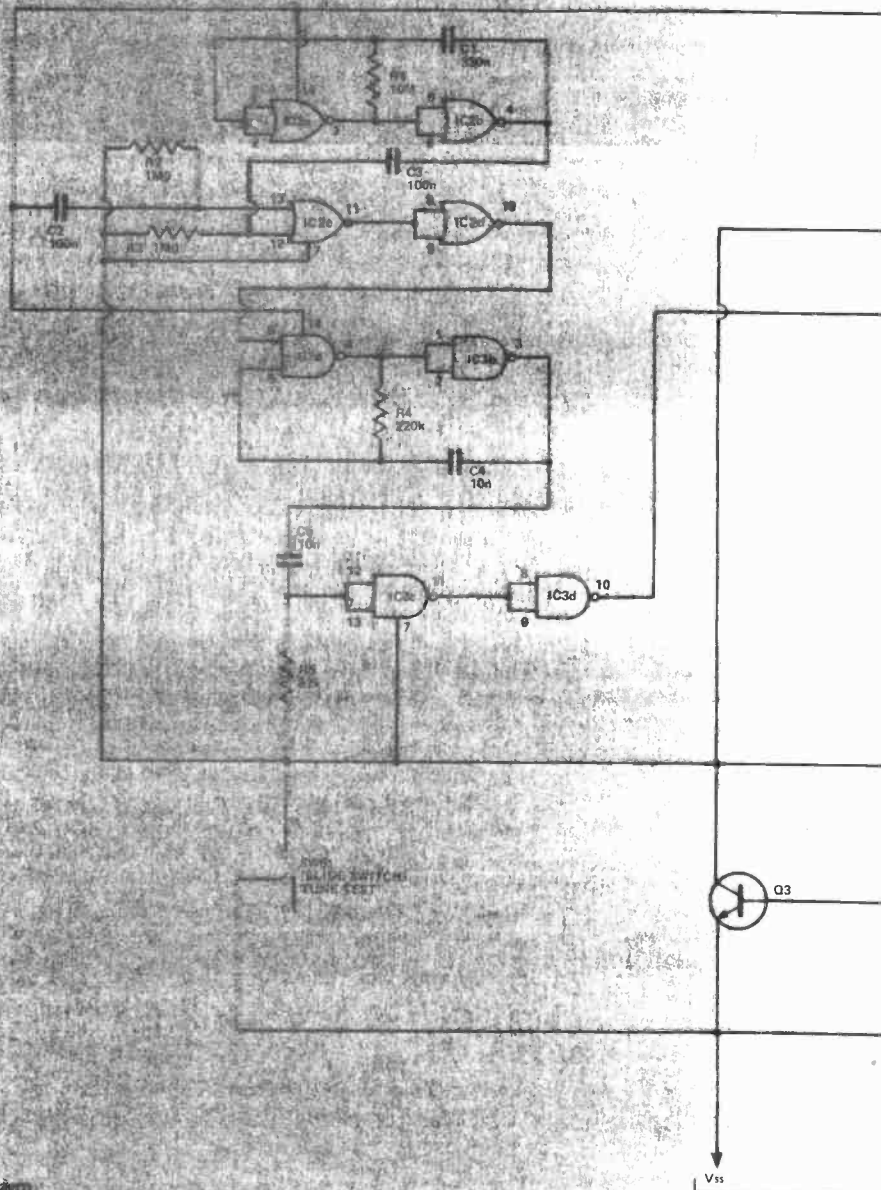


Fig.3(Above): Connections of the basic clock module for the Musical Alarm Clock.

HOW IT WORKS

The basic CM172 clock module is a ready-built, LCD-readout unit that forms the heart of our project. The module is powered by a 9V cell. Note that we've wired an enable slide-switch in series with the alarm set and time-set switches/buttons and with the back-light lamp button to guard against inadvertent operation of these mechanisms.

The CM172 module has two alarm-out terminals. In our particular application, a pulsed 1024 Hz tone (1 S on, 1 S off) is available at the AL1 output and a simple high potential is available at the AL2 output under the alarm condition. These outputs are available for a maximum of 12 minutes under the alarm condition; once activated, they can be temporarily cancelled (for ten minutes) by briefly closing snooze button PB3 or can be fully cancelled by momentarily or permanently turning SW3 off.

The CM172 circuit can be used as a stand-alone project, its operation being quite independent of the tick-tock and musical-alarm circuits used in the remainder of our alarm clock project.

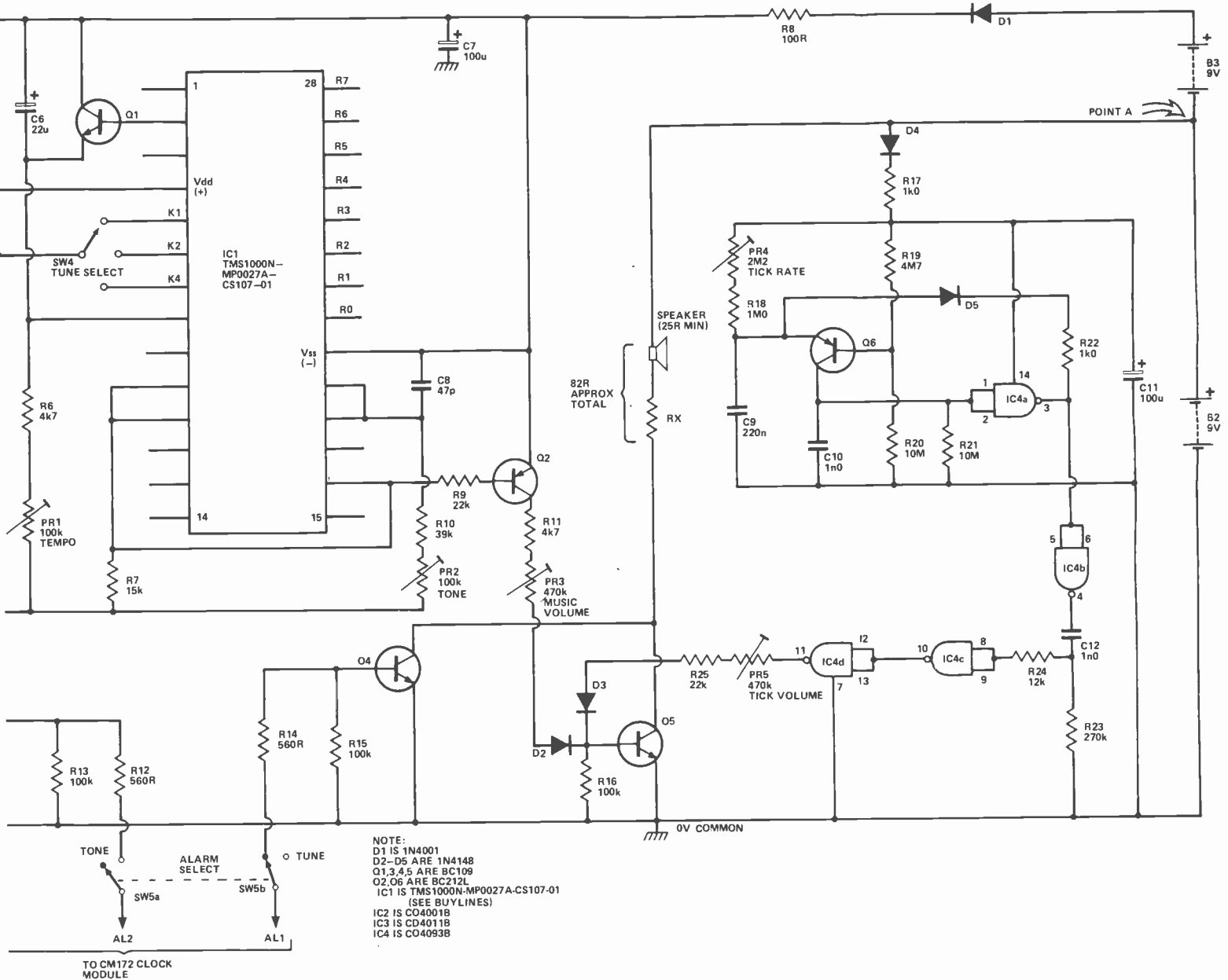
The tick-tock circuitry is powered from a 9 V supply (B1) and is designed around Q6-IC4 and Q5. A prime consideration in the design of this circuit is that of very low mean current consumption. The complete circuit typically consumes a mere 9 uA or so.

Q6 and IC4a are wired as a special astable circuit, powered from B1 via D1-R17 and C1. At the start of each astable cycle, C9 is discharged, Q6 is off and IC4a output is high. C9 then charges exponentially via R14 and R16 until eventually Q6 becomes forward biased and switches the output of IC4a (a Schmitt gate) low, at which point C9 is rapidly discharged via D5 and R22 and the operating cycle is complete. The cycle then repeats ad infinitum.

The output of IC4a is then fed to differentiating network C12-R23 via the 1.4k buffer, each differentiated spike is then converted to a clean pulse with a width of about 200 uA by IC4c and IC4d and is fed to pulse amplifier Q5 via the PR5 volume control and gate diode D3. Consequently, a very narrow current pulse is periodically fed to the speaker and causes the speaker (because of its inductive nature) to ring at 10 kHz natural resonant frequency and produce a characteristic tick sound (that this design should more correctly be called a tick-tick circuit). The tick rate can be varied by R14 to suit individual tastes.

The heart of the musical alarm is IC1, a microcomputer chip that contains a simple microprocessor together with a ROM pre-programmed with 24 tunes in digital form. Any one of these tunes can

PROJECT: Musical Alarm Clock



be selected by connecting the appropriate one of the $R_{\sigma}R_7$ terminals to the appropriate one of the K1, K2 or K4 terminals. Once a tune has been selected, it is made available in digitised analogue form across R7. The tune tempo is varied by PR1, the tone by PR2. The tune generator can be turned on by driving Q3 on or by closing SW6. In our application, the digitised analogue output of the tune generator is fed to the speaker via Q2-PR3 and via Q5 and gate diode D2.

The most unusual feature of our circuit is the method of tune selection and to understand this you need to know how IC1 actually works. IC1 normally selects tunes by sequentially scanning the $R_{\sigma}R_7$ pins to see if a connection exists between any of these terminals and any of the K pins, it being the time-coincidence of the feedback pulse to a K pin that causes actual selection. The scan frame is 10 mS, the scan rate is 450 μ S and the scan pulse width is 33 μ S.

In principle, therefore, it is possible to select a tune by simply feeding a narrow positive pulse to the appropriate K terminal, ignoring the R pins completely. If this pulse is frame-locked and time delayed, any required tune can be selected. If the pulse is not frame-locked, tunes will be selected at random from the available repertoire. Our cir-

cut uses this latter principle to implement random tune selection.

In our circuit IC2a and IC2b are wired as a slow (several seconds) astable. The output of this astable is converted to a periodic pulse (width about 100 mS) via C3-R3 and IC2c-IC2d and is used to gate a second astable comprising IC3a-IC3b. This astable has a period of about 3 mS and its output is converted to a 0.5 mS pulse via C5-R5 and IC3c-IC3d and fed to one of the K terminals of IC1 via SW4. The K signal thus comprises an occasional (once every few seconds) burst of 0.5 mS pulses with a 3 mS rate and causes successive tunes to be effectively selected at random.

Note that C2 and R2 are used in our circuit to ensure that the very first tune that is selected under the alarm condition is almost invariably the same, with the subsequent tunes being selected at random.

With SW5 in the tone position, the AL2 output of the clock module has no effect on our music generator circuit and the AL1 pulsed-tone signal of the clock module is fed to the speaker via Q4. When SW5 is in the tune position the AL1 output has no effect and the AL2 output is used to drive on Q3 via R12 and so activate the musical alarm circuit.

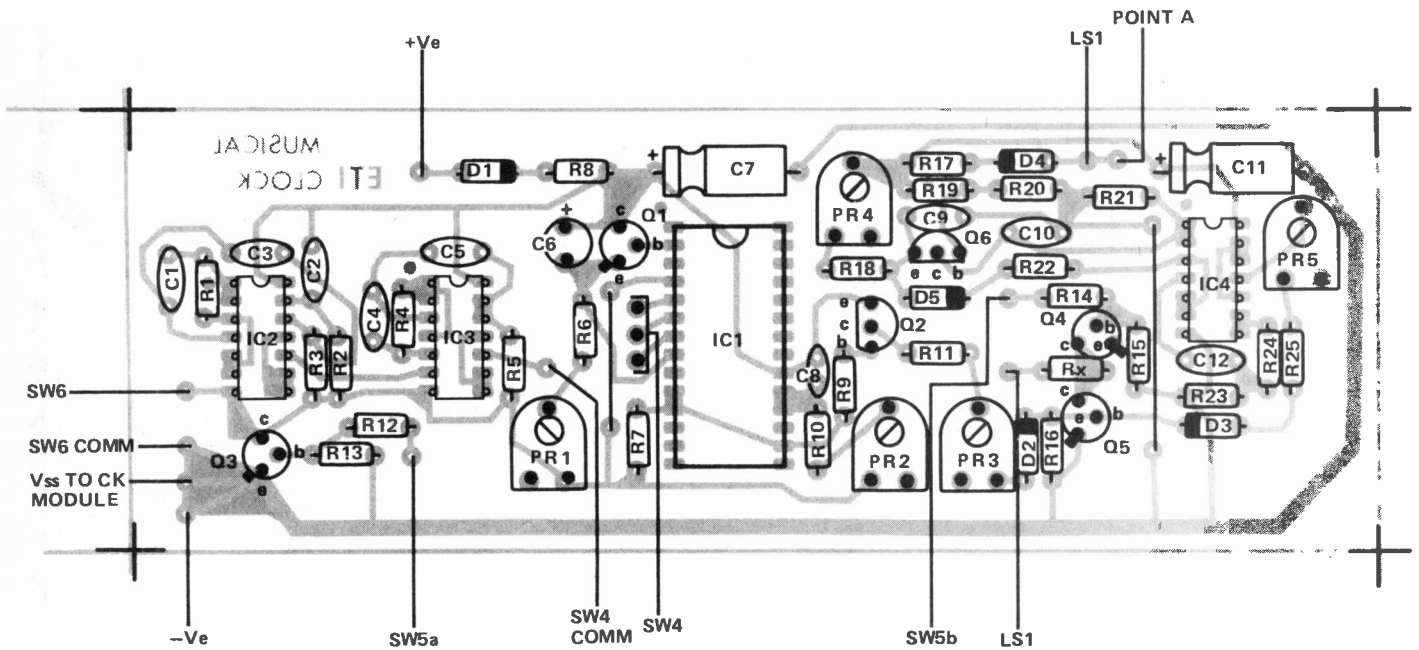


Fig.4 Component overlay for ETI Musical Alarm Clock.

PARTS LIST

Resistors All 1/4 W 5%

R1,20,21	10M
R2,3,18	1M0
R4	220k
R5	82k
R6,11	4k7
R7	15k
R8	100R
R9,25	22k
R10	39k
R12,14	560R
R13,15,16	100k
R17,22	1k0
R19	4M7
R23	270k
R24	12k
Rx	(see circuit diagram)

Potentiometers

PR1,2	100k miniature horizontal preset
PR3,5	470k miniature horizontal preset
PR4	2M2 miniature horizontal preset

Capacitors

C1	330n polycarbonate
----	--------------------

C2,3	100n polycarbonate
C4,5	10n polycarbonate
C6	22u 25 V electrolytic PCB type
C7,11	100u 25 V electrolytic axial
C8	47p ceramic
C9	220n polycarbonate
C10,12	1n0 polycarbonate

Semiconductors

IC1	TMS1000N — MP0027A
IC2	4001B
IC3	4011B
IC4	4093B
Q1,3,4,5	BC109
Q2,6	BC212L
D1	1N4001
D2-D5	1N4148
CM172	clock module

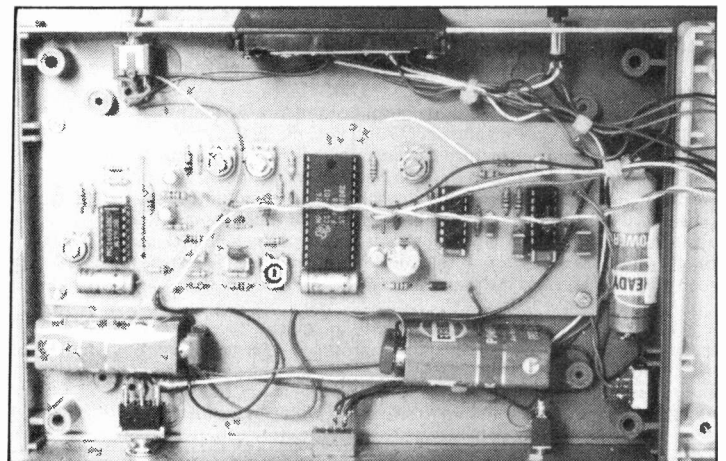
Miscellaneous

PB1,2,3,4 miniature push buttons; SW1,6 miniature slide switch; SW2 DPDT Centre off biased toggle; SW3 SPST miniature toggle; SW4 three position slide switch; SW5 DPDT miniature toggle; Vero case (order code 202-21034) plus tilt stand (202-21300G), PCB, Loudspeaker (see circuit diagram), Bezel.

BUYLINES

The clock module (CM172) and bezel is available from Ambit International. Most other components (except IC1) should be readily available from major stockists. Ambit International, 200 North Service Road, Brentwood, Essex.

IC1 is a special pre-programmed micro-computer chip and is exclusively available from Chromatronics, River Way, Harlow, Essex, under the designation TMS1000N — MP0027A. The chip costs about £5.



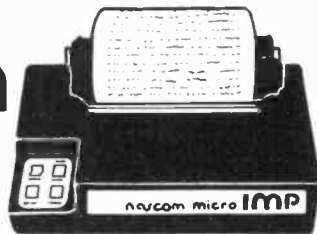
The photograph (right) shows the layout of our clock. Note the inclusion of three batteries.

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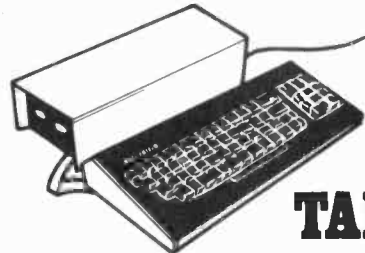


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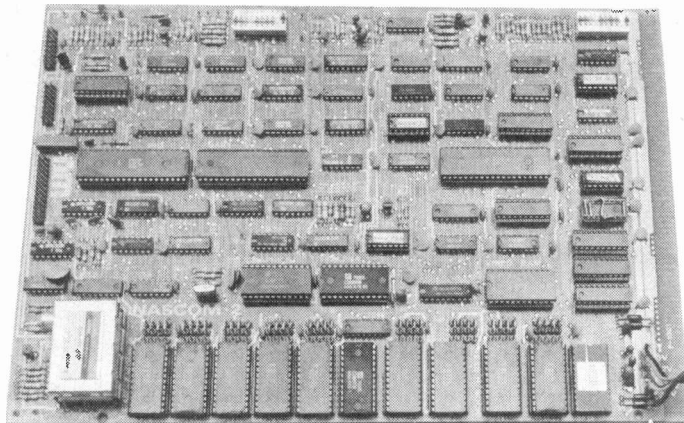
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MICROBASICS

This month Microbasics looks at the Ins and Outs of interfacing with computers and the special chips used. Henry Budgett explains the initials and the innards.



The NASCOM 2 is well equipped with I/O. Both the PIO (a PIA relative) and the UART can be seen centre left.

We have now reached the stage where we have a perfectly useable microcomputer system, except for one small point. We can neither communicate with it nor it with us! The electronic circuits that control these communications with the outside world are called interfaces and may, in general terms, be regarded as being one of three types; parallel, serial or system.

In this part of the series I shall deal with each in turn, leading up to the final part of the series on hardware aspects of microcomputers. Further episodes will deal with the complete system rather than the fundamentals.

Byte Sized Pieces

Parallel interfaces are generally used for local communication. They are extremely useful for transferring large amounts of data over reasonably short distances at high speed. Each transfer consists of a complete byte of data (hence the term parallel) and the interface must therefore consist of at least nine connections (the ninth being an earth or ground plane). In most cases there are more connections. These are controls which ensure that the data is sent only when needed and not sent when the receiving device isn't ready. This controlled transfer of data is known as 'handshaking' and varies in complexity from a simple strobe line, as is commonly found with ASCII keyboards, to a full-blown, defined standard such as the BS4421 interface, seldom seen nowadays outside specific institutions.

Versatile Interface

In implementing a parallel interface on a micro one generally uses a device such as a PIA (Programmable Interface Adaptor) or its close relative the VIA (Versatile Interface Adaptor). These come in a wide variety of guises but are essentially the same. The device contains a number of registers which can be directly accessed as memory locations by the programmer. Into these one may load information which will control the way the device behaves. A block diagram of a typical device is

shown in Fig. 1. Basically it consists of two 'ports' (a fairly obvious comparison) which may be set to operate as either inputs or as outputs. This behaviour is determined by the information set into the DDR (Data Direction Register). A logic '1' will select output and a logic '0' will select input.

To control the handshake there are usually two control lines provided per port. Each may be programmed to operate in a variety of modes, but a typical set-up is to have one line operating as a strobe. This signal is generated internally by the device and signals the data acceptor (that's the thing at the other end of the wire) that the data present on the lines at that instant is 'valid'. When the acceptor has taken the data off the lines it then signals back on the other control line that it has done so. This is the 'handshake'.

The programmer can monitor all these goings on by 'looking' at the various registers within the device (they appear to be memory locations) and inspecting the various data patterns. The job is thus made very easy for the programmer and the computer designer, unlike the days of minis.

Prior to the development of these devices, I/O, the ubiquitous acronym for Input and Output, was a complicated job involving logic to decode the various address and control busses and using the mildly complicated system of interrupts to find out which device needed to be serviced. Interrupts come outside the sphere of a hardware-based series because they are mainly dealt with in software.

Bits Of Information

The second interfacing method is serial connection. This, in theory if not in general practice, requires only two wires — one signal and one earth. A typical example of the species is the RS 232C interface, defined by the international telecommunications body CCITT. This (and most other examples) is driven from another fiendishly clever device acronymically known as a UART or Universal Asynchronous Receiver Transmitter.

In many of the modern devices this appears, like its parallel relative, as so much memory to the programmer and all the functions may be pre-defined in software

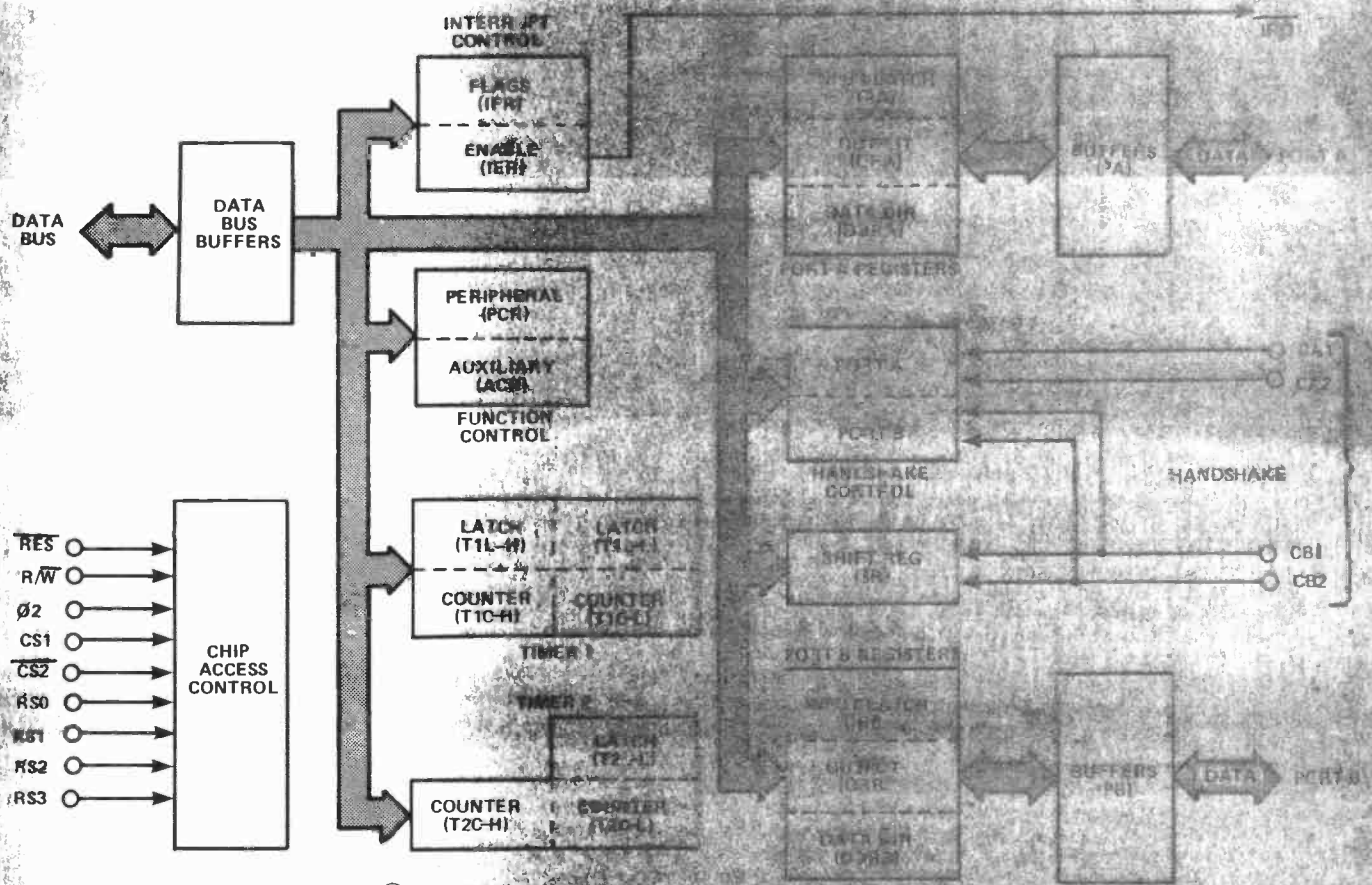


Fig. 1 A typical VIA device, the 6522, showing the various internal control registers and handshaking lines.

CONNECTOR PIN	FUNCTION	DIRECTION OF SIGNAL
1	PROTECTIVE GROUND	
2	TRANSMITTED DATA	DATA
3	RECEIVED DATA	SOURCE → ACCEPTOR
4	REQUEST TO SEND	SOURCE → ACCEPTOR
5	READY FOR SENDING	ACCEPTOR → SOURCE
6	DATA SET READY	ACCEPTOR → SOURCE
7	SIGNAL COMMON	
8	CARRIER DETECT	ACCEPTOR → SOURCE
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19	DATA TERMINAL READY	SOURCE → ACCEPTOR
20		
21		
22		
23		
24		
25		

Table 1 The V24 signal interconnection scheme. The source can be a VDU (for example) and the acceptor a modem or even the host computer.

rather than hardware. A typical device is shown in Fig. 2. Serial transmission has to follow a definite pattern or protocol, its version of handshaking. A typical sequence would be to transmit logic '1' until ready to go, then a single 'start' bit of logic '0' followed by the data, the associated parity bit and then to terminate with two bits of logic '1'. This pattern is shown in Fig. 3. It allows the

receiving device to recognise its bit to the data.

The key to an external device is its clock. This generally runs at 11 times the serial speed of the transmission; the data is actually sampled at 11 eighth cycles which allows a certain percentage tolerance between the transmitter and receiver frequencies.

There is obviously a protocol as simple as this will not prove very reliable at high speeds and several more control lines are added to perform a handshaking function. The signal connections of the V24, a close and direct relative and purpose, identical relative, is given in Table 1. The British equivalent is based on BS 4595 Part 5 and is again regarded as compatible. For full details the relevant standards documentation should be obtained.

Serial transmissions are often made via the PSTN (or Public Switched Telephone Network) to unscramble yet another acronym. This is done with a piece of equipment known as a MODEM. Yes, that's right, it's an acronym for Modulator/Demodulator. The device converts the serial data stream into two precise audio frequencies which are sent over the telephone line and detected by a similar unit at the other end, which reconverts them into meaningful data.

Systems On The Move

The system interface is generally called the bus. It is a parallel collection of all the necessary data, address and control signals required to operate not only the main CPU board but all the memory and peripheral devices as well.

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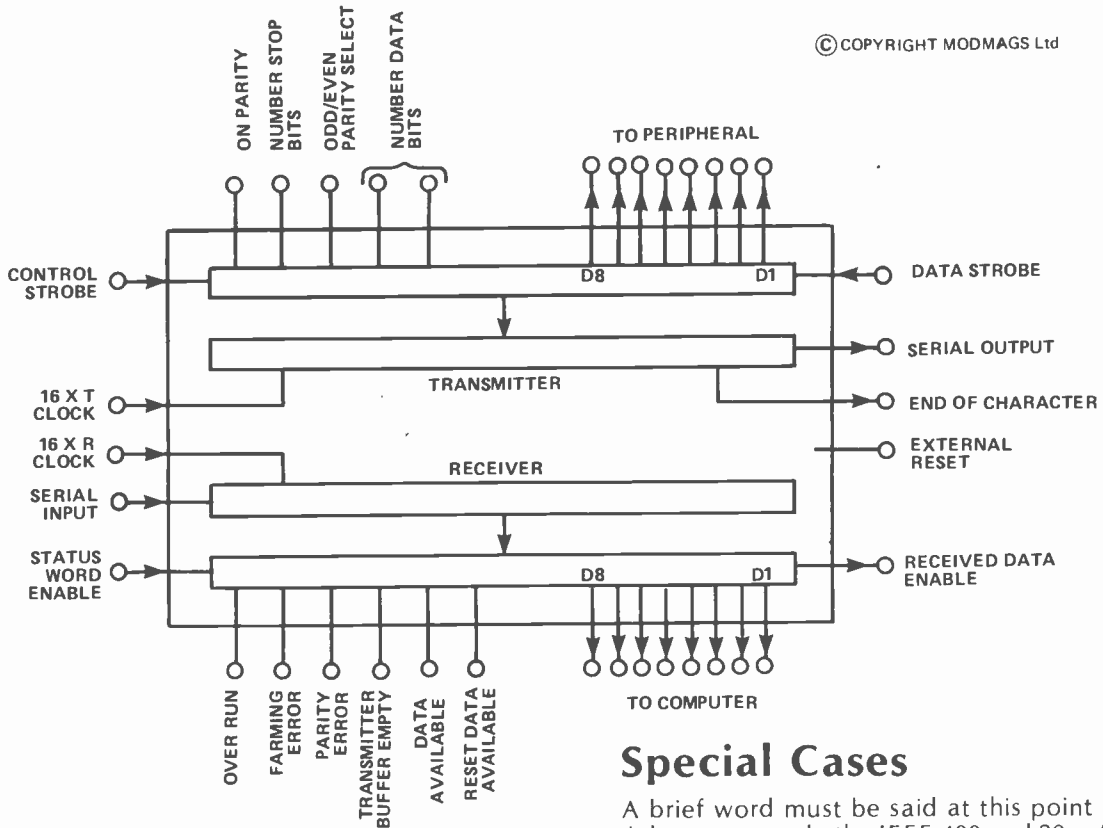


Fig.2 Block diagram of a typical UART.

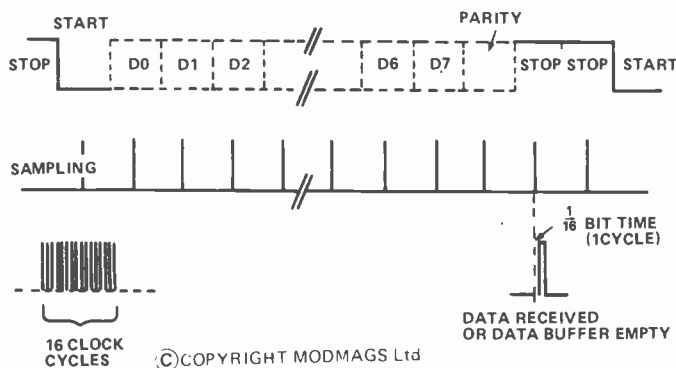


Fig.3 Timing diagram of a serial transmission.

Names such as S100, Eurobus, NASBUS, E78 and many more spring to mind, revealing that the world probably has rather more of them than is really necessary! By rights the system bus should be rigidly defined in both its operation and useage. One of the main reasons that the S100 had a bad name until the IEEE (Institute of Electronic and Electrical Engineers, of course!) got hold of it was its flexibility. This rigid defining process unfortunately takes time. We have now been waiting about three years for the E78, but perhaps even that will be slightly out of date when it arrives. If you are interested in the E78, they have produced a rather nice document, which should be available from The Secretary, E78 Committee, Avante House, 9 Bridge Street, Pinner, Middlesex HA5 3HR.

Special Cases

A brief word must be said at this point about some special cases, namely the IEEE-488 and 20 mA interfaces. The IEEE-488 or General Purpose Interface Bus came to the micro world in a rather mutilated form as the Commodore PET. Designed originally as a high speed data highway it allows multiple talkers (sources) and listeners (acceptors) to communicate along a single eight bit data bus. The bus is controlled by a number of signals and can be accessed by any of the devices. The original usage was in the laboratory where various recording instruments were connected to a single event recorder or data logger. In the case of the PET version, the pruning has resulted in one or two headaches among hardware designers, but it can be genuinely useful.

The original serial interfaces were designed around the teleprinter and teletype devices that are mainly built from solenoids. The device which controls these solenoids is very similar to the uniselectors found in old fashioned telephone exchanges and this is a current driven device. The 20 mA interface is built around a closed loop current source where the drive of 20 mA is turned on or off by a transistor which is in turn controlled by an external voltage. This allowed the interface to be electrically separated from the device, a considerable benefit as the back EMF generated by the coil of the uniselector could fry modern ICs and transistors to a turn if it escaped into the bowels of the computer.

In next month's episode we will be investigating the way in which all this magical, but rather dumb, hardware is kept together. The ingredient is, of course, that tenuous link of binary digits — software.

Post Haste

An excellent book has thudded onto my desk this month that is directly relevant to the hardware side of the series. Called 'The use of Microprocessors' by M Aumiaux and published by John Wiley & Sons it costs £12.00 in hardback and is highly recommended reading. The ISBN is 0 471 27689 8.

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Rotary on-off mains switch	1977	£0.58
Push switch - Push to make	1978	£0.18
Push switch - Push to break	1979	£0.21

Description	Colour	No.	Price
A range of rocker switches SPST - moulded in high insulation material available in a choice of colours ideal for small apparatus	RED	1980	£0.35
	BLACK	1981	£0.35
	WHITE	1982	£0.35
	BLUE	1983	£0.35
	YELLOW	1984	£0.35
	LUMINOUS	1985	£0.35

Description	No.	Price
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Miniature SPST toggle 2 amp 250V ac	1959	£0.86
Miniature DPDT toggle 2 amp 250V ac	1960	£0.92
Miniature DPDT toggle centre off 2 amp 250V ac	1961	£1.09
Push button SPST 2 amp 250V ac	1962	£1.04
Push button SPST 2 amp 250V ac	1963	£1.09
Push button DPDT 2 amp 250V ac	1964	£1.38

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1 pole 12 way	1965	£0.55
2 pole 6 way	1966	£0.55
3 pole 4 way	1967	£0.55
4 pole 3 way	1968	£0.55

Description	No.	Price
Plastic button gives simple 1 pole change over action Rating 10 amp 250V ac	1970	£0.29

OPTOELECTRONICS

NEW INCREASED RANGE—ALL 1ST QUALITY LEDS (diffused)

O/No.	Type	Size	Colour	Price
1501	ARL209 (TIL209)	3mm (-125)	RED	£0.12
1502	MIL3232 (TIL211)	3mm (-125)	GREEN	£0.22
1503	MIL3333 (OPT122A)	3mm (-125)	YELLOW	£0.22
1504	ARL4850 (FLV117)	5mm (-2)	RED	£0.12
1505	MIL5251 (TIL222)	5mm (-2)	GREEN	£0.22
1506	MIL5351 (MV5353)	5mm (-2)	YELLOW	£0.22
1509	FLV1111	5mm (-2)	CLEAR (ill. Red)	£0.13

SUPER 'HI BRITE' TYPE

Type	Size	Price
1521	MIL32	3mm (-125) RED £0.12
1522	MIL52	5mm (-2) RED £0.12
1514	ORP12	Light dependent resistor £0.63
1520	QCP71	Photo transistor £0.40

LED CLIPS

Type	Price
1508/125	pack of 5 125 clips £0.17
1508/2	pack of 5 2 clips £0.21

DISPLAYS

Type	Price
DL703	7 segment D P left (30° height) Common Anode £0.85
DL707	7 segment D P left (30° height) Common Anode £0.92
DL527	7 segment D P left (50° height) Common Anode £2.08
DL727	7 segment D P right (50° height) Common Anode £2.07
DL747	7 segment D P left (630° height) Common Anode £1.73

OPTO-ISOLATORS

Isolation Breakdown—Voltage 1500—continuous fwd. current 100 mA

Type	Price
CIL74	Single Channel 6 pin DIP standard type—optically coupled pair with infra-red LED Emitter and NPN Silicon Photo Transistor O/NO 1497 £0.61
CIL074	Multi-Channel 8 pin DIP Two Isolated Channels O/NO 1498 £1.22
CIL074	Multi-Channel 16 pin DIP Four Isolated Channels O/NO 1499 £2.69

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Silicon Photo Darlington Amplifier—V_{CC} 30V V_{EC} 10V I_c 100mA Prot 300mW/IL Min 0.5 Typ 2mA I₀ 100mA nA O/NO 1495 £0.29

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 Housing consists of Thermo plastic polyester

Type	Price
1728	Single connector in red/black or white £0.12 inc VAT
1729	Three-way connector black ONLY £0.23 inc VAT
1730	Four-way connector black ONLY £0.28 inc VAT

FUSE HOLDERS AND FUSES

Description	No.	Price
20mm x 5mm chassis mounting	506	£0.18
1 1/2in x 1/4in chassis mounting	507	£0.14
1 1/2in car inline type	508	£0.18
Panel mounting 20mm	509	£0.23
Panel mounting 1 1/2in	510	£0.37

QUICK BLOW 20mm

Type	No.	Type	No.	Price				
150mA	611	7p	1A	615	6p	3A	619	6p
250mA	612	6p	1.5A	616	7p	4A	620	10p
550mA	613	6p	2A	617	6p	5A	621	6p
800mA	614	6p	2.5A	618	7p			

ANTI-SURGE 20mm

Type	No.	Type	No.	Price	
100mA	622	1A	625	2.5A	628
250mA	623	2A	626	3.15A	629
500mA	624	1.6A	627	5A	630

QUICK-BLOW 1 1/2in

Type	No.	Type	No.	Price	
250mA	631	500mA	632	800mA	634

QUICK-BLOW 1 1/2in

Type	No.	Type	No.	Price	
1A	635	2.5A	638	4A	641
2A	637	3A	639	5A	642

NUTS AND BOLTS

BA BOLTS - packs of BA threaded cadmium plated screws slotted cheese head. Supplied in multiples of 50

Type	No.	Price	Type	No.	Price
1/8in OBA	839	£1.38	1/2in 4BA	845	£0.37
1/4in OBA	840	£0.86	3/4in 4BA	847	£0.29
1/2in 2BA	842	£0.75	1in 6BA	848	£0.46
3/4in 2BA	843	£0.52	1 1/2in 6BA	849	£0.24
1in 2BA	844	£0.60	2in 6BA	850	£0.29
1 1/2in 4BA	845	£0.51			

BA NUTS - packs of cadmium plated full nuts in multiples of 50

Type	No.	Price	Type	No.	Price
OBA	855	£0.83	4BA	857	£0.35
2BA	856	£0.55	6BA	858	£0.28

BA WASHERS - flat cadmium plated plain stamped washers in multiples of 50

Type	No.	Price	Type	No.	Price
OBA	859	£0.16	4BA	861	£0.14
2BA	860	£0.14	6BA	862	£0.14

SOLDER TAGS - Hot tinned supplied in multiples of 50

Type	No.	Price	Type	No.	Price
OBA	851	£0.46	4BA	853	£0.25
2BA	852	£0.32	6BA	854	£0.25

AUDIO LEADS

No.	Type	Price
107	FM indoor Ribbon Aerial	£0.69
113	3.5mm Jack plug to 3.5mm Jack plug Length 1.5m	£0.86
114	5 pin DIN plug to 3.5mm Jack connected to pins 3 & 5 Length 1.5m	£0.98
115	5 pin DIN plug to 3.5mm Jack connected to pins 1 & 4 Length 1.5m	£0.98
116	Car aerial extension Screened insulated lead	
	Fitted plug and socket	£1.44
117	AC mains connecting lead for cassette recorders and radios 2 metres	£0.78
118	5 pin DIN phono plug to stereo headphone Jack socket	£1.21
119	2 + 2 pin DIN plugs to stereo Jack socket with alternation network for stereo headphones Length 0.2m	£1.04
120	Car stereo connector Variable geometry plug to fit most car cassettes 8-track cartridge and combination units. Supplied with infixed fuse power lead and instructions	£0.69
123	6.6m Coded Guitar Lead Mono Jack plug to Mono Jack plug Black	£1.73
124	3 pin DIN plug to 3 pin DIN plug Length 1.5m	£0.86
125	5 pin DIN plug to 5 pin DIN plug Length 1.5m	£0.86
126	5 pin DIN plug to Tinned open end Length 1.5m	£0.86
127	All colour coded Length 1.5m	£1.50
128	5 pin DIN plug to 5 pin DIN socket Length 1.5m	£0.92
129	5 pin DIN plug to 5 pin DIN plug mirror image Length 1.5m	£1.21
130	2 pin DIN plug to 2 pin DIN inline socket Length 5m	£0.78
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5 Length 1.5m	£0.95
132	2 pin DIN plug to 2 pin DIN socket Length 10m	£1.13
133	5 pin DIN plug to 2 Phono plugs Connected pins 3 & 5 Length 1.5m	£0.86
134	5 pin DIN plug to 2 Phono sockets Connected pins 3 & 5 Length 23cm	£0.78
135	5 pin DIN socket to 2 Phono plugs Connected pins 3 & 5 Length 23cm	£0.78
136	Coded stereo headphone extension lead Black Length 6m	£2.01
178	AC mains lead for calculators etc	£0.52

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	£1.04
2022	9V-0-9V 75mA	£1.04
2023	12V-0-12V 100mA	£1.29

MINIATURE MAINS Primary 240V
with two independent secondary windings

No.	Type	Price
2024	MT1280 0-6V 0-6V RMS	£1.84
2025	MT1550-0-12V 0-12V RMS	£1.84

1 AMP MAINS Primary 240V

No.	Secondary	Price	P & P
2026	6V-0-6V 1 amp	£2.88	45p
2027	9V-0-9V 1 amp	£2.30	45p
2028	12V-0-12V 1 amp	£2.99	55p
2029	15V-0-15V 1 amp	£3.16	66p
2030	30V-0-30V 1 amp	£3.97	86p

STANDARD MAINS Primary 240V
Multi-tapped secondary mains transformers available in 1/2 amp, 1 amp and 2 amp current rating. Secondary taps are 0 19 25 33 40 50V. Voltages available by use of taps 7 8 10 14 15 17 19 25 31 33 40 25-0-25V

No.	Rating	Price	P & P
2031	1/2 amp	£3.81	86p
2032	1 amp	£5.06	86p
2033	2 amp	£6.27	1.1

2035 240V Primary 0-55V @ 2A Secondary £7.30 P & P 1.1

CASES AND BOXES

INSTRUMENT CASES. In two sections vinyl covered top and sides aluminium bottom front and back

No.	Length	Width	Height	Price
155	8in.	5 1/2in.	2in.	£2.01
156	11in.	6in.	3in.	£3.10
157	6in.	4 1/4in.	1 1/2in.	£1.93
158	9in.	5 1/4in.	2 1/2in.	£2.59

ALUMINIUM BOXES. Made from bright all folded construction, each box complete with 1/2-inch deep lid and screws.

No.	Length	Width	Height	Price
159	5 1/2in.	2 1/2in.	1 1/2in.	£0.98
160	4in.	4in.	1 1/2in.	£0.98
161	4in.	2 1/2in.	1 1/2in.	£0.98
162	5 1/4in.	4in.	1 1/2in.	£1.10
163	4in.	2 1/2in.	2in.	£0.98
164	2in.	2in.	1 1/2in.	£0.67
165	7in.	5in.	2 1/2in.	£1.54
166	8in.	6in.	3in.	£1.98
167	6in.	4in.	2in.	£1.32

SLOPE. Front aluminium boxes with black vinyl base and sides and aluminium back top and front - strong construction, easily accessible.

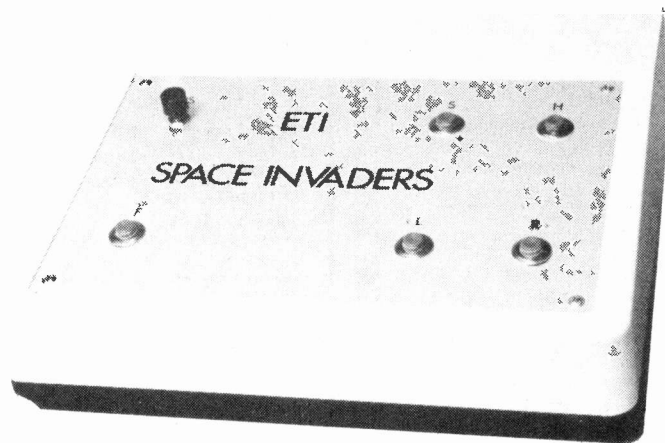
No.	Length	Width	Height	Price
169	2 1/2in.	5 1/2in.	2 1/2in.	£8.21
168	2 1/2in.	7 1/4in.	4in.	£6.45

Terms cash with order. Cheques/Postal Orders made payable to Bi-Pak at above address



SPACE INVASION SOUND EFFECTS

Your first space invasion is but a moment away. We conclude our Invasion Game project with constructional details of the control and sound effects board. Design and development by Steve Ramsahadeo.



Last month we dealt with the main board and power supply, but before you can start repelling invaders you need a handful of controls. Our control board incorporates a sound effects generator — a must for this game.

There are four sounds in all — heartbeat, fire, saucer and explosion. The explosion is not produced by the sound board. It's taken care of by the software. When you press the start button (S on the front panel) the aliens start to advance across and

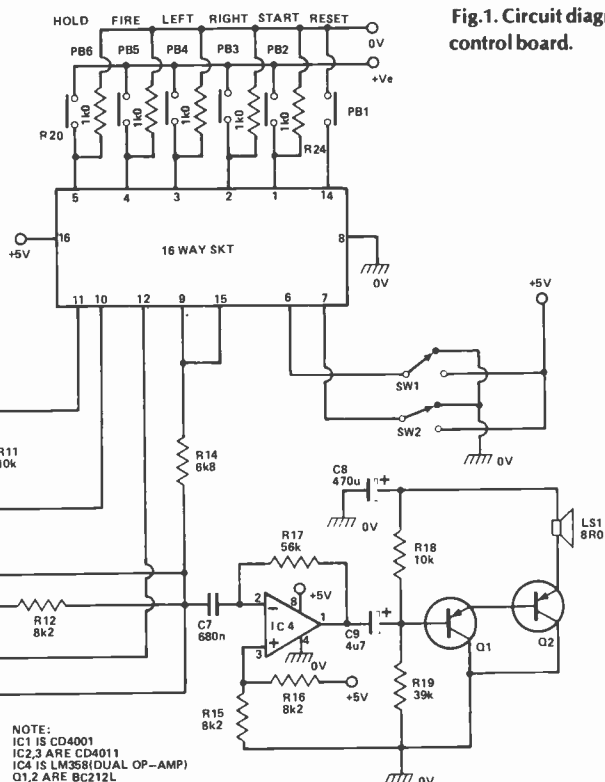
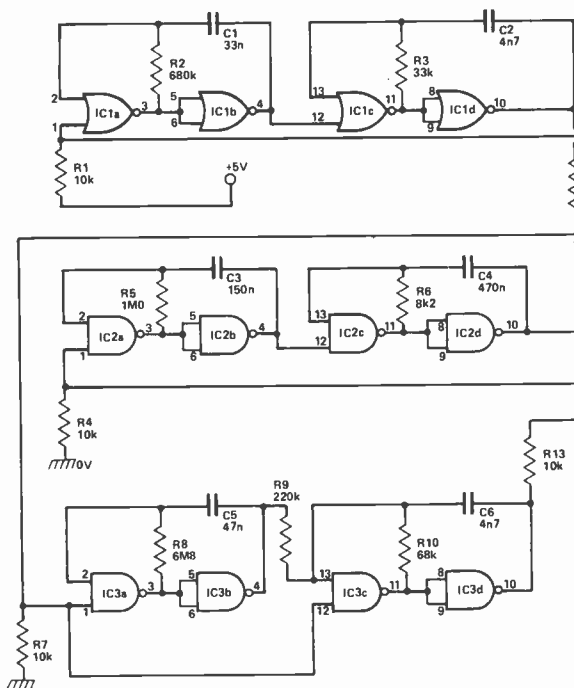


Fig.1. Circuit diagram of the control board.

NOTE:
IC1 IS CD4001
IC2,3 ARE CD4011
IC4 IS LM358(DUAL OP-AMP)
Q1,2 ARE BC212L

down the screen, accompanied by the heartbeat — an ominous pulsing sound, which speeds up as the aliens gather momentum towards you.

The universe can only be saved for humanity and Nicholas Parsons if you fight back and destroy the invaders. When you fire, the sound generator bursts into life again to let everyone know that you mean business.

BUYLINES

Tangerine Computers Ltd can supply the ETI Space Invasion project built for £99.85 all inclusive (£80.85 in kit form). The sound generator and keypad section is available built for £20.25 all inclusive (or £15.38 in kit form).

If you want to shop around for your own components, you can get the main PCB for £21.15 and the sound generator board for £5.60. The ROM is available for £17.75. Prices are all inclusive. Tangerine Computers Ltd, Forehill, Ely, Cambridgeshire.

We built the project in a new plastic desk-top, sloping front case from Vero measuring 228x216x76mm (industrial order code 65-5033K).

Vero Electronics Ltd, Industrial Estate, Chandler's Ford, Hampshire SO5 3ZR.

HOW IT WORKS

Logic instructions are transferred to and from the main board via a 16 way socket. Instructions go to IC27 on the main board via pins 1-7 and 14 and return from IC26, main board via pins 9, 10, 11, 12. For example, when the fire button (PB5) is pressed, the main board detects this and gates pin 1 of IC1a low (logic 0) via pin 11 of the socket. IC1 is wired as a dual gated NOR astable and generates a pulsed tone signal to give the 'fire' sound.

IC2 and IC3 generate the heartbeat and saucer sounds in a similar way except that these are gated on by a high (logic 1) at the respective socket pins (12 and 10), and so NAND astables are required.

The hit sound is programmed into the software and is made available at pin 9 of the 16 way socket.

IC4 acts as a summing amplifier, combining at pin 2 the outputs of the three oscillators and the hit sound (via C7). R11-14 and R17 determine the relative gain of each of the sounds. The output of IC4 is then amplified by transistors Q1 and Q2.

PARTS LIST

Resistors all ¼ W 5%

R1,4,7,11,13,18	10k
R2	680k
R3	33k
R6,12,15,16	8k2
R8	6M8
R9	220k
R10	68k
R14	6k8
R17	56k
R19	39k
R20 - 24	1k0

Capacitors

C1	33n polycarbonate
C2, 6	4n7 polycarbonate
C3	150n polycarbonate
C4	470n polycarbonate
C5	47n polycarbonate
C7	680n polycarbonate
C8	470u 25 V electrolytic
C9	4u7 16 V tantalum

Semiconductors

IC1	CD4001
IC2,3	CD4011
IC4	LM358
Q1,2	BC212L

Miscellaneous

SW1,2	SPDT miniature toggle
PB1-6	momentary push buttons
LS1	2" diameter speaker
2 off 16 way DIL IDC (Insulation Displacement Connector)	
PCB	
Vero case	

You can gamble on boosting your score to an all-time record by ignoring the aliens for the moment and firing at a flying saucer, which zooms across the top of the screen every now and then. The appearance of the saucer is heralded by its very own unmistakable sonic trademark (in other words — the racket it makes is different from the others). Keep banging away at the aliens or divert your attack to the flying saucer? It's your decision.

Construction

The unit is assembled on one PCB with a separate power supply. Construction is straightforward provided that care is taken and attention paid to the orientation of all polarised components.

Begin by inserting all wire links and Veropins followed by the IC sockets, resistors, diodes, capacitors and transistors. The ICs should be inserted last, after all the wiring to the hardware components has been completed.

The PCB fits neatly in the top left-hand corner of the specified Verocase as shown in the accompanying photographs.

A 200 mm length of 16 way Speedbloc ribbon cable using DIL (dual-in-line) connectors at each end will have to be made up. This cable will link the main board and sound board, completing the logic and power supply connections.

The pushbuttons (PB1-6) and difficulty switches (SW1,2, mounted at the rear of the case along with the mains switch) can now be wired up.

Finally, the loudspeaker is mounted at the top of the case, a few drops of Super-glue being enough to fix it firmly into place.

After checking all is well, prepare for battle!

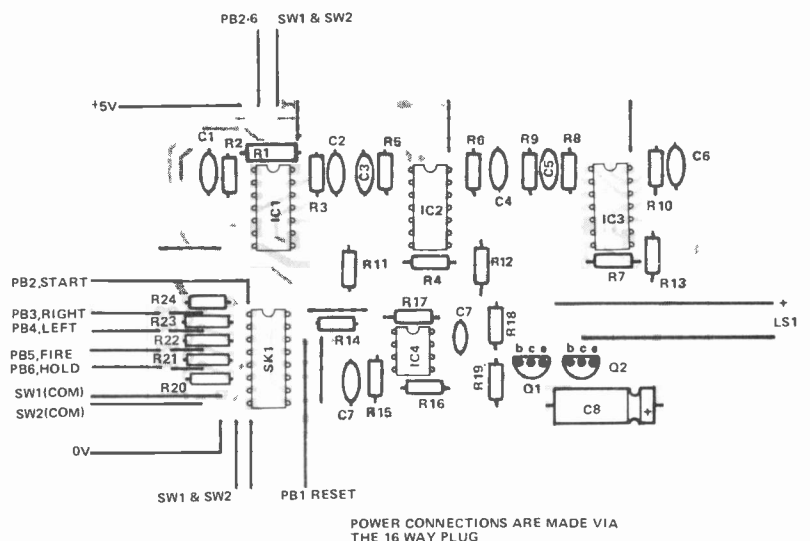
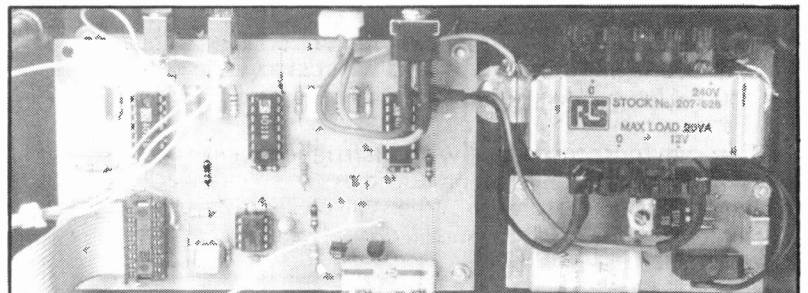


Fig.2. Component overlay.

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- Button touch also displays month and year and dates for a designated month with Sunday dates flashing.
- Stores dates in memory up to 11 ahead, flashes 'MEMO' on designated dates.
- Illuminated time and calendar display.
- Display flashes when battery nears life end.
- Stainless steel case and wrist strap (adjustable).

In presentation case with instructions.

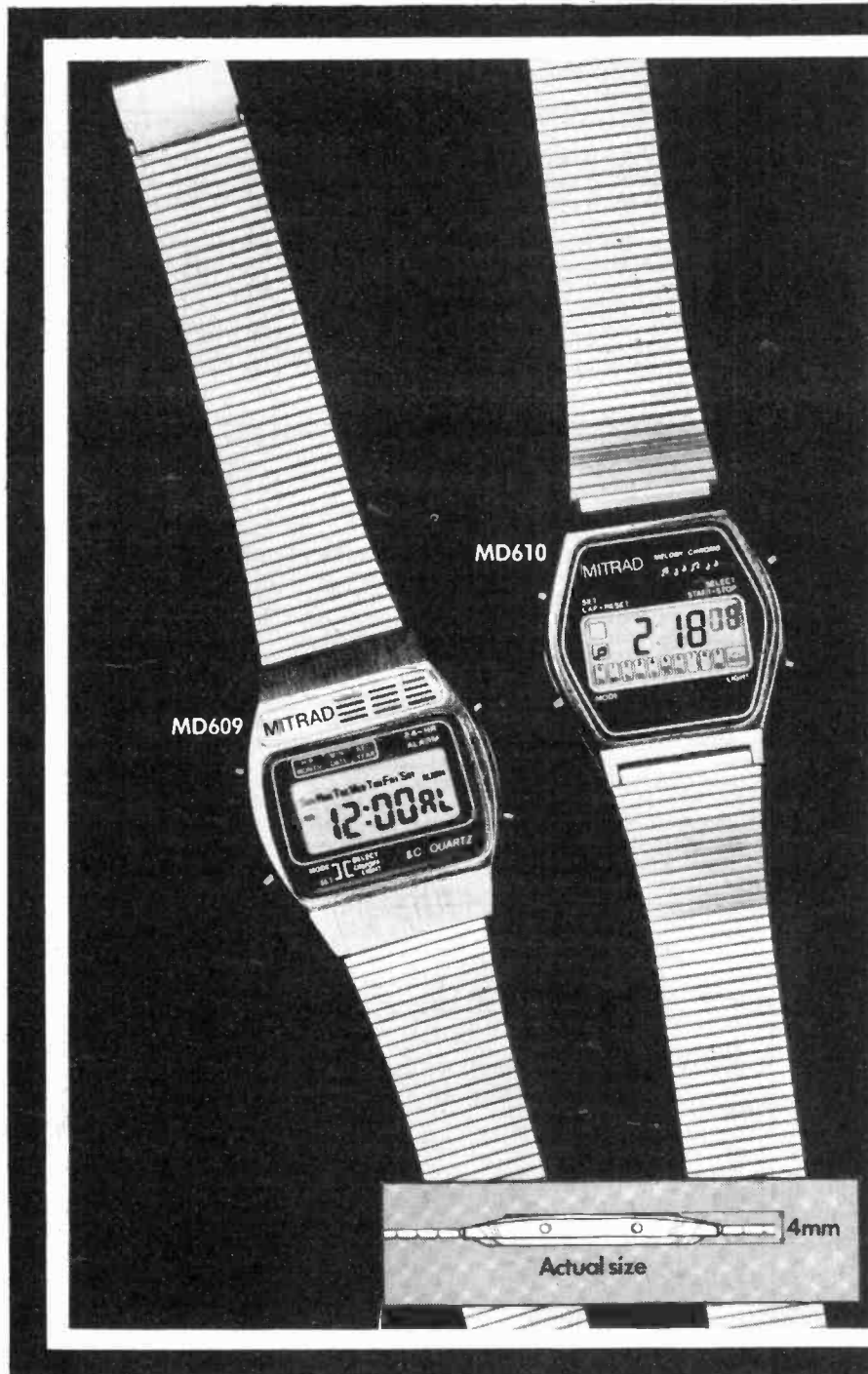
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MD605 Ladies musical alarm chrono. Continuous display of hours, minutes, seconds; optional display of day, date, month. Auto calendar. Chronograph with lap timing facilities, to 1/10 sec. 24 hour alarm plays 30 seconds of Beethoven's 'Fur Elise'. Back light. Infinitely adjustable stainless steel strap.
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MD607 Ladies slim 'sugar coated' dress watch. Continuous display of hours and minutes; optional display of month and date. Auto calendar. Back light. Integral watch and strap. In gold or silver finish.
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MD608 Gentleman's musical alarm chrono. Continuous display of hours, minutes, seconds, plus day indication. Also month and date. Chronograph with lap timing facilities, to 1/10 sec. 24 hour alarm plays 30 seconds of Beethoven's 'Fur Elise' or can be set to awaken to a single note. Back light. Infinitely adjustable stainless steel strap.
£15.50 + 85p p&p

AUDIOPHILE

Ron Harris lends an ear to a trio of record decks, from budget to top-of-the-range, and dons headphones to try the latest hip-mounted hi-fi.

This month has seen the launch of the first (of the many) Stowaway imitators — the Binatone "HipFi". (At least it's a better name.) I haven't had a chance to directly compare the two machines yet, but if the demonstration they put on at the press launch is anything to go by, Sony should be flattered but not worried.

The Hipfi sells at £59.95, as against £95 for the Stowaway and, at the launch anyway, the price differential was audibly apparent.

To say it was unimpressive is being polite. To say it sounded rotten is accurate. Impolite, but accurate.

There was a great deal of noise present in the sound, as though the treble was being boosted somewhere along the line, without the programme content at these frequencies to justify it. The headphones in use were comfortable enough, and folded flat for storage.

Overall, though, the sound was very undistinguished — rather like playing a decent cassette with the Dolby switched "out" on an encoded tape. HipFi, like Stowaway, has no Dolby — maybe Binatone were using encoded demo tapes without realising it? Most odd.

Tales Of Three Decks

Ever mindful of the call to consider budget audio more seriously within these pages, Audiophile this month takes a look at both ends of the Dual range of record decks.

The new CS505 has set a rumour rebounding around the halls that it is worthy of a high rank. Consideration was thus made with due interest and deference.

The 731Q is Dual's present top-of-the-range direct drive deck, with which the user is supplied a version of the Ortofon LM30 pickup — last seen in Audiophile hidden within an integral arm.

Just for good measure, Sony supplied me with a PSX 75 manifestation of their art, fitted with the new XL-44 moving coil pickup. Since this and the 731Q are direct competitors I thought the comparison might prove entertaining. The Dual has a slight edge in price, though, as the XL-44 is vended separately and will cost around £45 in most emporiums. It has been designed with the aim of bringing the virtues of the XL-55 Pro into more peoples' lives, by lowering the cost significantly.



CS505 — Table For All Budgets

This design is apparently meant to provide competition for such as Sansui's 222 and JVC's QLA5R decks. In order to reach a comparable price (approx £70) Dual have opted not to supply a fitted cartridge — the first time for them and a welcome development.

Features include a pitch control — unusual for a belt drive such as this — four point suspension for the whole turntable/arm assembly and a claimed ability to track high quality cartridges. Dual make great play of the arm fitted to the CS505 and on appearance it is a claim hard to justify. As you can see from the photo, it looks rather ordinary — old fashioned even.

Overall the deck is well constructed and is in stark contrast to many 'flash' oriental offerings. After seeing it around for a few weeks though, I *still* think it looks old fashioned!

Cartridge fitting is not easy by any means, but then without removable headshells or arms it never is. Dual's system of using a sub-carrier, to which the pickup is attached and which is clicked into place by the finger lift is ingenious and works well.

I fitted the Empire 400TC cartridge initially, as I felt this representative of the units that a 505 would be expected to earn its living carrying around an LP groove. Arm friction was commendably low.

Resulting Results

For a deck at this price the CS505 came through the bench test well and barring accidents, or grievous bodily harm, it is unlikely to intrude audibly to any significant extent.

After a week or so of supplication I managed to insinuate the 505 into a system next to the Sansui 222 — the great competitor. The owner of said deck was not keen at first — methinks he feared the voice of comparison.



Above: the Dual CS505 hi-fi record deck. A good clean sound quality was obtained in play.

After an evening's listening to the decks — using the Empire 400 — it transpired that both of us preferred the sound of the Dual. It came across more convincingly, with a much better mid range. Without trying a number of different cartridges, there is no ultimate way this can be taken to prove the Dual a better deck than the Sansui. It does seem, though, that the CS505 can be taken as a serious contender at least. Sound quality is undeniably good, being less muddled than most decks at the price.

Finishing Touches

Comparisons such as this allow some standard to be drawn, against which a number of people will be able to reference the facts. Physically the Dual is probably not as nice to use as the Sansui, but I would not expect this to deter many people. The final arbiter should be the sound quality and on that score the CS505 is a good product.

Baby Bio (Tracer) Growth

Biotracers are back and there are likely to be more of them this time. Last year Sony had a deck on the market with an electronic arm, in which all movement was sensed and controlled using linear motors. It cost around £600 and apparently sold "reasonably well".

The idea was obviously too good to waste on the idle rich and since then a horde of little Japanese genii has been beavering away to bring the marvels of bionic record playing to a wider audience. The result is the £270 PSX 75.



Sony PSX-75 bionic record deck. Note the pillar in the background and the prisms set into the turntable mat. These control record size indication.

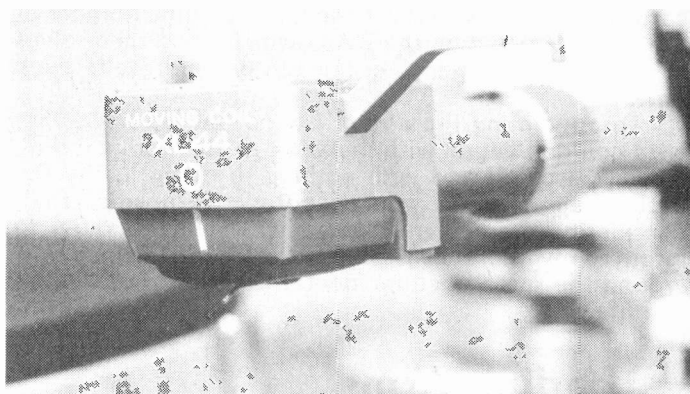
The PSX 75 sells as a mid-price (eh?) general purpose record deck, which has full electronic control of the arm. Photoelectric cells are used with small prisms (mounted inside the turntable mat!) to sense record size and there is push button movement control over the arm from outside the dust cover. Quartz-locked speed — naturally — and a 'dial-on' tracking weight control are also present. This means you can set the value while the deck is actually playing a test record. Neat, that.

What I do not like, however, is the lack of a separate bias control. Twiddling the tracking force automatically selects a value for bias and this cannot be altered. I found this meant I was having to set up cartridges to higher forces than were usually needed to obtain secure tracking. Not a vital issue, maybe, but an unnecessary hindrance.

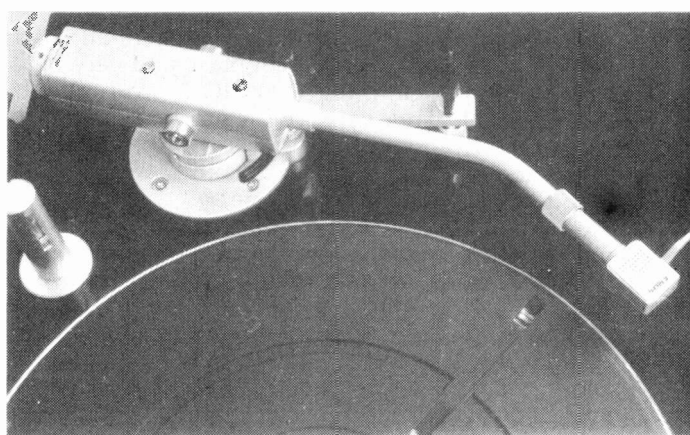
Traces of Trackers

Rather than using up half the words in the Oxford Dictionary trying to describe the Biotracer principle, deflect your eyes onto the drawing for details. Incidentally, you too can have your very own copy of this artwork. All you have to do is buy a PSX 75. The diagram comes stuck on the dust cover as transparent film!

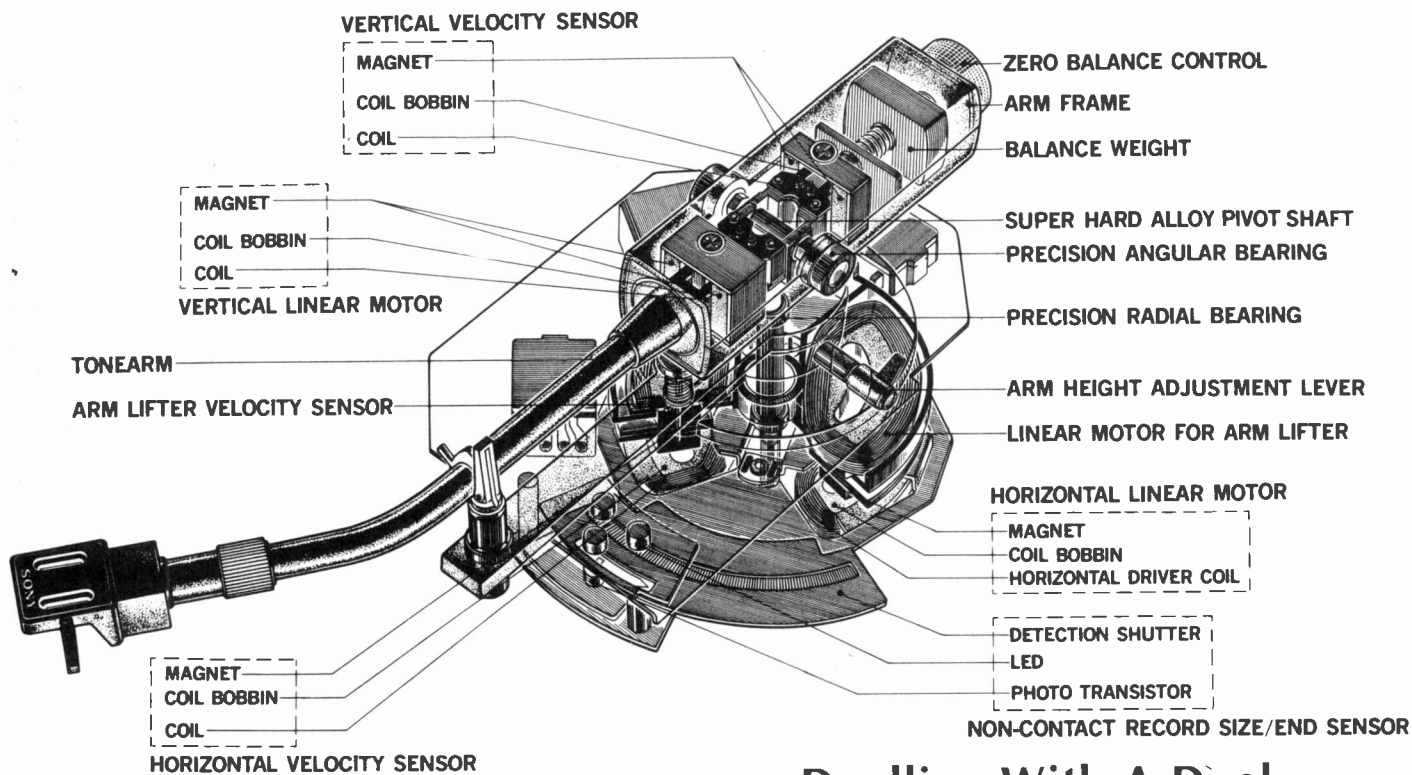
There is no setting up to do with this deck, save that required by the pickup. Arm height is adjustable too, so that vertical tracking angle can be optimised — even the arm rest moves up and down in time with the pillar!



Above: the XL-44 moving coil cartridge. It comes as part of its own headshell.



Above: the mighty linear-motor driven Biotracer pickup arm. On the next page you will find an exploded diagram to explain the clever bits! →



Above: the ultimate in complexity? Note the use of two linear motors along each movement axis.

Sony supplied the deck with that XL-44 moving coil cartridge, their new baby. I tried it out with a number of head-amps, including the HA55 which Sony themselves make and recommend, obtaining similar results each time.

Disappointing I'm afraid. I liked the old XL-55 Pro, but I couldn't get on with the XL-44 at all. I found it dull, lacking in detail and with nothing to really justify the exchange of fifty pound notes. Surprising that, considering the pedigree, but it was always a relief to return to my reference pickup, a Coral MC81 (which sells around the same price incidentally) for the extra detail and life.

Loading Arms

The PSX 75 itself is an excellent performer, however. I tried a variety of top flight cartridges, including the Coral, and was returned good results with them all. That arm, bionic or not, has a fairly high mass and very high compliance units, ie Goldring G900 IGC, are best left alone. Moving coils work very well, so the loss is not an horrendous one. If you still harbour any lingering wisps of mistrust about auto-play decks, take a walk into a dealers and have a play with this one.

Despite the little prisms, I'd still recommend anyone who buys a PSX 75 to change the mat and play singles by use of the arm transport controls. Both the Metrocare mat and a GA Soundisc improved the mid-range performance of the deck, with the Soundisc cleaning up the bass considerably, too.

Overall, then, the deck is a good product, well suited to its intended market and sensibly priced. The finish is immaculate as one would expect, with the controls working well at all times.

Duelling With A Dual

As a direct competitor with the Sony, the Dual 731Q could not be more of a contrast. The arm is the exact opposite of the Biotracer. Dual have gone for refining the simplest method possible and concentrated upon resonance suppression. As you can see from the diagram, the counter weight is a complex affair and there is provision to 'tune' the arm/cartridge resonance for individual pickups, to give best bass performance.

Like all Dual decks (except the CS505) the 731Q arrives with resident cartridge — in this case an Ortofon. I reviewed the LM30 in Audiophile only recently (June 80 issue) and would refer Seekers Of The Tiniest Detail thence. Suffice it to say here, that this is a low mass, high compliance design, capable of excellent sound quality.

The 731Q has quartz speed lock and pitch control, just to be different. Here, however, the pitch lock is not disengaged if you alter the speed from nominal. Now you can have accurate 32 RPM, if the mood takes you. Why anyone would want a deck that ran at the wrong

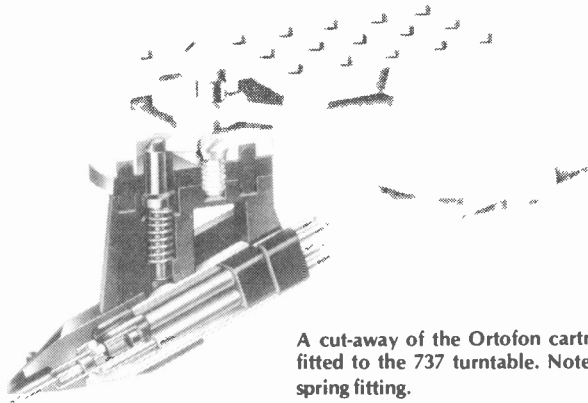


Above: the 731Q top-line Dual. Quartz of course.

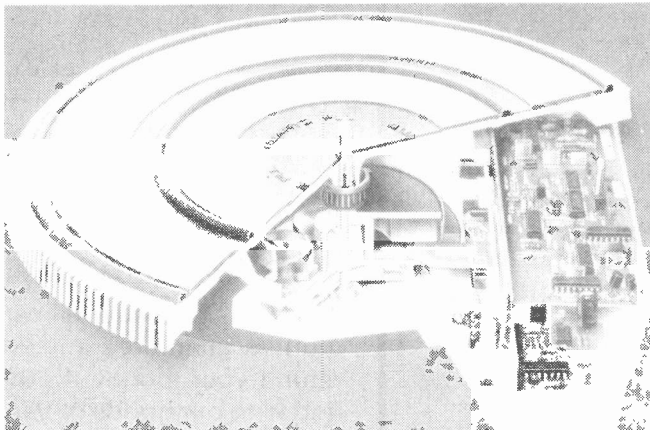
speed accurately is quite beyond me. Maybe the orchestra were a little slow one day? Speed 'em up lads! It's all quartz-locked!

Very silly.

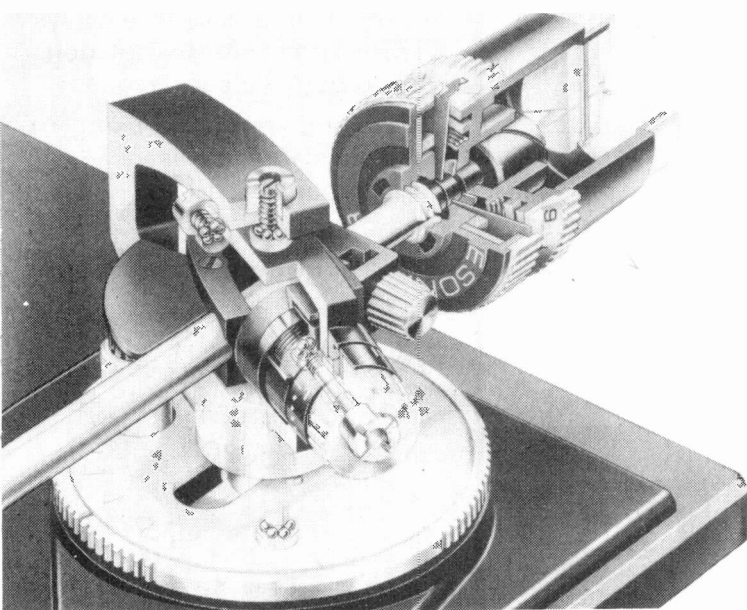
Once again, here is an expensive record deck with a mat fitted to it that would be better employed under a plant pot. In this case it is *really* bad and Dual should sell off their stocks, as floppy frisbees or something, quick,



A cut-away of the Ortofon cartridge fitted to the 737 turntable. Note the spring fitting.



Above: being a bit fond of cut-away photos, Dual supplied this shot of the 731Q circuitry. More complex than a belt of rubber is it not?



Above: even the counter-weights are complex these days. This shows the Dual's ability to mass-tune the resonance of the pick-up arm and cartridge assembly. Dead clever these continentals.

and look to something more substantial. The difference in the sound of the 731Q with a good sensible mat fitted was astounding.

With a Spectra or Metrocare in place the Dual/Ortofon is a fine combination and good value for money — as purchased, however, it simply does not allow the LM30 to do its stuff. Come on Dual, give yourselves a chance!

Comparative Studies

I suppose having mentioned the competitive links between the two decks, the question which remains to be answered is which of the two, Sony or Dual actually represents better value for all that money. The nice thing here, for me, is that the two products are so totally different in their approach to a common end that sidestepping a final choice is easy!

The Sony offers a better finish, better ergonomics and leaves the choice (and the cost) of pickup to the user. The Dual offers a very high quality cartridge as part of the package, at a lower price overall, and a very good arm which is tunable for a range of cartridges. Trouble is, having supplied you with a pickup in the first place, chances are you're never gonna use the facility to its fullest extent.

If you like the sound of the Ortofon LM30, then the Dual 731Q will probably be for you. Anyone who doesn't is stuck with it, it seems. Including a cartridge in a deal with a turntable invariably means you're selling the sound of the cartridge rather than the deck. Dual must be happy with the idea at least.

If for no other reason than that, I'd tend to prefer the Sony and go my own way with pickups. Either way you're going to need a new turntable mat and a fairly big shelf to take the deck, as neither of them is exactly compact.

At the price it is worth noting that £210 would buy you a TD160S and SME Series IIIS — a combination which would sound better than either, albeit at the cost of considerably more trouble to set-up, adjust and use.

Trailing Off

Next month we're giving the once-over to the two Pioneer cassette decks, namely the CT-200, which is the new low price metal deck and the CTF-1250, the not-so-new, not-so-low-price flagship design.

	DUAL CS505	SONY PSX 75	DUAL CS731Q	
WOW AND FLUTTER:	±0.05%	±0.035%	±0.025%	(ALL DIN)
SIGNAL-TO-NOISE RATIO:	69 dB	79 dB	75 dB	(ALL DIN B)
START-UP TIME (to 33 1/3):	2 S	1 1/2 S	2 S	
SUSPENSION:	4 point — spring	—	4 point — spring	
TRACKING ERROR:	0.16°/cm	+2, -1°	0.16°/cm	
TRACKING WEIGHT RANGE:	0-3 g	0-3 g	0-2 g	
CARTRIDGE WEIGHT RANGE:	2 g-10 g	1 g-15 g	2 g-9 g	
APPROX. PRICE:	£70	£270	£240 (inc. cartridge)	ETI

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12:30^{pm}
Hours mins secs

8 14TH
Month date day

0:00⁰⁰
Min secs 1/10 1/100



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M9 Price £11.95

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Only 8mm thick.
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and back.
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M3 Price includes POST & PACKING

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Hours mins secs

8 14TH
Month date day

7:30^A
Alarm



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6 functions plus Alarm.
Conference signal,
5 minute snooze alarm,
Conference signal sounds
4 secs. before main alarm
to give advance warning
and an option to cancel.
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after main alarm and is
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8 14TH
Month date day

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mode. Alarm test.
Chronograph, lap
time, stop watch 1/10
secs.

M64 Price includes POST & PACKING

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Hours mins

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Hours mins

8 14
Month date

:45
Secs



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Hours mins

8 14
Month date

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Secs



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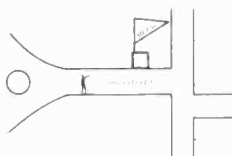
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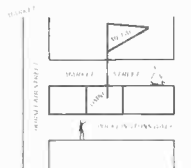
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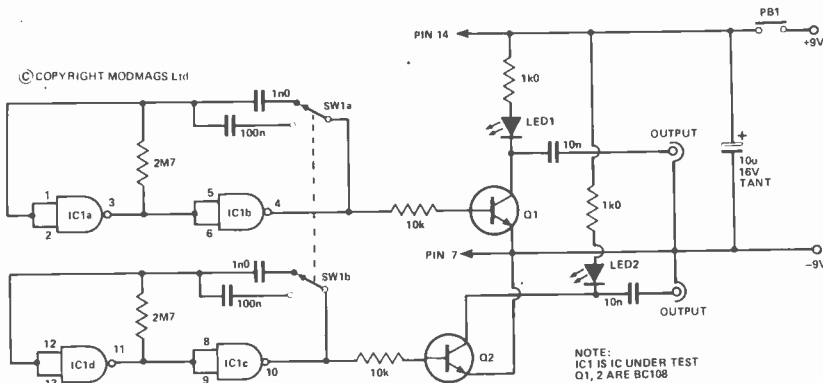
CMOS Tester

C. Jordan, Sompting

This circuit was designed to test 4001 and 4011 devices which were suspected of being damaged due to static from

careless handling. Two gates on each side of the 14 pin DIL package are tested independently. Each pair is connected as an astable, the timing capacitor being switched, to allow the device to oscillate at two different frequencies.

The output of the astable is fed to a transistor which acts as a buffer, driving the LED and providing an audio output to a crystal earpiece. PB1 should be a push-to-make type, so that it is impossible to insert or remove a device with the power on. Although intended to test 4001 and 4011 devices, it will also quite happily test 4030, 4071, 4077, 4081 and 4093.



Digital Clock Switch

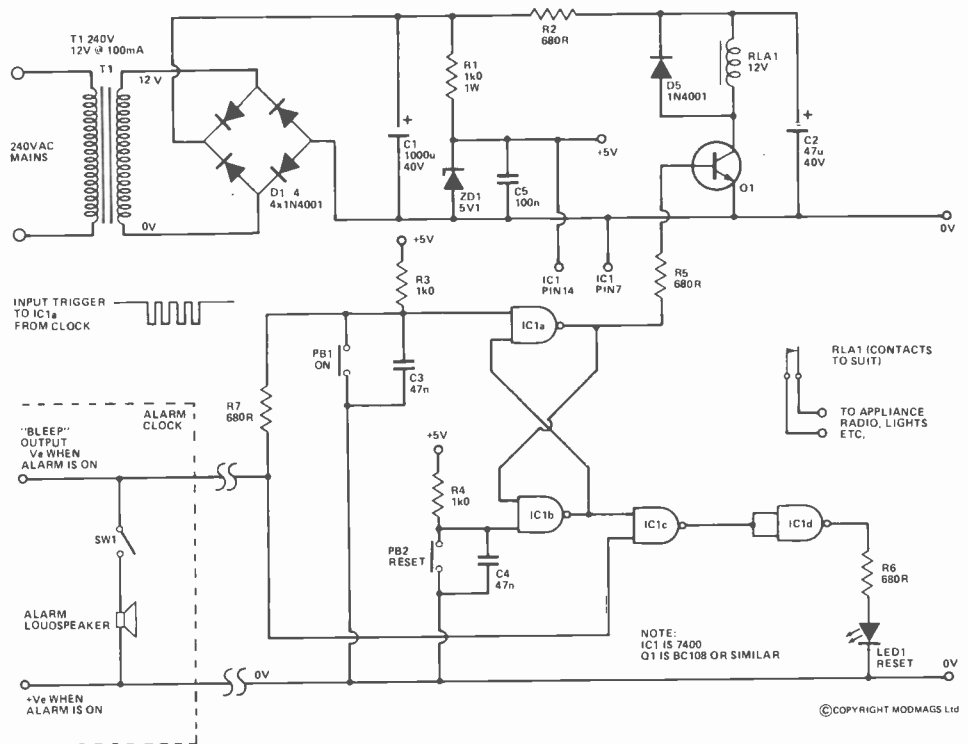
R.D. Pearson, Sheffield

This circuit was designed for a digital alarm clock such as the Hanimex alarm clock sold by ETI's marketplace. It will switch an appliance such as a light or radio on or off manually using push-button switches and will also switch the appliance on when a negative output from an alarm clock triggers it.

IC1a,b form a flip-flop driving the relay via Q1 or an LED via IC1c,d. Input triggers are provided by PB1 and PB2 which are suppressed by R3, C3 and R4, C4 to prevent erratic operation from mains transients and interference.

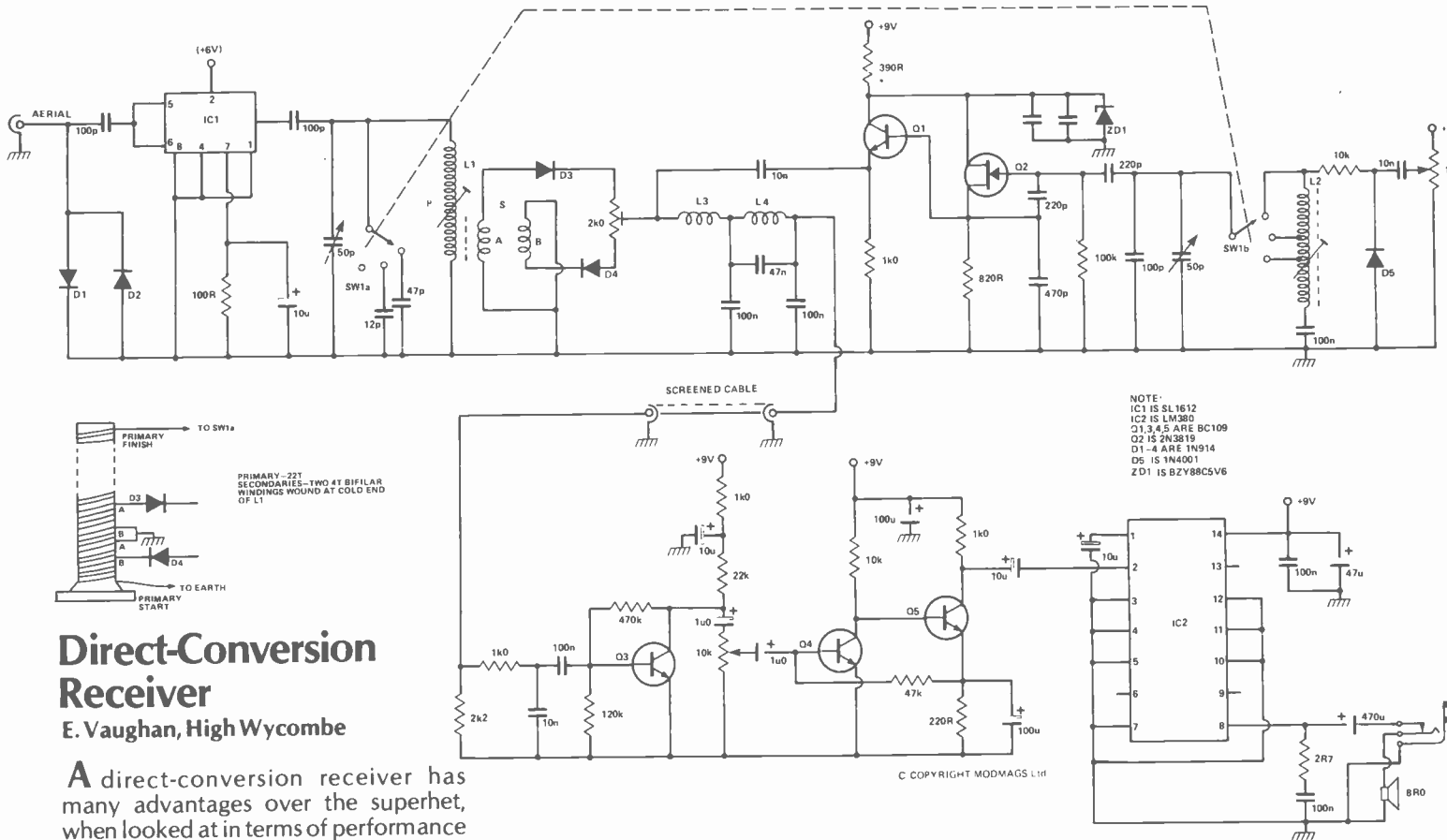
The ON input trigger to IC1a is driven by a negative pulse from a digital alarm clock. The easiest place to find this is on the loudspeaker of the clock using a multimeter or 'scope across the speaker terminals when the alarm is bleeping. The negative output is connected to the trigger input and the positive output to 0V.

IC1c,d provide a flashing LED indication that the alarm is on. If desired, switch SW1 may be connected in series with the loudspeaker.



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Direct-Conversion Receiver

E. Vaughan, High Wycombe

A direct-conversion receiver has many advantages over the superhet, when looked at in terms of performance versus complexity and cost (this receiver can be built for around fifteen pounds or less). The SL1612 is an RF amplifier providing pre-mixer gain. D1,2 protect the IC. The mixer is a balanced type, driving an M-derived single section lowpass filter with a cut-off frequency of 3 kHz. The oscillator is a Colpitts type followed by a buffer stage to prevent pulling of the oscillator when tuning. Although mainly for SSB and

CW, AM can be resolved by tuning to zero beat. The circuit employs varicap tuning.

Using a wire aerial 66 feet long, separated at 33 feet by an insulator and fed with 75R coax, it is possible to pick up stations from all over Europe, North and South America and Africa. When

correctly set up, this receiver should switch-tune to the 14 MHz, 21 MHz and 28 MHz amateur bands.

L1,2 are wound on 3/8 inch diameter slug tuned formers using 36 SWG wire. Winding details of L1 are shown in the diagram. L2 is 25 turns tapped at 9 and 14 turns. L3 is 1 mH and L4 10 mH.

Automatic Nicad Charger

M.G. Baker, Port Elizabeth

This circuit will charge up to eight 1V25 Nicad cells at a constant current of up to 100 mA. When the battery voltage reaches a preset level, the charger trips and charging ceases.

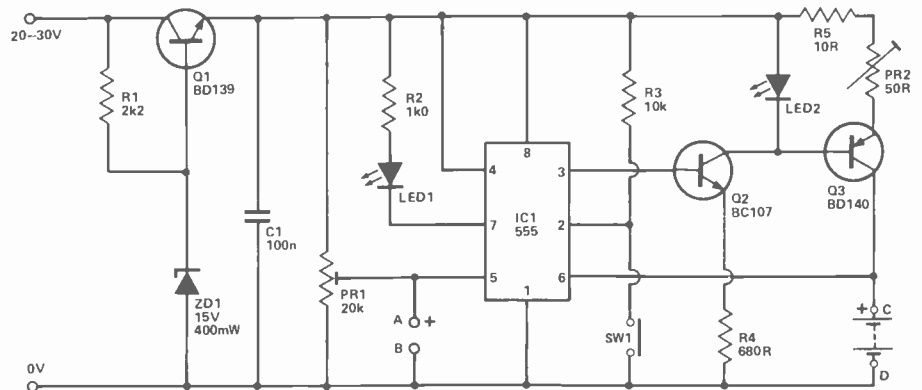
The voltage of a Nicad cell increases as it is charged and reaches a value of approximately 1V45 when fully charged. A battery of eight cells would, therefore, be fully charged when its voltage is 11V6. The recommended charging current of a Nicad cell is usually 10% of its mAh rating ie 50 mA for a 500 mAh battery.

To set up the circuit, connect a voltmeter across terminals A and B. PR1 is adjusted to the desired trip voltage eg

11V6 for eight cells. A milliammeter is then connected between terminals C and D. Reset button SW1 must be momentarily depressed and the required charging current is adjusted by PR2.

The battery may now be connected

between terminals C and D. When SW1 is depressed, LED 2 comes on indicating the battery is charging. When the battery voltage exceeds the preset trip voltage, the charging current drops to zero and LED 1 comes on indicating the battery is fully charged.



CHROMASONIC electronics

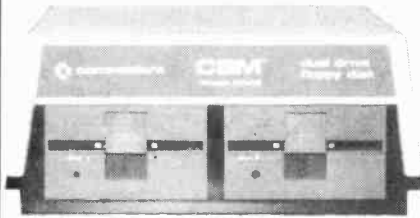
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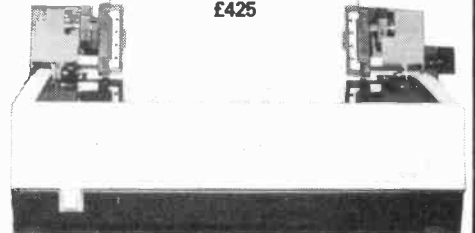


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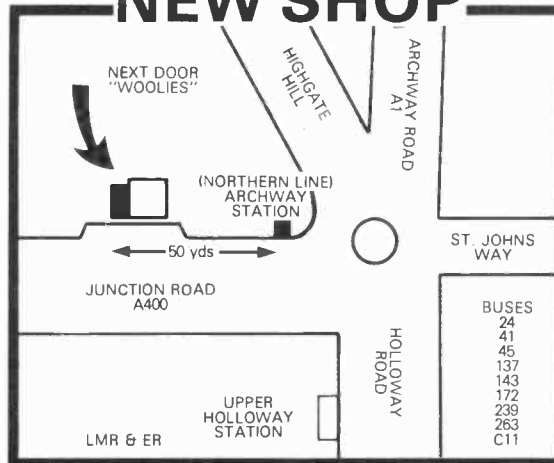
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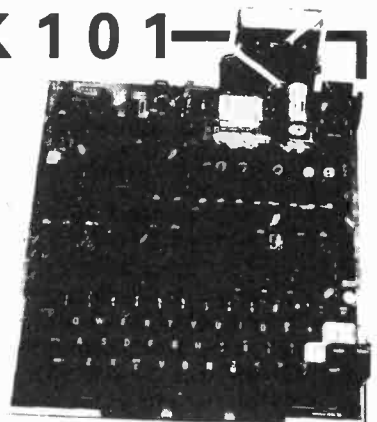
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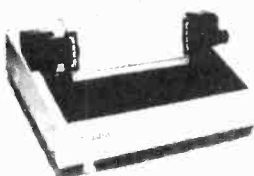
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RISE TIME Approx 17.5n sec (20MHz) Approx 35n sec (10MHz)
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CHOP FREQUENCY Approx. 200 kHz
*HORIZONTAL AXIS 1-2-5 sequence, 20 ranges

SWEEP TIME 0.4µsec 0.5 sec/DIV (within ± 5%)
(WITH 5X MAG.) 0.04µsec 0.1 sec/DIV (within ± 5%)
SWEEP STOP Sweep stops and trace becomes a spot.
*EXTERNAL SWEEP MODE X-Y mode (CH1: X axis) (within ± 5%)
FREQUENCY RESPONSE DC (AC 2Hz) ~ 1MHz
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X-Y PHASE DIFFERENCE within 3° at 50kHz
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FREQUENCY RESPONSE DC ~ 5MHz

INPUT RESISTANCE Approx. 110kΩ
*CALIBRATION VOLTAGE WAVEFORM Square wave, Approx. 1kHz
OUTPUT VOLTAGE 1Vp-p ± 3% * CRT TYPE 5-inch round-type PHOSPHOR B31 (Green) ACCELERATION VOLTAGE* Approx. 2kV EFFECTIVE AREA 8 DIV x 10 DIV (1 DIV = 9.5mm) GRATICULE ILLUMINATION Brightness is continuously variable
* POWER REQUIREMENTS AC LINE VOLTAGE 100V, 110V, 120V, 220V, 230V, 240V, ± 10% FREQUENCY 50/60 Hz POWER CONSUMPTION Approx. 40VA
*MECHANICAL SPECIFICATION MAXIMUM DIMENSIONS 250W x 210H x 435D mm WEIGHT Approx. 8 kg (17.6 lb.)

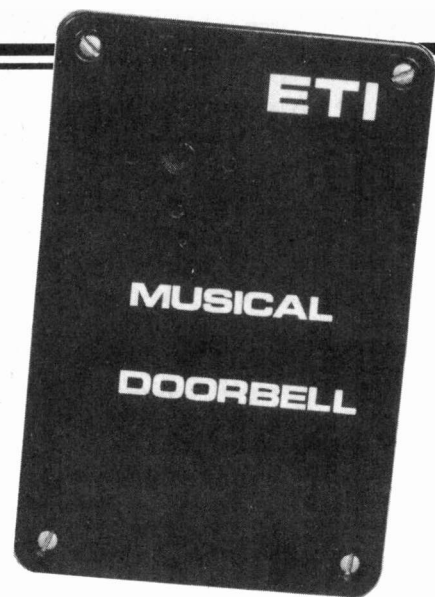


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MUSICAL DOORBELL



An inexpensive programmable doorbell project for your home. This instrument will play any nine-step melody of your choice. Design by Ray Marston. Development by Steve Ramsahadeo.

Modern doorbells come in two basic types, the simple electrical 'ding-dong' (chime) or the sophisticated microprocessor-controlled multi-tune (Rule Britannia, etc) types. In either case you pay your money and have to accept the sounds that the manufacturers have pre-programmed into your particular device. If you ever get tired of your bell's limited range of sounds, you have little option but to buy a new unit.

We have decided to overcome this by designing a musical doorbell project that the owner can self-program to play any desired (but brief) melody. The essence of our project is that it is simple; it is devoid of hard-to-get micros, PROMs, double-sided PCBs, etc, yet gives an entertaining performance.

Our doorbell is designed to play a nine step melody made up of a selection of five basic notes or tones. The melody lasts for 2-3 S. If the bell-button is briefly operated, the complete melody plays once only; if the bell-button is held closed, the melody repeats continuously. The unit is designed so that the owner can select or 'program' his own melody by hard wiring the interconnections between various pins on the unit's PCB.

The nine step, five note choice enables any one of a selection of almost two million (5^9) different melodies to be programmed into the unit!

A feature of our doorbell is that it incorporates a bistable electronic switch that connects power to the unit in such a way that it consumes virtually zero power when in the 'standby' mode. Whenever the bell-button is pressed, the bistable connects power to the unit for the duration of the tune play and then automatically disconnects the power when the melody is complete; this facility ensures long battery life.

Construction

Construction of this unit should present very few problems, if the overlay is followed with care. Note that IC1 and IC3 are CMOS devices and are best mounted in suitable sockets. Also note that an insulated link is connected between pin 3 of IC2 and pin 14 of IC3 on the underside of the board and that Veropins are used to facilitate top-side connections on the PCB.

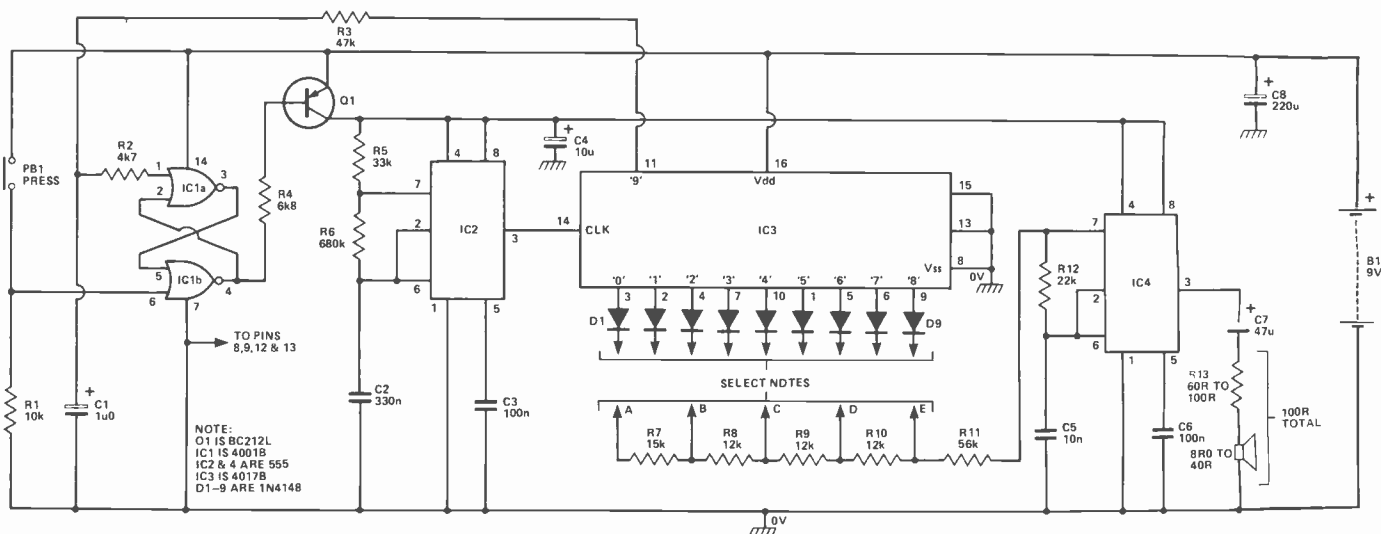
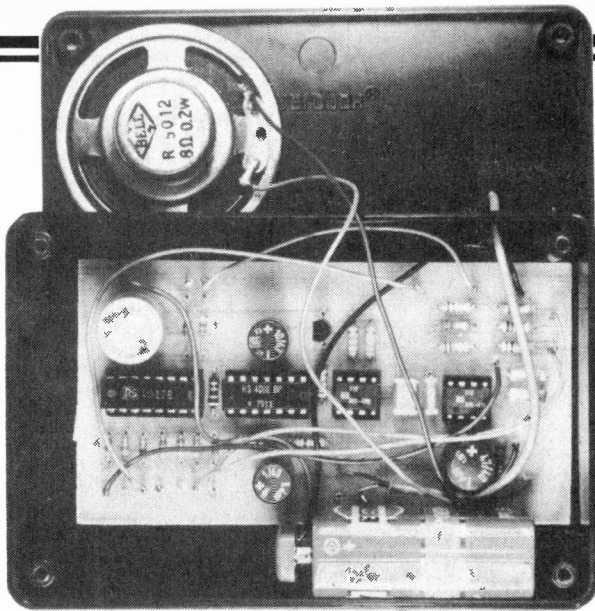


Fig. 1. Circuit diagram of the Musical Doorbell. The connections you make between diodes D1-D9 and the points A-E determine the tune that is played.



Everything fits in the case except the pushbutton; the wire to this can be seen leaving the Verobox.

When construction of the PCB is complete, connect up a suitable speaker, battery and push-button switch and prepare to give the unit a functional check. When selecting a speaker, note that output volume is proportional to speaker impedance and that a high impedance unit will give the loudest results.

When you are ready to try out the unit, connect a flying lead from D1 to one of the A — E note-select points and press PB1 to test the first note in the sequence. You can then wire in the D2 to D9 note-selection connections, one at a time, to establish the rest of the sequence, testing the unit at each step in the wiring sequence.

Once you've finished 'programming' your unit you can fit the PCB, battery and speaker into a suitable box, hang the unit on your front door and finally connect it up to a suitable push-button switch.

HOW IT WORKS

The circuit comprises a bistable (IC1) and a transistor power switch (Q1), two 555 astable multivibrators (IC2 and IC4) and a 4017 decade counter/divider (IC3). The bistable (IC1) is designed around two gates of a CMOS 4001B and controls the base bias of Q1, which in turn controls the positive power supply connections to IC2 and IC4, the two 555 chips.

Normally, the output (pin 4) of the bistable is high, so Q1 receives no base drive and is cut off. Under this condition, IC2 and IC4 consume no power: IC1 and IC3, being CMOS devices, also draw negligible power under this condition. The entire circuit, in fact, consumes a typical 'standby' current of only a microamp or so.

The circuit is activated by briefly pressing PB1, thereby causing the IC1 bistable to change state and connect power to the IC2 and IC4 astables via Q1. IC2 is wired as a low frequency astable (a few Hertz) and delivers clock pulses to IC3. IC3 is a 4017B decade counter/divider; it has ten decoded outputs, which sequentially go high on the arrival of successive new clock pulses, only one output being high at any given time. In our application, the first nine decoded outputs are used to sequentially select (via D1 to D9) timing resistors in a second astable, the IC4 tone generator, which drives a speaker via C7.

The first nine clock pulses from IC2 thus cause nine tones to be sequentially selected via the R7-11 resistor network. On the arrival of the tenth clock pulse, pin 11 of IC3 goes high and resets the IC1 bistable via R3 and C1, thereby cutting off Q1 and removing power from IC2 and IC4, thus completing the operating cycle.

The action of the IC1 bistable is such that, if PB1 is briefly pressed, the instrument plays a single sequence of nine notes (total duration is 2-3 S) and then automatically switches off. If PB1 is held closed, however, the sequence continuously repeats. Note that the owner can set up any tone sequence that he wishes by suitably interconnecting the diode outputs of IC3 to the 'A' to 'E' selection pins on the R7-11 note-selection chain.

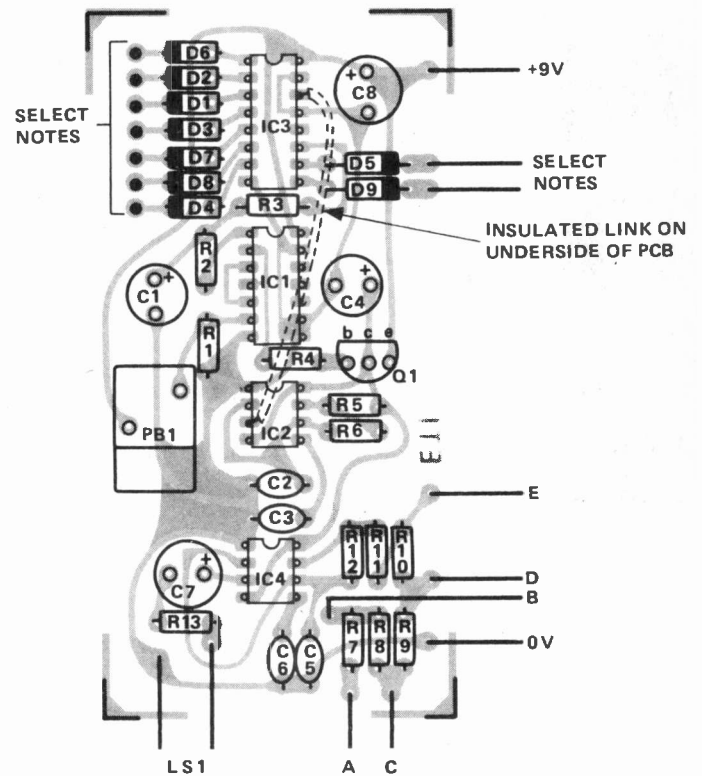


Fig. 2. Component overlay.

PARTS LIST

Resistors All ¼W, 5%	
R1	10k
R2	4k7
R3	47k
R4	6k8
R5	33k
R6	680k
R7	15k
R8,9,10	12k
R11	56k
R12	22k
R13	100R

Capacitors	
C1	1u0 63 V electrolytic PCB type
C2	330n polycarbonate
C3,6	100n polycarbonate
C4	10u 63 V electrolytic PCB type
C5	10n polycarbonate
C7	47u 25 V electrolytic PCB type
C8	220u 25 V electrolytic PCB type

Semiconductors	
IC1	4001B
IC2,4	555
IC3	4017
Q1	BC212L
D1-9	1N4148

Miscellaneous	
LS1	Any 8R0 to 40R speaker: see text
PB1	momentary action
B1	PP3
Case	

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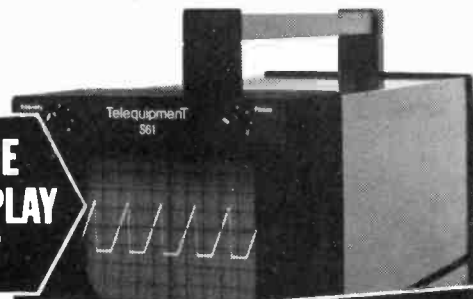
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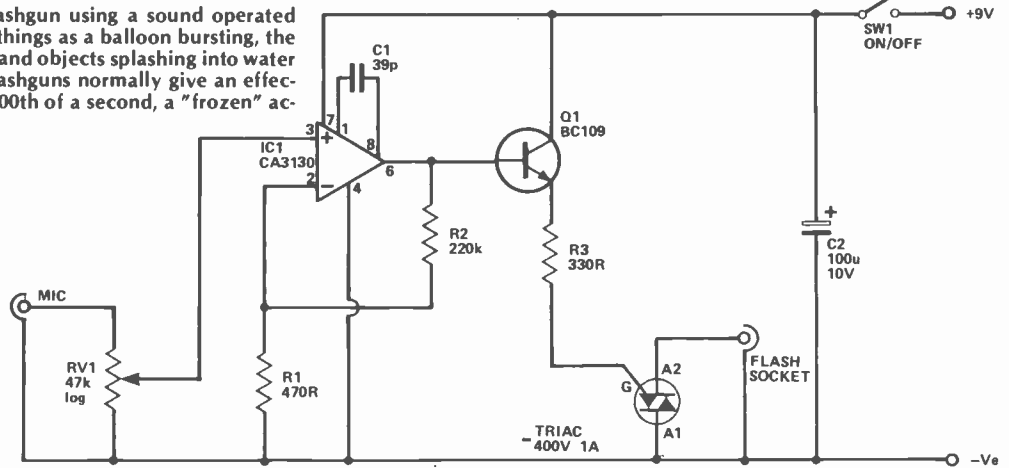
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The photograph must be taken under fairly dark conditions so that the ambient light does not give an exposure if the camera's shutter is set to "B" and opened.

The circuit is based on operational amplifier IC1 which is used in the non-inverting amplifier mode. R1,2 are a negative feedback network which set the gain of the unit at about 500. RV1 (sensitivity) biases the non-inverting input to the negative supply rail. Ideally the input should be fed from a crystal or high impedance dynamic microphone, but the unit will work quite well using a low impedance dynamic microphone or even a high impedance speaker as the signal source.

Q1 is used as a discrete emitter follower output stage which provides the relatively high trigger current required by the triac. R3 is a current limiting resistor. Under quiescent conditions the output of IC1 will be at virtually negative supply potential, and the triac, therefore, receives no gate current. When a signal is

received by the microphone, positive going signals are amplified by IC1 to give an output that is a few volts positive. The triac then receives a strong gate bias, causing it to trigger and give a low resistance across its A1 and A2 terminals. These terminals connect to the flashlead via a suitable socket (or flash extension lead with the unwanted plug removed) and the flashgun is, therefore, fired. The circuit operates almost instantly, giving very little delay between the commencement of the sound and the flashgun being triggered. Sometimes more interesting photographs can be obtained by introducing a small delay.

This can be achieved by moving the microphone a metre or two away from the object(s) being photographed.

The current consumption of the unit is approximately 4 mA. It is advisable not to advance RV1 much more than is absolutely necessary in order to give reliable triggering, as frequent spurious operations of the unit could otherwise result.

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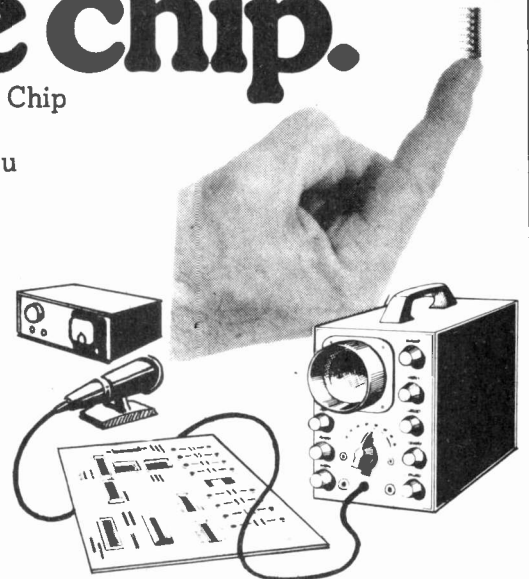
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ASTROLOGUE

Satellites in Surrey and spying on storms. Ian Graham has news of a British spacecraft and the latest addition to the World Weather Watch network.

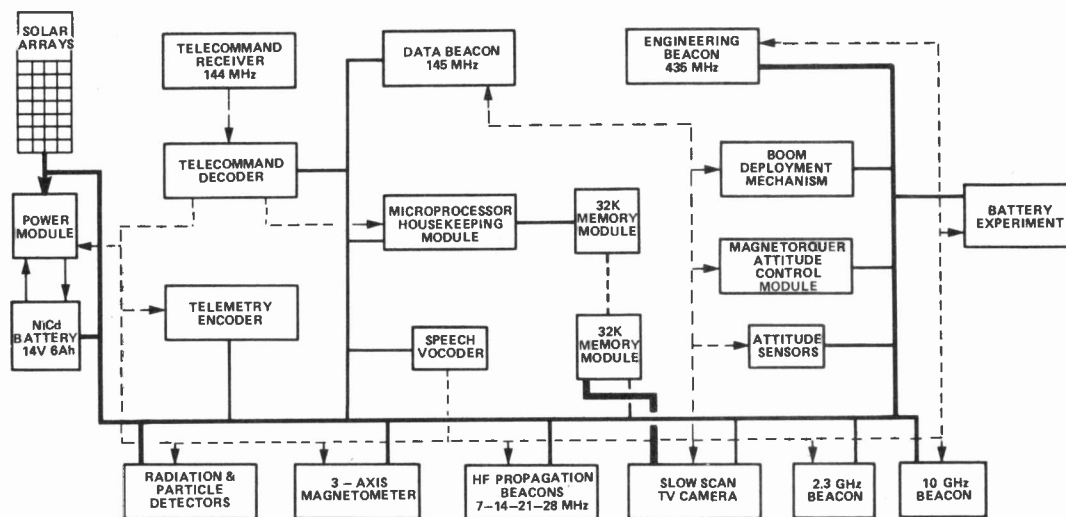


Fig.1 System diagram of the UK amateur scientific spacecraft — UOSAT.

Just over a year ago scientists and engineers began building Britain's first amateur satellite — UOSAT. It isn't a British copy of its American predecessors (the OSCAR series), whose function was to improve long distance VHF and UHF communications. UOSAT has much broader and far-reaching mission objectives — to allow radio amateurs and amateur scientists to study the electromagnetic propagation properties of the atmosphere from HF to microwave frequencies, stimulate active participation in space science (particularly in schools, colleges and universities), establish sources of hardware for the AMSAT programme and pave the way for future amateur spacecraft, possibly operating at new frequencies. That's an ambitious list of objectives.

The project is supported by British industry and research organisations, AMSAT, RSGB (Radio Society of Great Britain) and the University of Surrey, where the spacecraft is being built. A great deal of the design work is complete and systems testing is under way.

On Board

The Propagation Studies Experiment will carry beacons transmitting from 7 MHz up to over 10 GHz, particle radiation counters and a magnetometer. The Education Experiments comprise an Earth-pointing slow-scan TV camera and a synthesised voice telemetry system. The payload will also include two Future

Systems Experiments — a two axis, Earth-pointing, gravity gradient spacecraft stabilisation system and an on-board microcomputer to investigate image processing, telemetry/command management and data store/dissemination.

Even when the Space Shuttle is operational, a satellite launch will be an expensive operation in terms of a project such as UOSAT. Fortunately, NASA have agreed to launch UOSAT free of charge as a piggy-back 'passenger' with the Solar Mesosphere Explorer (SME). SME is due to be placed in a circular polar orbit in September 1981 by a Delta 2301 launcher. UOSAT will be placed in a 530 km Sun-synchronous orbit.

Although Astrologue is naturally largely devoted to the multi-million dollar/pound/rouble headline-grabbing space shots it makes a pleasant change to hear of projects like UOSAT. If your university or business is managing or contributing to a space programme in any way, I'd like to hear about it.

One Small Launch . . .

GOES-D, the latest American weather satellite, is now safely in a slightly elliptical orbit about 40,000 km above the equator following a successful launch from Cape Canaveral on September 9th. Over the next few weeks GOES-D's engines will be used to circularise the orbit at 35,600 km. During its planned lifetime of seven years, Geostationary Operational Environmental

Satellite D will, like its predecessors, gather and transmit information on weather conditions over Canada, the United States and South America and a large area of the Atlantic.

Although GOES-D is concerned with American weather, the GOES satellites are part of a worldwide system — the World Weather Watch (WWW) project. Europe has contributed its Meteosat series to WWW, which, as the name suggests, maintains a global weather monitoring service.

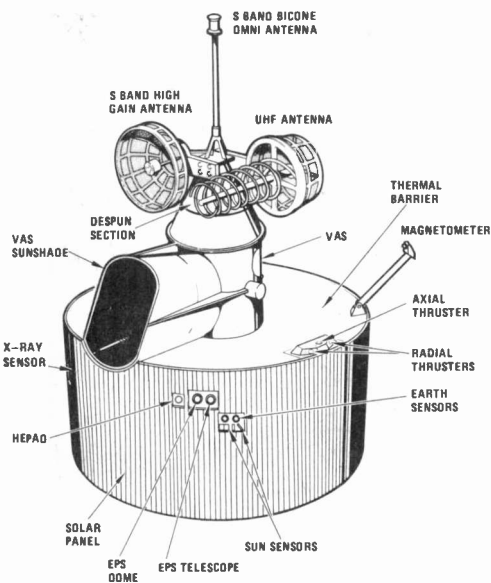


Fig.2 A quick guide to the GOES satellite. Notice the main experiment (VAS) behind its sunshade. The antennae are carried on the despun section (top).



GOES-D has now been redesignated GOES-4. It's the first satellite to be put in orbit as a joint operational and research mission of the National Oceanic and Atmosphere Administration (NOAA) and NASA. This is the first picture to be received from GOES-4, transmitted on September 24th. South America is clearly visible on the right. The remnants of Hurricane Hermine are still swirling over Southern Mexico and Honduras. Storms which begin far out into the Pacific Ocean (two can be seen here) can be tracked, giving ample time to warn major population centres.

... But A VAS Difference

The Hughes Aircraft Company are building three of the spacecraft (GOES-D, E and F), the main instrument of which is a visible and infra-red spin-scan radiometer (VISS) atmospheric sounder. The whole instrument is called a VAS for short (thank goodness). The VAS will look down on the atmosphere and gather information on temperature and moisture at different altitudes.

It doesn't sound very exciting, but in fact the onset of very severe weather conditions is characterised by the

development of higher and higher cloud tops. Up to now the instruments used could not look down through the highest clouds and watch cloud building at lower altitudes.

On The Data Trail

The information collected by VAS is processed and transmitted to the Wallops Island (Virginia) receiving station, where it is further processed and sent back up to the satellite for relay to US users.

The satellite also carries instruments to detect solar protons and electrons, alpha particles, X-rays and magnetic fields — information useful in telecommunications and power distribution.

The Hardware

GOES-D weighs in at a shade under 400 kg (orbital weight). It's basically a cylinder covered with solar cells and surmounted by antennae (overall height 12 ft, by 7 ft in diameter). The main body spins at 100 RPM, but the antennae are held stationary with respect to Earth.

The spinning motion is used to photograph the Earth. A frame is exposed each time the craft spins round. After each spin, a scanning mirror in the camera turns slightly, so that the camera gradually scans from pole to pole. It takes around 1800 steps to produce a full image of the Earth in 18 minutes.

During the recent eruption at Mt St Helen's a GOES satellite tracked the cloud of volcanic ash across the US.

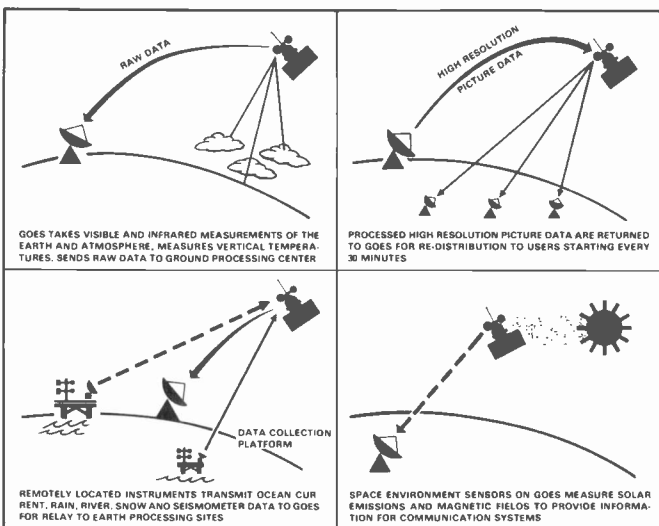


Fig.3 On the GOES data trail, complete with American spelling.



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HEF4002	22	HEF4047	109	HEF4517	478	CA3130E	99	IN4002	5	BC184L	12
HEF4003	119	HEF4049	57	HEF4518	118	CA3140E	48	IN4004	7	BC212	11
HEF4007	22	HEF4050	57	HEF4519	69	CA3189E	293	IN4007	9	BC212L	12
HEF4008	100	HEF4051	87	HEF4520	118	LM301AN	34	IN4148	4	BC214	11
HEF4011	22	HEF4052	90	HEF4521	235	LM339N	78	IN5402	15	BC214L	12
HEF4012	22	HEF4053	90	HEF4528	124	LM339N	104	2N2399	21	BC547	13
HEF4013	57	HEF4066	62	HEF4532	150	LM381AN	198	2N2946	46	BC548	11
HEF4014	105	HEF4067	475	HEF4534	638	LM3900N	75	2N2926G	13	BC549	12
HEF4015	100	HEF4068	22	HEF4539	138	MC3403P	156	2N3053	9	BC557	15
HEF4016	57	HEF4069	22	HEF4585	122	NE551	131	2N3054	55	BC558	15
HEF4017	100	HEF4070	22	HEF4724	214	NE538T	289	2N3055	55	BCY10	15
HEF4018	100	HEF4071	23	HEF40097	113	NE555N	28	2N3702	9	BCY21	15
HEF4019	58	HEF4072	23	HEF40098	92	NE568N	86	2N3704	9	BD131	39
HEF4020	112	HEF4073	23	HEF40106	78	NE568N	171	2N3705	10	BD132	39
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HEF4024	76	HEF4078	23	Voltage Regulators				T8A120S	88	BF895	29
HEF4025	22	HEF4081	23			TD4102Z	713	2N3904	9	BFY86	17
HEF4026	54	HEF4082	23			UA741CN	20	2N5457	39	BFY50	17
HEF4027	22	HEF4085	80			LM309DA(K)	119	2N5459	35	BFY61	17
HEF4028	89	HEF4086	80			UA723CN	42	40673	88	BFY39	50
HEF4029	113	HEF4093	63			JA7805CU	78	TL084CN	156	BSX20	21
HEF4030	58	HEF4094	219			UA7812CU	78	UA741CT	47	LC8960	2850
HEF4031	250	HEF4104	206			UA7815CU	78	Zener		TP131	48
HEF4035	138	HEF4502	114			UA7812CU	97	Diodes		TP32	54
HEF4040	94	HEF4505	714			UA7815CU	97	Diodes		TP42C	76
HEF4041	97	HEF4508	230			JA78L05CS	38	400mW CAV7-C33		TP2955	75
HEF4042	83	HEF4510	135			UA78L15CS	38	BZY88/BZ X79		TP3055	60
HEF4043	100	HEF4511	157			UA78L15CS	38	+ Voltage		TP543	36

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-10% to +50% Tol. Cap 018 - µF				Dipped Type, C280/352 Style			
µF	V	18	28	40	63	100	150
1.0	16	9	9	0.01	352	380	µF
1.5	16	9	9	.0015	7	1.5	7
2.2	16	9	9	.0022	6	7	11
3.3	16	9	9	.0033	6	7	11
4.7	16	9	10	.0047	6	7	14
6.8	16	8	10	.0068	6	7	17
10	16	8	10	.01	6	8	10
15	16	8	10	.015	6	8	10
22	16	8	10	.022	6	8	10
33	16	8	10	.033	6	8	10
47	16	8	11	.047	6	8	10
68	16	9	13	.068	7	8	10
100	16	9	13				
150	16	9	13				
220	16	10	13				
330	16	10	13				
470	16	10	13				
680	16	10	13				
1000	16	10	13				
1500	16	10	13				
2200	16	10	13				

RESISTORS				SKELETON PRESETS, MINIATURE			
Carbon Film, Fixed				0.1W, E3 Values, 100R-1M, Lin. Vertical Mounting			
0.25W, E24 Values IRO-10M, 5% Tol. 2 each Res RD%				8 Min. Preset V			
100/100 (Mult 10/Value)				8 Min. Preset H			
0.5W, E12 Values IRO-4M7, 10% Tol. 3 each Res RD%				+ Value			
+ Value				Skeleton Presets, Standard			
Metal Film, Fixed				0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting			
0.5W, E24 Values, SR-1M, 2% Tol. 8 each Res MR30				11 Std. Preset V			
2.5W, E12 Values, TOR-27K, 5% Tol. 16 each Res PR52				11 Std. Preset H			
+ Value				+ Value			
Metal Glaze, Fixed				Potentiometer, Rotary			
0.5W, E24 Values, IM-33M, 5% Tol. 16 each Res VR37				0.5W, E3 Values, 1K-2M2 Lin			
+ Value				39 Ro Pot Lin			
				0.25W, E3 Values, 4K7-2M2 Log			
				45 Ro Pot Log			
				+ Value			
				Potentiometer, Slider			
				0.5W, E3 Values, 2K2-47K Lin.			
				45 Sp Pot Lin			
				0.25W, E3 Values, 1K0-1M0 Log			
				45 Sp Pot Log			
				+ Value			

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Secondaries may be connected in series or parallel to give wide voltage range				ABS Box, C/W Brass Bushes, and Lid In Orange			
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Approx. 18% Regulation F C 54, H36, W35				L150 W80 D50 131 Case B1M2005 OR			
0.4 5V, 0.4 5V Secondaries Trans 8VA				L190 W110 D80 223 Case B1M2008 OR			
0.5V, 0.6V				Plastic Boxes with Metal Lids			
0.12V, 0.12V				Recessed Top Box			
0.15V, 0.15V				ABS Base, C/W Brass Bushes, In Orange			
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Approx. 18% Regulation F C 70, H48, W46				L111 W71 D42 180 Case B1M4004 OR			
0.4 5V 0.4 5V Secondaries Trans 20VA				L161 W98 D53 208 Case B1M4005 OR			
0.8V, 0.6V				Diecast Boxes			
0.12V, 0.12V				Draught Box and Flanged Lid			
0.15V, 0.15V				Aluminium Box and Lid in Natural Finish			
0.175V, 0.175V				Order Code			
0.20V, 0.20V				L113 W83 D31 124 Case B1M5003 NA			
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TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT	TYPE	SECONDARY RMS VOLTS	SECONDARY RMS CURRENT
1X010	6+6	2.50	5X012	12+12	6.66
1X011	9+9	1.66	5X013	15+15	5.33
1X012	12+12	1.25	5X014	18+18	4.44
1X013	15+15	1.00	5X015	22+22	3.63
1X014	18+18	0.83	5X016	25+25	3.20
1X015	22+22	0.68	5X017	30+30	2.66
1X016	25+25	0.60	5X018	35+35	2.28
1X017	30+30	0.50	5X028	110	1.45
			5X029	220	0.72
			5X030	240	0.66
50VA	80mm dia. x 35mm	£5.19	225VA	110mm dia. x 45mm	£10.59
Weight 0.9 Kg			Weight 2.2 Kg		
(+£1.10 p.p. + 0.94 VAT)			(+£1.50 p.p. + £1.81 VAT)		
2X010	6+6	4.16	6X014	18+18	6.25
2X011	9+9	2.77	6X015	22+22	5.11
2X012	12+12	2.08	6X016	25+25	4.50
2X013	15+15	1.68	6X017	30+30	3.75
2X014	18+18	1.38	6X018	35+35	3.21
2X015	22+22	1.13	6X026	40+40	2.81
2X016	25+25	1.00	6X028	110	2.04
2X017	30+30	0.83	6X029	220	1.02
			6X030	240	0.93
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3X010	6+6	6.64	7X016	25+25	6.00
3X011	9+9	4.44	7X017	30+30	5.00
3X012	12+12	3.33	7X018	35+35	4.28
3X013	15+15	2.66	7X026	40+40	3.75
3X014	18+18	2.22	7X028	110	2.72
3X015	22+22	1.81	7X029	220	1.36
3X016	25+25	1.60	7X030	240	1.25
3X017	30+30	1.33			
3X028	110	0.72			
3X029	220	0.36			
3X030	240	0.33			
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4X011	9+9	6.66	8X017	30+30	8.33
4X012	12+12	5.00	8X018	35+35	7.14
4X013	15+15	4.00	8X026	40+40	6.25
4X014	18+18	3.33	8X028	45+45	5.55
4X015	22+22	2.72	8X033	50+50	

THE BIG BANG THEORY

Over billions of years gas clouds condensed into stars and planets. The primeval soup bubbled. Self-replicating organisms writhed. Fish struggled onto the land and took their first breath of air (dramatic stuff). The result of it all — A.S. Lipson. Here, he discusses how it all began.

One of the many questions that has intrigued man since he first learned to speak is that of the origin of the universe. How did it all begin? Where did our world come from and what caused its existence? Scientists, being only human, (or so we are told) have not been immune to this type of curiosity — even Isaac Newton hypothesized about the origins of the stars. However, it is only fairly recently (during the second half of this century) that any research on this topic has been viewed as 'respectable', or fit material for a serious investigation. During this time, two main opposing theories as to the origin of the universe have developed; the Steady-state theory and the Big Bang theory. It is the latter which tends to be generally accepted these days, as we shall see later. But first we'll need to look at some of the background information.

The Red Shift Mystery . . .

It was found during the 19th century that when light from the Sun was passed through a narrow slit and then split into a spectrum by a prism, the spectrum showed hundreds of tiny dark lines across it. The reason for this was not known until the advent of quantum mechanics this century, but it was noted that the lines always occurred in the same positions in the spectrum, corresponding to set frequencies or wavelengths of the light. In 1868, it was found by Sir William Huggins that not only were all the same lines found in the spectra of stars, but in some stars, the lines were shifted very slightly from their positions in the solar spectrum. Sometimes the shift was towards shorter wavelengths; the blue end of the spectrum, and sometimes to longer wavelengths; the red end of the spectrum. With a disappointing lack of originality these two changes became known as the blue shift and the red shift, respectively. In order to explain the shifts, Huggins used an analogy with sound. When you are standing still, and are suddenly passed by a fast moving car (of course Huggins, working in 1868, did not explain it in terms of cars, but anyway. . .) which is emitting some sound, you may have noticed that as the car passes you the pitch of the sound drops. (Producing the eeeee-owwww sound beloved of motor sport enthusiasts.)

This change in pitch, or frequency of the sound waves is caused by the relative velocity between the car and yourself. It follows that light, which is also a wave, is affected in the same way by relative motion between the object emitting it and the object receiving it. In fact, the light from a star moving away from us at great speed is shifted slightly to the red end of the spectrum, and a star moving towards us has its light shifted very slightly to the blue end of the spectrum. This explains the red and blue shifts. Now, it so happens that the wavelength of the dark lines in a spectrum is one of those quantities which physicists find relatively easy to measure with extreme accuracy. By doing this, and comparing the wavelengths of dark lines in the spectra of stars to the wavelengths of the same lines in the spectrum of the Sun, it is possible to calculate fairly precisely just how fast a star is moving towards or away from the Earth.

In The Beginning . . .

Things really began to get interesting, though, when astronomers looked at the shifts in the spectra of other galaxies. They discovered that the distant galaxies appear to be moving away from our own galaxy — the Milky Way. There are one or two exceptions; for instance, the Andromeda Nebula, the closest large galaxy to our own, appears to be moving towards us at about 300 kilometres per second. In general, however, the other galaxies seem to be moving away. In fact it appears that almost every galaxy we can see is rushing away from every other galaxy. This can be simply expressed by saying that 'the universe is expanding'. As a general rule, distant galaxies show a distinct red shift in their spectra and the further away the galaxy, the greater the red shift tends to be, indicating that the further away a galaxy is, the faster it is likely to be travelling away from us.

It began to look as though a long time in the past, all the galaxies were squashed up together and then a massive explosion sent them flying apart. This is the bare bones of what became known as the Big Bang theory and various calculations have shown that if this is indeed what happened, then the 'beginning' — the creation of the universe — took place about 10-20 billion years ago. →

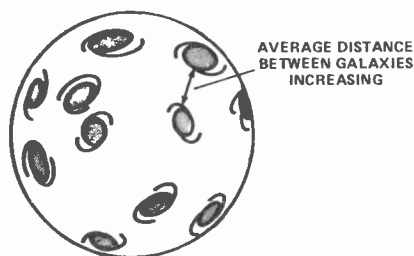


Fig.1 If you visualise our three-dimensional universe as being on the two-dimensional surface of an expanding balloon, you can see that, although the galaxies are getting further away from each other, the centre of expansion is not on the surface.

Before Genesis

Some cosmologists, however, were somewhat unhappy with this explanation of the expansion of the universe. It involves a 'beginning' and therefore raises the awkward question of what was 'before'. In fact, it was reasoned, it would be much more satisfying philosophically if a theory could be found which did not involve a 'beginning' for the universe, (this idea, that a theory ought to be philosophically satisfying, is not quite as silly as might be thought. Time and again in physics, the theory which *feels* best has been the correct one). In the late forties Hoyle, Bondi and Gold proposed the Steady-state theory. This takes care of the expansion of the universe in a most ingenious manner; although the various galaxies are receding from each other all the time, new matter is continuously being created to 'fill up the gaps'. As more matter is created, it collapses by gravitational attraction to form new galaxies. Thus there is no need in this theory for there ever to have been a beginning — the universe is as it is simply because it has always been the same. According to the Steady-state theory, there never was a beginning to the universe, and presumably there will never be an end — it will just keep expanding, old galaxies dying, new ones forming. This theory does have a certain 'neatness' about it that is rather satisfying.

As a first impression it might seem that it would be impossible to tell which of the two main theories — Big Bang or Steady-state — is correct. The only real difference to the universe now would be that, if the Steady-state theory is correct, the rate of expansion would be constant, whereas if the Big Bang theory is correct, the expansion would be slowing down somewhat, as gravitational attraction attempts to pull the galaxies back together again. This slowing-down, however, is far too slight for us to be able to measure. So how can we decide which theory is correct?

Well, for a start, there are one or two things which can only be explained in terms of the Big Bang theory. One of these is the abundance of the element helium in the universe — there is far too much of the stuff around for it to be explained in terms of the Steady-state theory (exactly why doesn't really concern us here). Another is the 'three degree Kelvin microwave background' — which we will consider later. Finally, there is this; according to the Steady-state theory, the universe has always been much the same as it is now, whereas according to the Big Bang theory, it has only evolved to its present state slowly, and it was different in the past. If only we had some way of looking at the past of the universe, we could compare it with the present. If the two were largely similar, we could conclude that the Steady-state theory is roughly correct. If, however, there was a noticeable difference in, say, the structures of galaxies then and now, we might conclude that

the Big Bang theory is correct. But we can't look at the past. Or can we? When we look at the stars, we do not see them as they are, but as they were when they emitted the light we see. Light takes only about eight minutes to reach us from the Sun, but nearly four and a half years from even the closest star. When we look at the more distant galaxies, we see them as they were many millions of years ago. Evidence is not 100% conclusive (it rarely is in cosmology) but weighing the facts one against the other, it seems it is the concept of the 'Big Bang' that is correct.

The Microwave Background

Now it is time, then, to elaborate a little on the Big Bang theory. A common misconception is that this theory states that about 15 billion years ago, a massive explosion occurred at one point in space, throwing out matter which eventually condensed into stars, galaxies, planets and (finally) us. In fact, this is not correct. The explosion is not imagined to have occurred at one particular point in space. It took place at every point in space, occupying the entire universe. It makes no sense, then, to ask "Where was the explosion?" The best way of understanding this is to imagine our universe as being on the two-dimensional surface of a balloon, which is being inflated. It makes no sense to ask where on the surface of the balloon is the centre of expansion; every point is just as much the centre as any other.

We will now see what it is thought the precise beginning of the universe was like. Nobody actually knows what the universe was like during the first few fractions of a second; our knowledge only starts after this. After the first tenth of a second or so, the vast and intense quantities of energy that had just sprung into existence with the universe were making the temperature of the universe an incredible 30 billion degrees on the Kelvin scale (at temperatures as high as this, the Kelvin and Centigrade scales are virtually identical). Apart from the pure energy in the form of photons, a lot of electrons and positrons were in existence, together with equally large numbers of particles called neutrinos. In addition, there was a slight contamination of heavier particles, like protons and neutrons. After a second or so, the temperature had dropped to only ten billion degrees or so and this was still far too hot for protons and neutrons to form atomic nuclei. This process didn't begin until three or four minutes after the beginning,

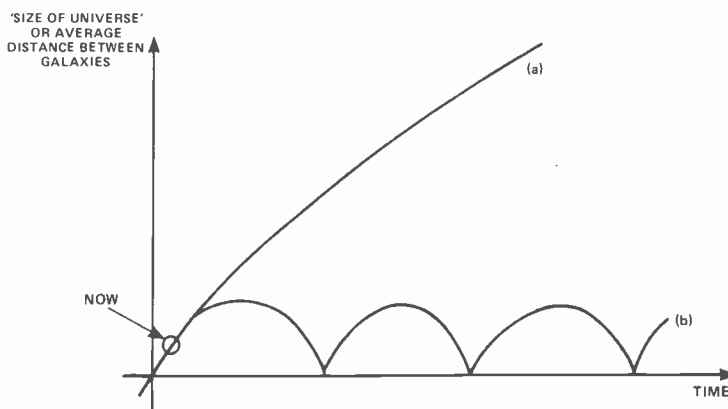


Fig.2 Will the universe keep expanding (a) or will the gravitational attraction be strong enough to make it collapse again, only to start another expansion (b)?

when the temperature had dropped to a mere (. . . a mere . . . !!! . . .) 900 million degrees. Even though nuclei had been able to form, there was still far too much energy for electrons to be able to join up with the nuclei to form stable atoms. It took nearly three quarters of a million years for that to occur and by that time, most of the original electrons and positrons had vanished. (When an electron meets a positron, the two disappear, giving off energy. This is what is thought to have happened, leaving just a few particles behind.) Gradually, gravity clumped the atoms together, and then clumped the clumps, to form stars and galaxies. Eventually, life developed: but that happened much later.

Cold Radiators

So how can we test this theory? Well, if it is correct, there should still be some radiation hanging around from this beginning. The appropriate calculations have been performed, and it turns out that the radiation ought to be roughly equivalent to that emitted by a perfect radiator at a temperature of about three degrees Kelvin (minus 270° Centigrade). This doesn't seem to be a lot, (things that cold don't radiate much heat) but despite this it is measurable. In the mid-sixties, Penzias and Wilson measured this 'three degrees Kelvin radiation background', more or less by accident. At first they blamed poor readings on their equipment and on a pair of pigeons which had nested inside the horn-shaped antenna they were using!

That's it then. It looks very much as though the Big Bang theory is in fact the correct explanation of the origin of the universe. There are still unanswered questions, however.

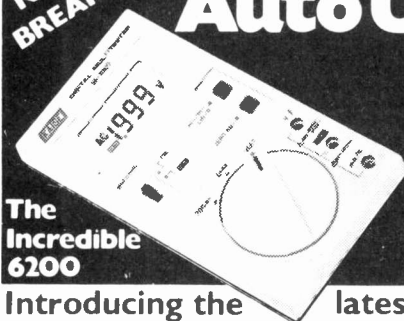
What's on Next?

We've seen an explanation of how the universe began, but how will it end? Will it just keep expanding, getting larger and larger and cooler and cooler, or will gravitational attraction pull the galaxies back together again, the expansion of the universe slowing and eventually stopping, then 'going into reverse'? This depends on exactly how much matter there is in the universe. If there is enough, then the gravitational pull will be strong enough to make the universe collapse back in again. If not, then the expansion will continue. In the former case, the universe is said to be 'closed', and in the latter case, 'open'. Either way, the human race will certainly be long extinct before it happens. So we may never know which is the case. Some evidence seems to indicate that the universe is closed; some that it is open. Until fairly recently, it seemed that the universe was probably closed. However, it is now thought possible that the sub-atomic particles known as neutrinos might have mass, contrary to what has been thought for many years. There are so many neutrinos in the universe that, if this is the case, it might be enough to make the difference between an open and a closed universe.

We will finish with one more fascinating possibility. It has been suggested that, if the universe does collapse back on itself, it would first return to its original state of intense heat, and then possibly explode outwards again, beginning the whole thing all over again. We can imagine the universe forever exploding outwards, contracting again, exploding, contracting . . . Perhaps the universe we live in is formed from the remnants of the cycle before. . . . Sadly we shall never know. . . .

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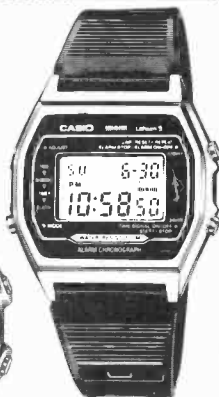
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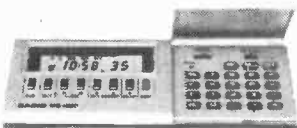
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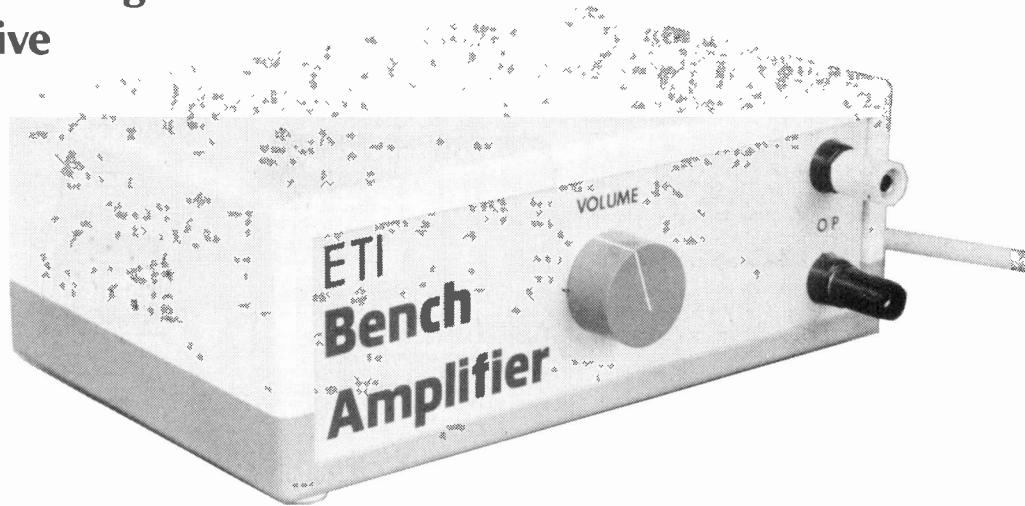
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Our bench amplifier has been designed with low cost and good functional performance in mind. The unit has a high-impedance (10 M) input stage which is accessed via a pair of panel-mounted terminal sockets. The unit is mains powered

and can deliver approximately 4 W into an 8R0 speaker. The bench amplifier is designed to be used with external speakers, which are connected to the instrument via a second set of panel-mounted terminal sockets.

The amplifier works best when used with external 8R0 speakers, but can in fact be used with any speaker impedances in the 4R0 to 16R range. Fidelity is reasonably good, with distortion typically being less than 0.1% at 1 W at 1 kHz. The frequency response is virtually flat to 200 kHz.

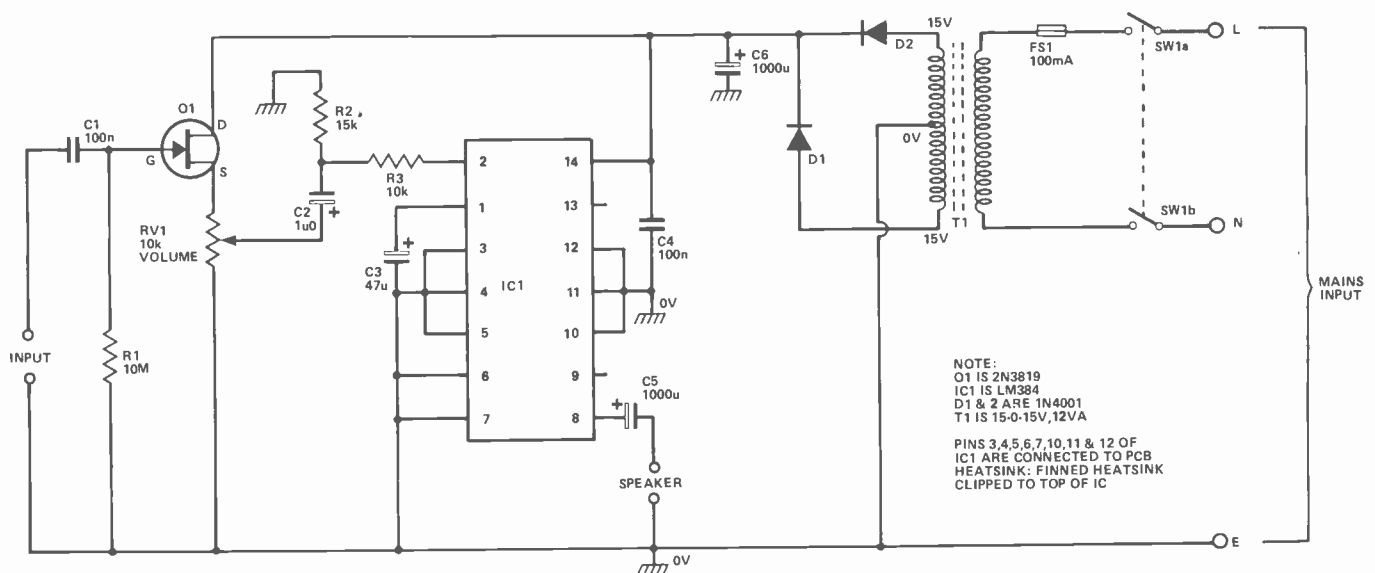
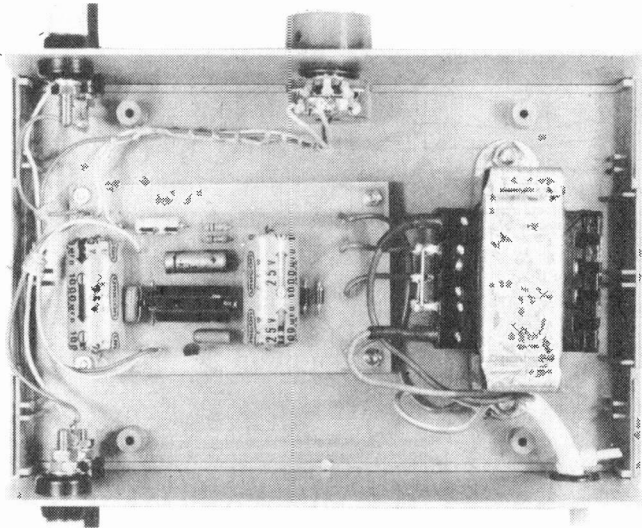


Fig. 1. Complete circuit diagram for the ETI Bench Amplifier.



This photograph shows everything fitted, wired up and ready to go. Volume and output sockets are on the front panel, input sockets are on the back. Note the heatsink on the IC.

Construction

The circuit is very simple, so construction should present few problems. IC1 should be soldered directly to the PCB, without the use of a socket. This IC uses a modest area of PCB foil as a partial heat sink and has additional sinking provided by a finned clip-on heat sink (see Buylines). The PCB should be provided with ten Veropin terminals, to facilitate connections to T1, RV1 and the input and output terminals.

When PCB construction is complete, fit it into a suitable cabinet (we used a Verobox on our prototype) and make the inter-connections to T1, RV1 and the input and output terminals. On our prototype we omitted FS1 and SW1 from the actual unit, since these facilities are already provided by the fused mains plug and the switched power socket of our bench installation. We fitted volume control RV1 and the speaker terminals to the unit's front panel and fitted the input terminals to the rear. Note that holes should be drilled in the sides (or top) of the completed cabinet, to aid heat dissipation.

When construction is complete, fit a suitable speaker (ideally 8R0) in place, connect a suitable input signal and switch the unit on. Check that good quality reproduction is obtained (the unit will drive roughly 4 W into an 8R0 speaker) and that the volume can be varied via RV1. The unit is then complete.

HOW IT WORKS

There really is not a great deal we can say here, as the circuit is so simple. Q1 is a high-impedance FET (field effect transistor) and is used as a unity-gain buffer amplifier. Its output is fed to the input of IC1 via RV1, the volume control.

IC1 is a 5 W power amplifier (actually an up-rated version of the LM380 2 W IC), with an integral heat sink that is coupled to the three centre pins on either side of the IC package. The output of the power amplifier is passed to an external speaker via C5 and the whole shebang is mains powered via T1-D1-D2 and C6.

The output of the IC is (according to the manufacturers) short circuit proof and can work into any speakers with impedances in the 4R0 to 16R range. In practice, the circuit works best with 8R0 speakers. To ensure adequate power handling capability, our IC is soldered to a PCB heat sink and is also fitted with a finned clip-on heat sink.

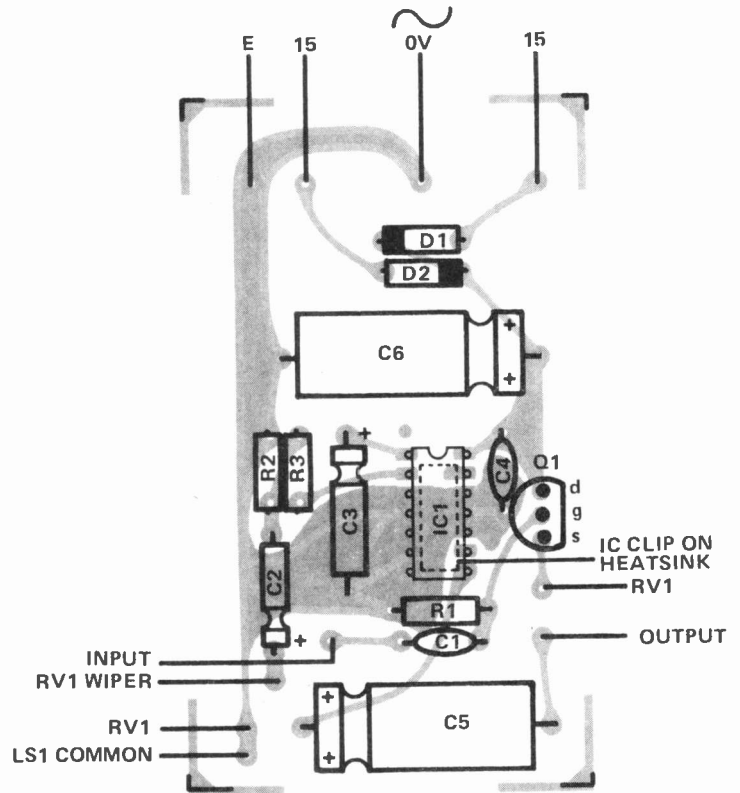


Fig. 2. Component overlay of the Bench Amp.

PARTS LIST

Resistors all ¼ W 5%

R1	10M
R2	15k
R3	10k

Potentiometer

RV1	10k logarithmic
-----	-----------------

Capacitors

C1, 4	100n polyester
C2	1u063 V axial electrolytic
C3	47u 25 V axial electrolytic
C5, 6	1000u 25 V axial electrolytic

Semiconductors

Q1	2N3189
IC1	LM384
D1, 2	1N4001

Miscellaneous

FS1 100 mA and holder, SW1 DPDT miniature toggle, T1 15-0-15 12 VA mains transformer.

BUYLINES

All components used in the ETI Bench Amplifier should be readily available from major stockists. The clip-on heat sink can be obtained from Watford Electronics.

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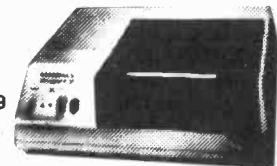
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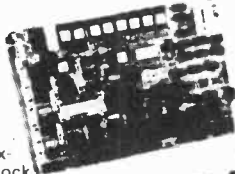


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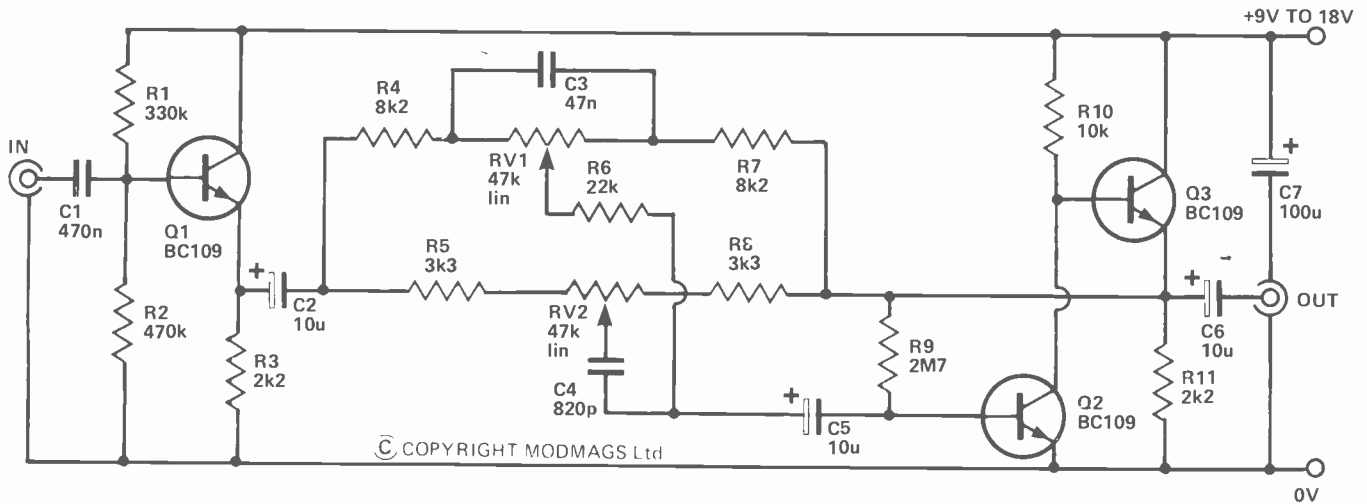
Active Tone Controls

This tone control circuit is easy to incorporate in a stereo amplifier, disco unit, or whatever, as it has a high input impedance (over 100k), a nominal voltage gain of unity and a low output impedance. The usual bass and treble controls are included in the unit, with about 12 dB of boost and cut being available at 100 Hz and 10 kHz. The noise and distortion produced by the circuit are both extremely low due to the large amount of negative feedback used and the unit can handle output signal levels of several volts RMS without clipping.

Q1 is used in a straightforward emitter follower buffer stage that gives the unit a high input impedance. C2 couples the output of Q1 into the

tone control circuitry. This is an active circuit which provides frequency-selective negative feedback over an amplifier. The amplifier uses Q2 as a conventional common emitter stage direct-coupled to emitter follower output transistor Q3. The latter gives the unit a low output impedance.

The tone control networks are slightly simpler than the usual "Baxandall" configuration, but give a perfectly acceptable level of performance. RV1 controls the bass while RV2 is the treble control. Feedback is at a maximum with the sliders of the potentiometers to the right and at a minimum with the sliders set fully to the left. Of course, the gain of the circuit is inversely proportional to the level of feedback. Maximum feedback therefore corresponds to maximum cut and not to full boost. The current consumption of the circuit is a little under 1 mA per supply volt.



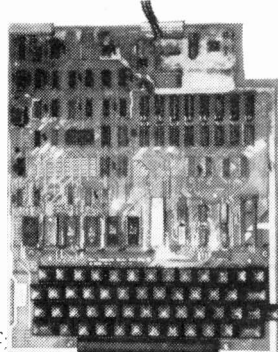
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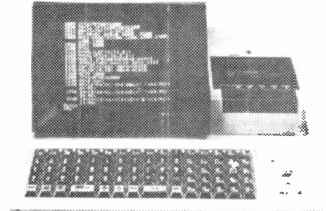
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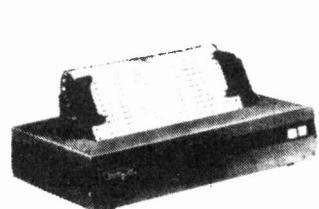
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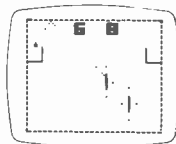
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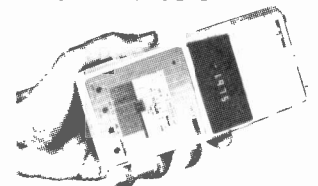
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DESIGNER'S NOTEBOOK

This month Ray Marston takes an in-depth look at the VCO section of that ubiquitous CMOS chip, the 4046B phase-locked loop.

The 4046B CMOS chip is probably one of the most versatile and least-used of all the ICs in the CMOS range. The device glories in (or suffers from) the descriptive title of 'micropower phase-locked loop' and there is a widespread misconception amongst many electronics amateurs and professionals that the device can only be used in PLL applications. In fact nothing could be further from the truth.

The Inside Story

The 4046B actually contains a pair of phase-comparators, a zener diode and one VCO or voltage-controlled oscillator. All of these sections are independently accessible via the IC pin-outs. The VCO section of the device is probably the most versatile and cost-effective voltage-controlled oscillator on the market. It produces a well-shaped symmetrical square wave output, has a top-end frequency limit in excess of 1 MHz, can be voltage-scanned through a 1,000,000:1 range (1 Hz to 1 MHz) when used with a single timing resistor or through any range from 1:1 to infinity (0 Hz to 1 MHz) when used with a pair of timing resistors.

If that were not enough, the voltage-controlled oscillator can also be independently gated on and off via an INHIBIT terminal, can be operated from any supply in the range 3-18 V and can, when used in conjunction with one of the 4046B's phase comparators, produce a two phase output. The linearity of the VCO is typically a healthy 1% or so.

Basic 4046B VCO Circuits

Figure 1 shows the internal block diagram and the pinouts of the 4046B phase-locked loop IC. The device contains two types of phase comparator, a VCO and a zener diode. In practical PLL applications, the VCO and one or other of the comparators are interconnected to form a 'loop', which causes the VCO to lock the the mean frequency of an input signal connected to pin 14.

For our present purposes the most important element of the IC is the VCO, or voltage controlled oscillator. The operating frequency of the oscillator is governed by the value of a capacitor connected between pins 6 and 7 (minimum value 50 pF), by the value of a resistor wired between pin 11 and ground (minimum value 10k) and by the voltage applied to VCO-input pin 9 (any value up to the supply voltage in use).

Figure 2 shows the simplest possible way of using the VCO section. Here, the pin 9 'voltage control' input is tied permanently high and the circuit acts as a basic square wave oscillator, with its frequency variable over a 10:1 range by RV1. Note at this point that the VCO output (pin 4) is tied directly to the pin 3 phase comparator input. If pin 3 is allowed to float, the comparators tend to self-oscillate at about 20 MHz and superimpose an HF signal on the top part of the VCO output waveform.

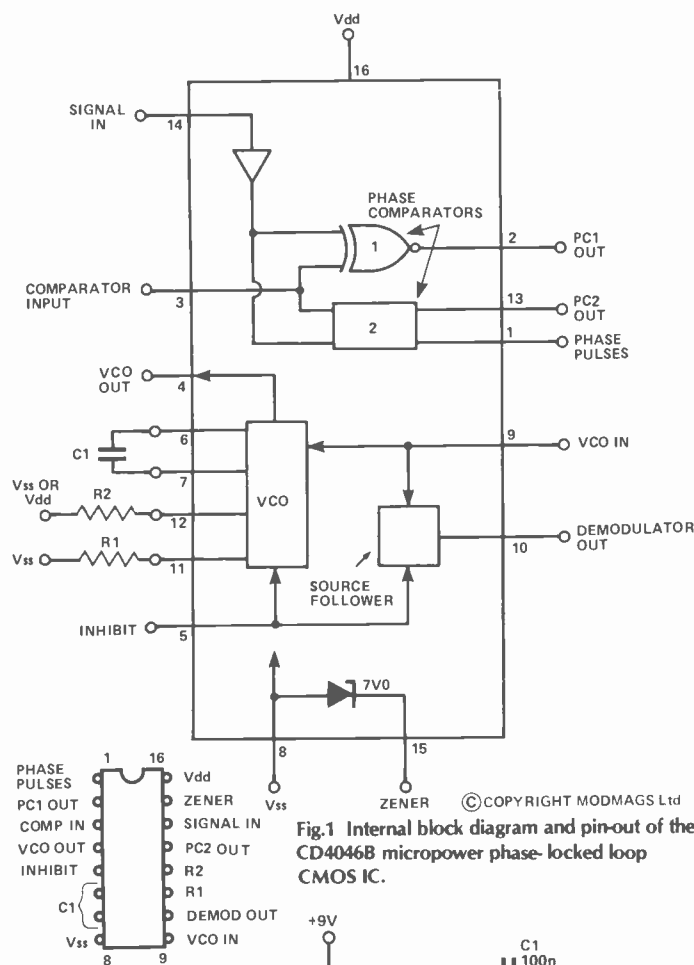


Fig.1 Internal block diagram and pin-out of the CD4046B micropower phase-locked loop CMOS IC.

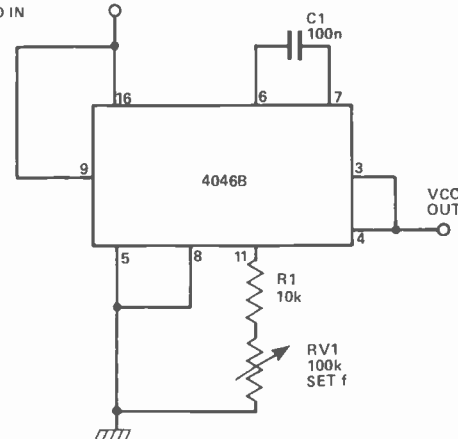


Fig.2 Simple variable-frequency (200 Hz to 2 kHz) square wave generator. →

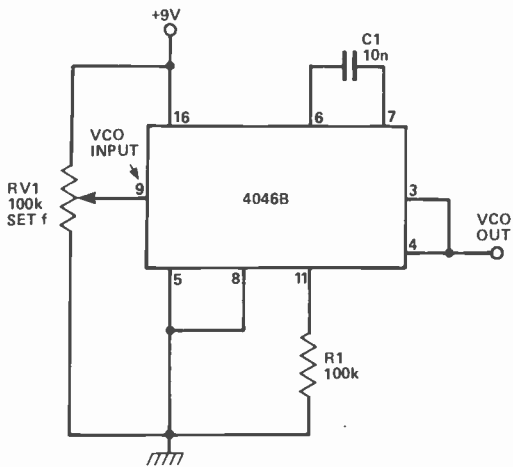


Fig.3 Wide range VCO with frequency variable from near zero to 1.4 kHz via the pin 9 voltage.

Ranging Far And Wide

Figure 3 shows how to connect the 4046B as a genuine wide-range VCO. Here, R1-C1 determine the top (maximum) frequency that can be obtained and RV1 controls the actual frequency via the pin 9 voltage. The frequency falls to near-zero (a few cycles per minute) with pin 9 at 0 V. The effective control range of pin 9 varies from roughly 1 V below the supply value to 1 V above zero, ie RV1 has a 'dead' control area of several hundred millivolts at either end of its range.

Figure 4 shows how these 'dead' areas can be eliminated by wiring a silicon diode in series with each end of RV1. The circuit also shows how the minimum operating frequency can be reduced to absolute zero by wiring a high value resistor (R2) between pins 12 and 16. Note here that, when the frequency is reduced to zero, the VCO output randomly settles in either the logic 0 or logic 1 state.

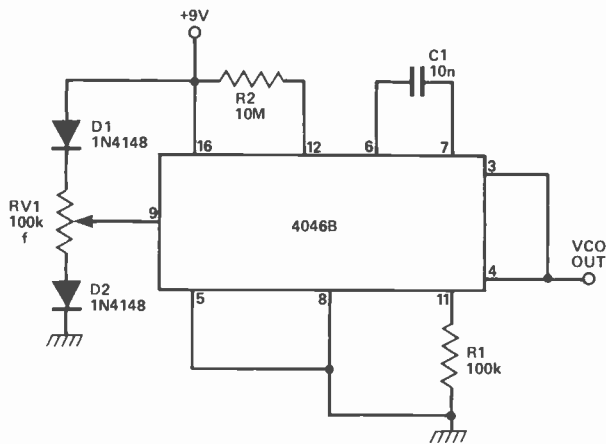
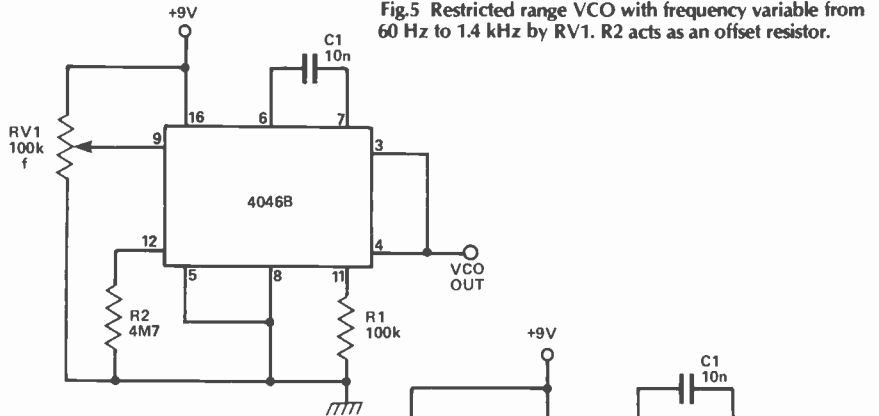


Fig.4 Wide range VCO with frequency variable down to absolute zero.

Figure 5 shows how the pin 12 resistor can alternatively be used to determine the minimum operating frequency of a restricted-range VCO. Here, f_{min} is determined by R2-C1 and f_{max} is determined by C1 and the parallel resistance of R1-R2.

Figure 6 shows an alternative version of the restricted-range VCO, in which f_{max} is controlled by R1-C1 and f_{min} is determined by C1 and the series combination of R1 and R2. Note that, by suitable choice of the R1 and R2 values, the restricted-range VCO can be made to span any range from 1:1 to near-infinity.



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Fig.5 Restricted range VCO with frequency variable from 60 Hz to 1.4 kHz by RV1. R2 acts as an offset resistor.

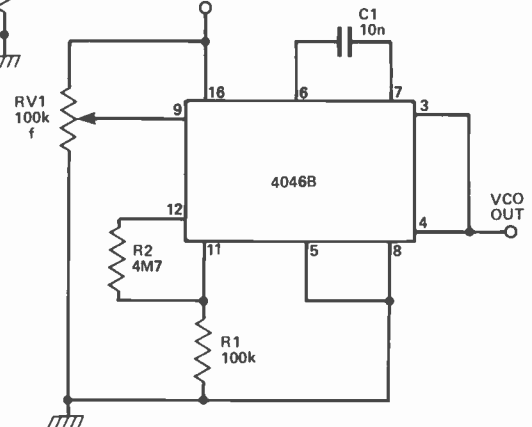


Fig.6 An alternative restricted range VCO, in which f_{max} is controlled by R1-C1 and f_{min} by (R1 + R2)-C1.

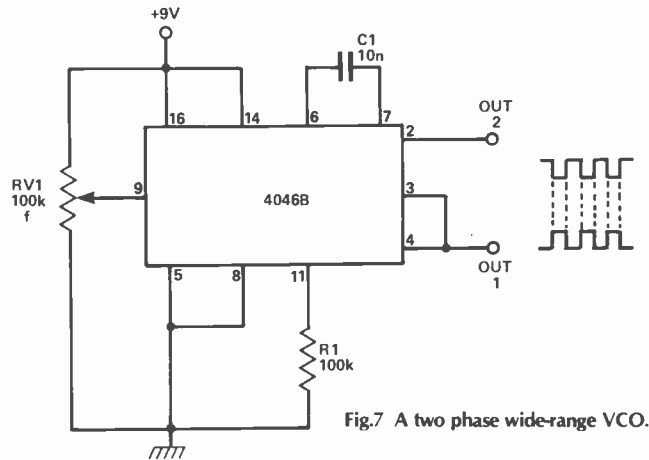


Fig.7 A two phase wide-range VCO.

Square Pear

The VCO can be made to generate a pair of anti-phase square wave outputs by connecting its output to the phase-comparator input, taking the signal input (pin 14) high and taking the anti-phase output from pin 2. Figure 7 shows the connections. Note that this circuit makes use of the IC's built-in EX-OR gate (phase comparator 1).

The VCO section of the 4046B can be disabled by taking pin 5 of the package high (to logic level 1). This feature enables the VCO to be gated on and off by external signals. Figure 8 shows how the VCO can be manually gated via a push button connected directly to pin 5, while Fig.9 shows how the circuit can be gated electronically by an external gate inverter. Alternatively, if the two phase output facility is not required, the internal EX-OR phase detector can be used to provide gate inversion, as shown in Fig.10. Note in this latter case that pin 4 is not connected to pin 3.

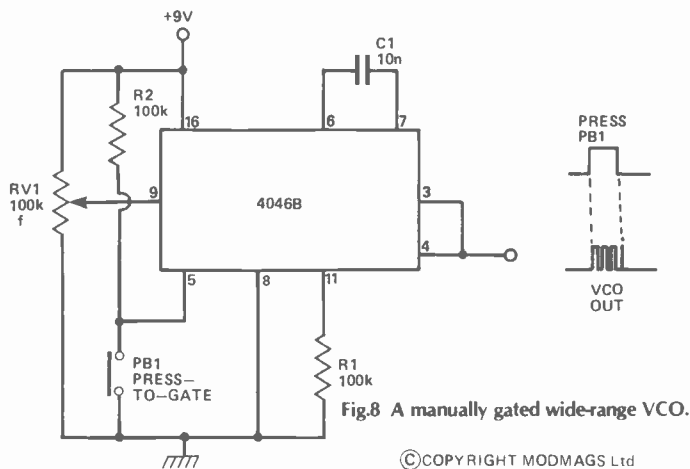


Fig.8 A manually gated wide-range VCO.

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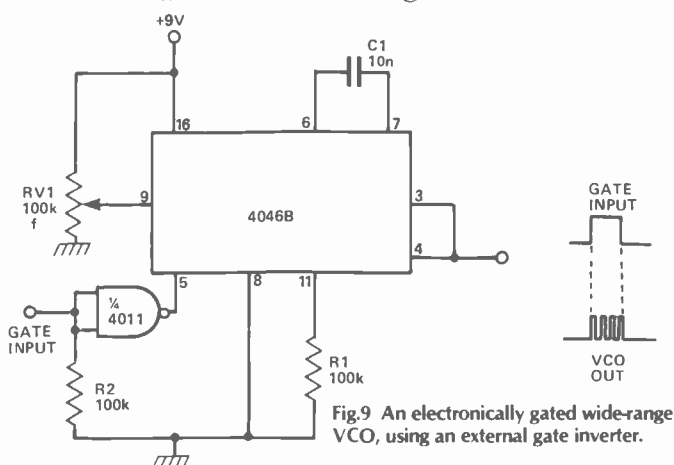


Fig.9 An electronically gated wide-range VCO, using an external gate inverter.

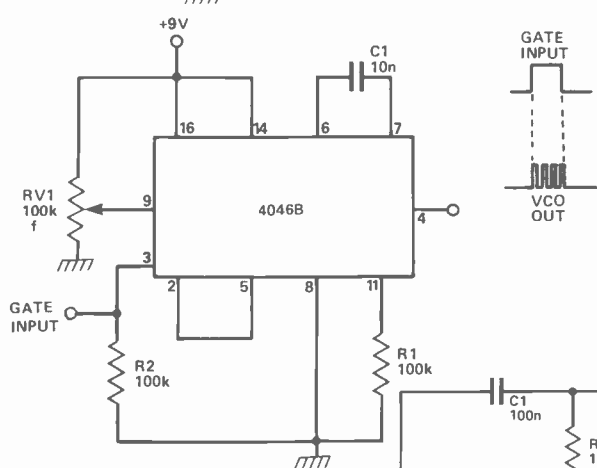


Fig.10 An electronically gated wide-range VCO using the internal EX-OR phase detector for gate inversion.

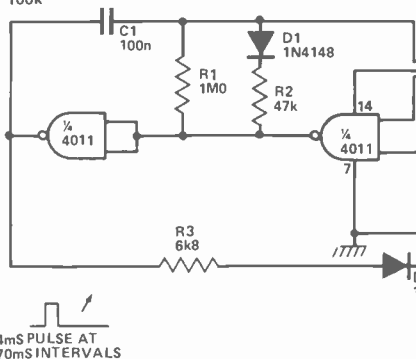


Fig.13 Phaser sound generator circuit.

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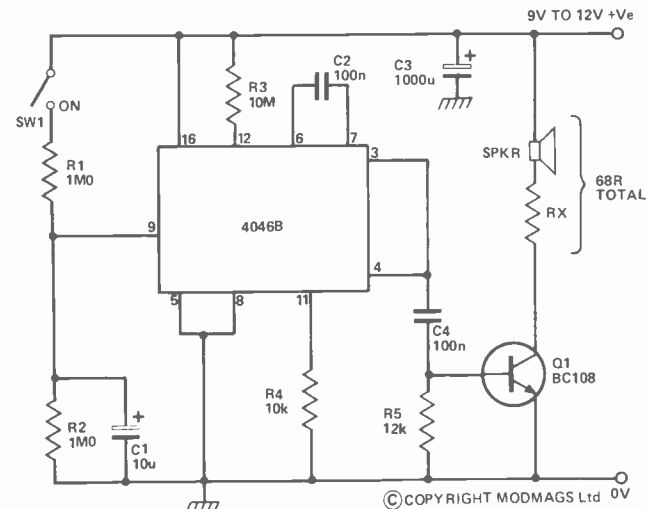


Fig.11 An electronic siren giving slow rise and fall of its operating frequency.

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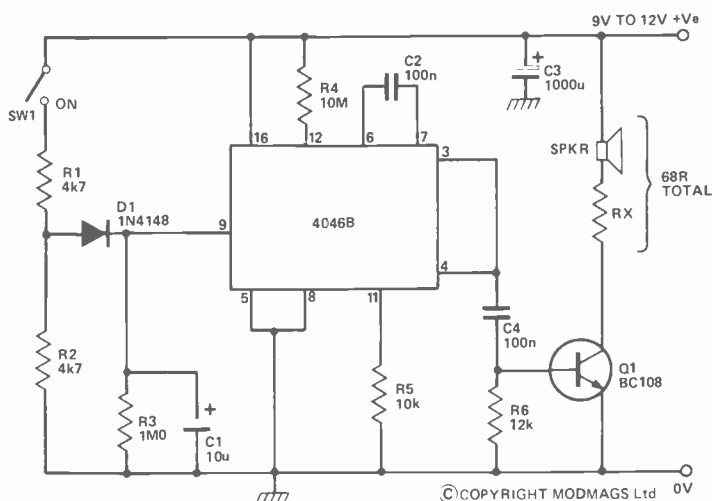


Fig.12 This quick-start siren gives a rapid rise and slow fall of its operating frequency.

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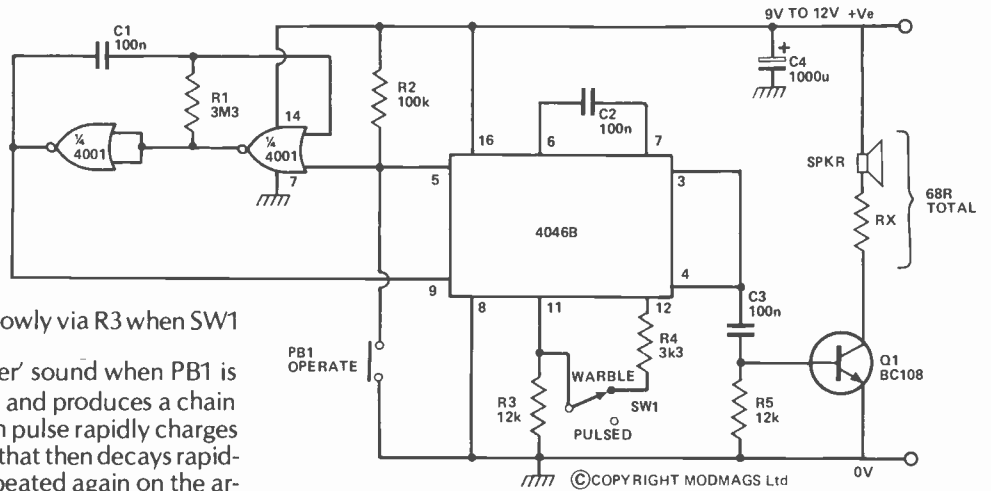
and the VCO frequency rises slowly from zero to a maximum value. When SW1 is opened, C1 discharges via R2 and the operating frequency slowly decays to zero. The VCO output is AC-coupled to the speaker via C4 and Q1.

The Fig.12 quick-start siren is similar to the above, except that C1 charges rapidly to half-supply volts via R1-R2 and

Sirens And Sound Effects

Figures 11 to 14 show some practical siren and sound effects generator VCO circuits. Figure 11 is a conventional siren circuit. When SW1 is closed, C1 charges exponentially via R1

Fig.14 Combined pulsed tone/warble tone alarm generator. The high tone is determined by R3, the low tone by (R3 + R4).



D1 when SW1 is closed and discharges slowly via R3 when SW1 is opened.

The Fig.13 circuit produces a 'phaser' sound when PB1 is closed. The 4011 astable is gated by PB1 and produces a chain of 4 mS pulses at intervals of 70 mS. Each pulse rapidly charges C2 via R3 and D2, to produce a high tone that then decays rapidly as C2 discharges via R5, only to be repeated again on the arrival of the next pulse.

The Figure 14 circuit generates either a pulsed tone or a warble tone signal (depending on the setting of SW1) when PB1 is closed. PB1 is used both to enable pin 5 of the 4046B and to

frequency (tens of kHz) and effectively generates a random number of clock pulses. When PB1 is released, Q1 turns off and the VCO timing is governed by R8. Simultaneously, C1 rapidly discharges to half-supply volts via R1-R2-D1, so the VCO operates at only 100 Hz or so. C1 then slowly discharges via R3 and the VCO frequency slowly decays to zero over a period of about 15 S.

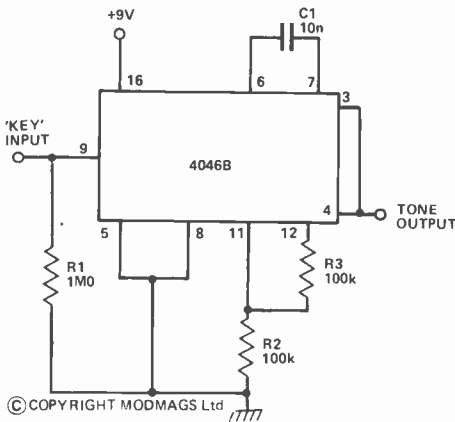


Fig.15 FSK generator -- logic 0 = 1.2 kHz, logic 1 = 2.4 kHz.

gate on the 4001 astable, which then applies a rectangular (alternatively fully-high and fully-low) waveform to pin 9. In the pulsed mode the VCO generates zero frequency when pin 9 is low. In the warble mode it generates a tone that is 20% down on the high tone when pin 9 is low.

Miscellaneous VCO Circuits

Figures 15 to 19 show a miscellany of 4046B VCO circuits. The Fig.15 circuit is that of a FSK generator which produces a 2.4 kHz tone when a logic 1 signal is applied to pin 9 and a 1.2 kHz tone when a logic 0 signal is applied. The high tone is controlled by R2 and the low tone by R2 and R3.

Figure 16 is a 220 kHz FM generator. The internal zener of the 4046B (pin 15) is used to provide a stable 7V0 supply to the x20 3140 inverting amplifier, which is quiescently biased at 3V5 by the R2-R3 potential divider. The pin 9 VCO signal is thus a mean 3V5 potential amplitude modulated by an amplified version of the AF input signal, which thus frequency-modulates the output of the VCO.

Running Down

The Fig.17 circuit is that of a run-down clock generator of the type used in dice and roulette games. When PB1 is pressed, C1 charges to a high voltage via D2. Simultaneously, Q1 is biased on via D3-D4 and effectively connects R6 between pin 11 and ground. Under this condition, the VCO operates a high

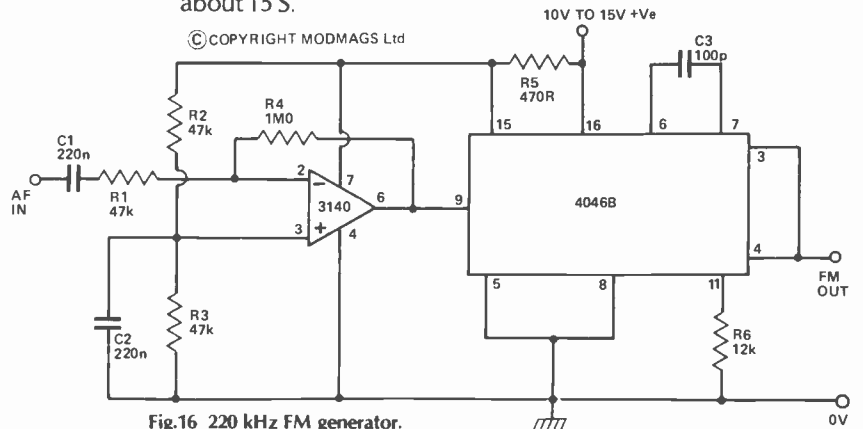


Fig.16 220 kHz FM generator.

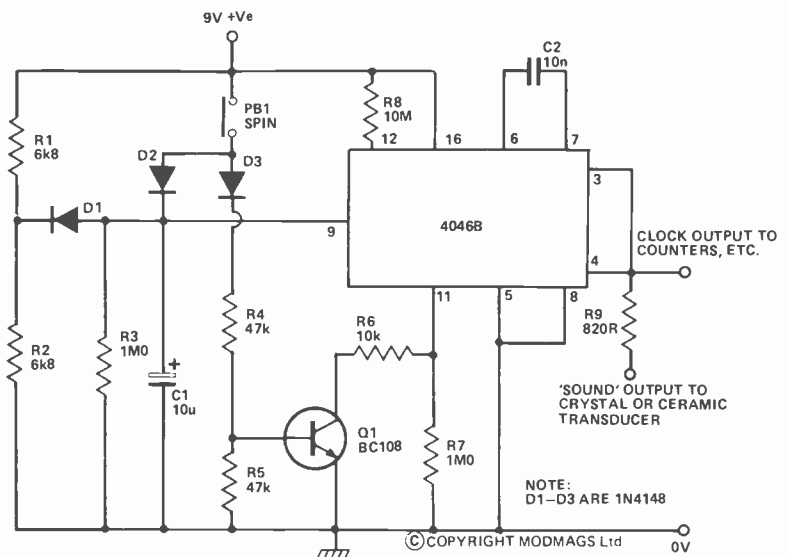


Fig.17 Run-down clock/sound generator for use in dice/roulette games. The circuit is suitable for use with edge-sensitive clock circuits only. The output can be used to directly clock most types of counter and can be fed, via R9, to crystal or ceramic transducers to directly produce 'run down' sounds. When the run-down is complete this circuit may settle in either logic 0 or 1, so it cannot safely be used to clock level-sensitive circuitry.

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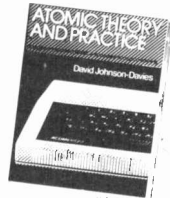
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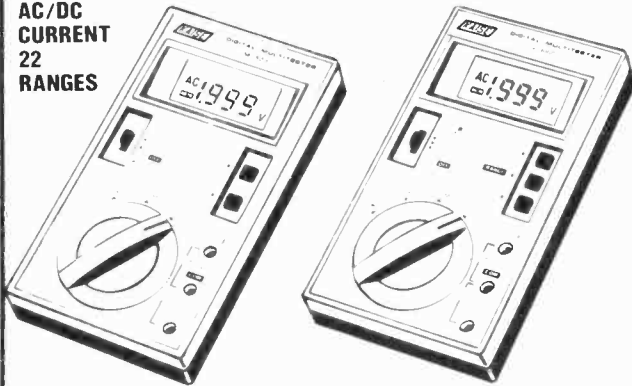


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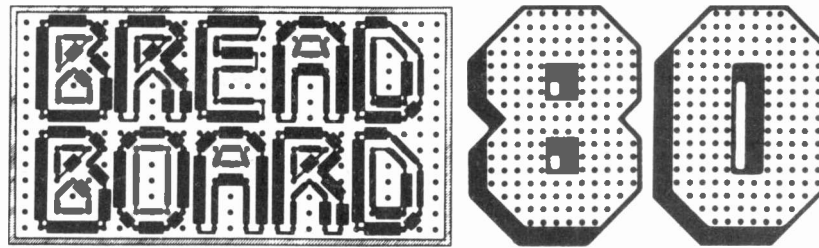
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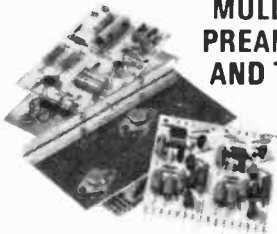


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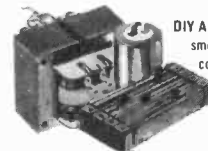
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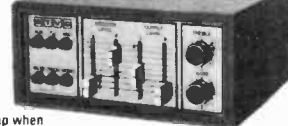
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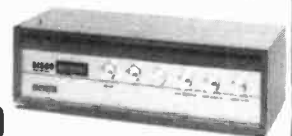
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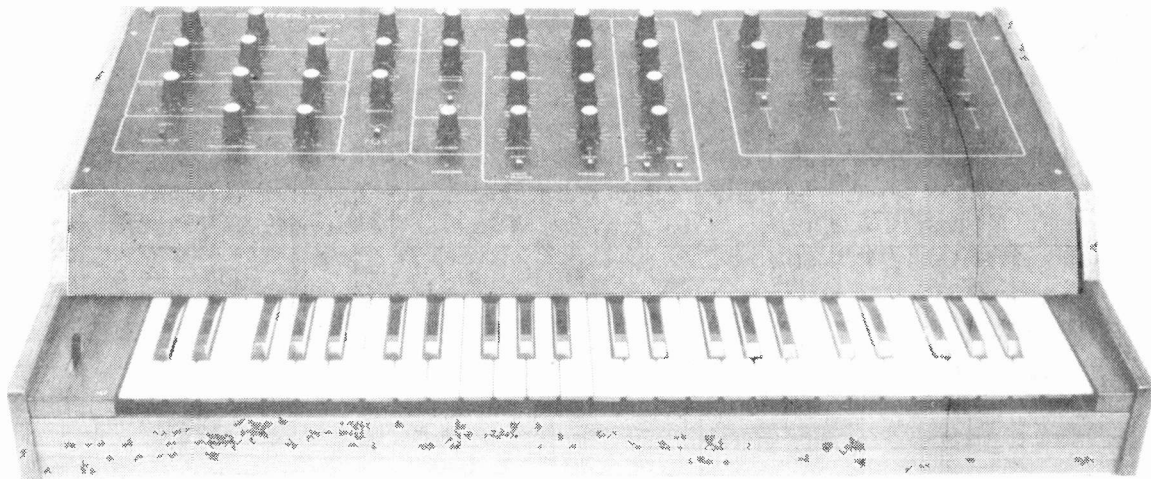
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POLYSYNTH



The Transcendent Polysynth is no ordinary synthesiser — it's a family of them. Each of its voices is a complete synthesiser in itself with two VCOs, two ADSRs, a VCA and a VCF in addition to all the usual synthesiser functions. Design and development by Tim Orr.

The Polysynth is a four octave polyphonic music synthesiser. The standard unit has four voices making it possible to play up to four notes simultaneously. Each voice is a complete synthesiser in itself, having two VCOs, two ADSRs, one VCA and one VCF. The voices are totally voltage controlled which enables them to be ganged up in a bus system. So when the master sustain level is adjusted, the sustain level on all voices is set to the same value. However, by providing independent pitch and gate signals, it is possible to control each voice from the keyboard and yet have a common control over the other parameters. The machine can be expanded (with an extra mother board (PS4), four voice boards (PS7) and a panel board (PS6)) to a system with eight independent voices.

The design has minimal wiring (Fig.1), most of which is made with preformed ribbon cable links. Also, the four voice boards, which require nearly 50 signals each, plug into a Molex connector bus system.

All the common controls, such as ADSR parameters, modulation oscillators, volume and noise level are located on the left hand panel board (PS5).

The right hand board (PS6) handles the individual parameters of oscillator tuning and the voice on/off control. Both the panel boards deliver their signals to the mother board (PS4) which then distributes them to the voice slots. Pitch and gate parameters are independently fed to the voices, these signals being generated by PS1, 2 and 3.

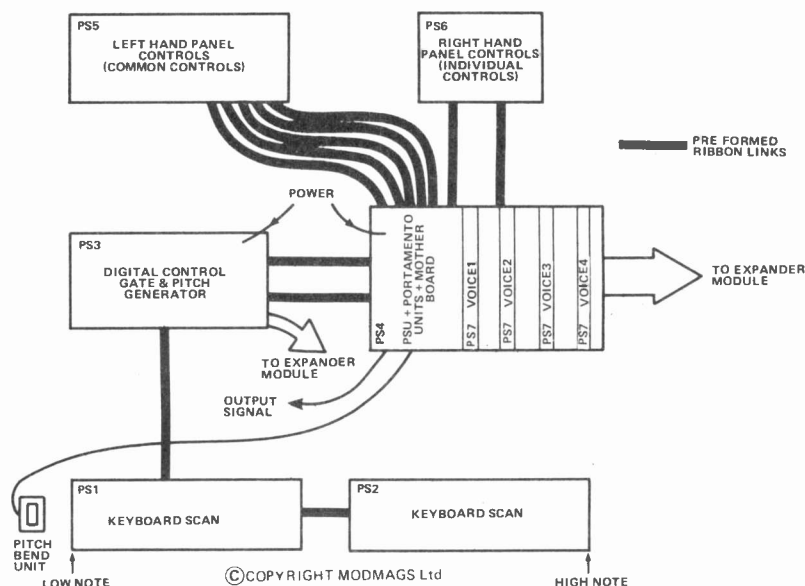
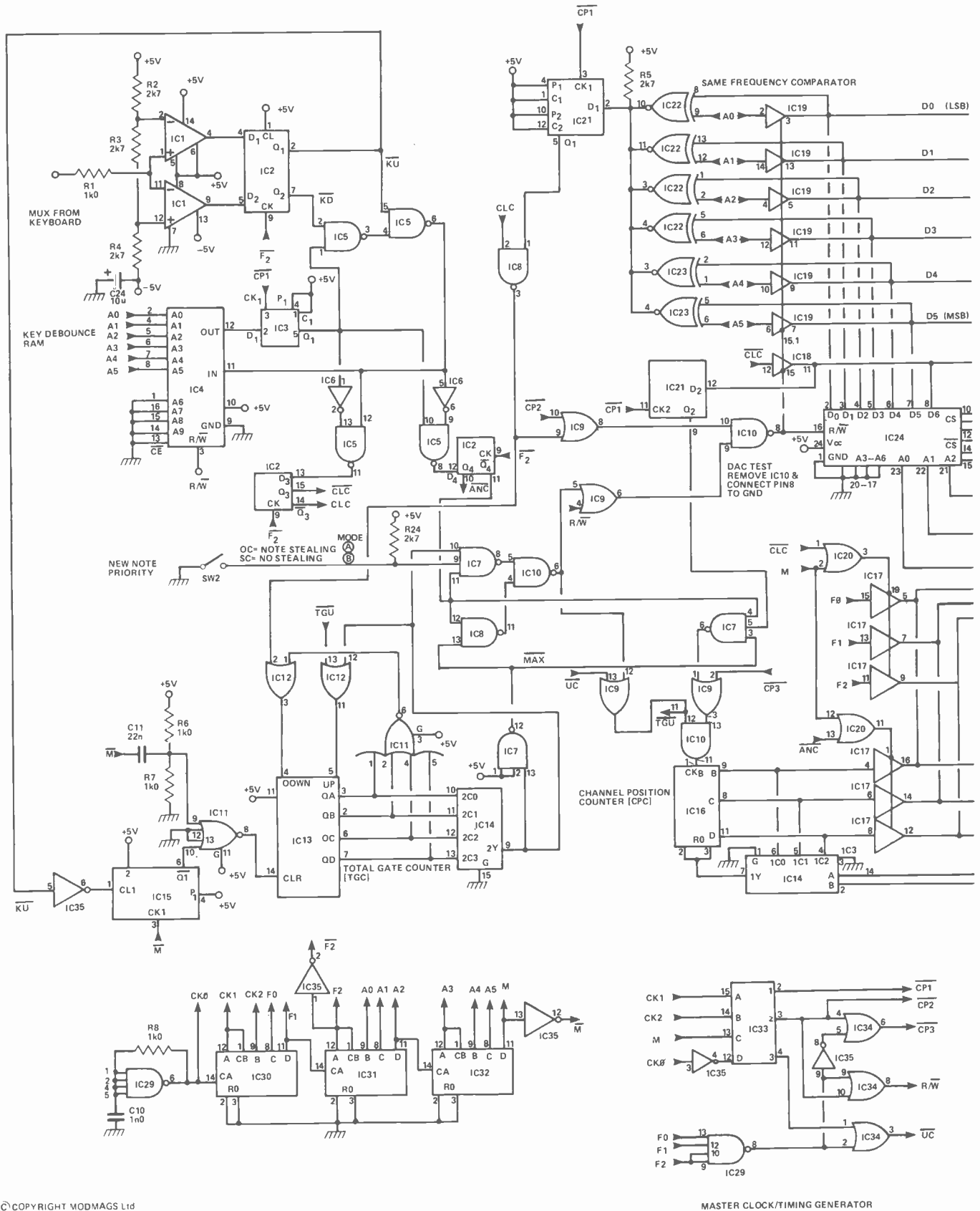
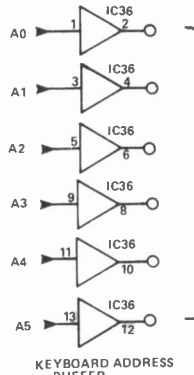
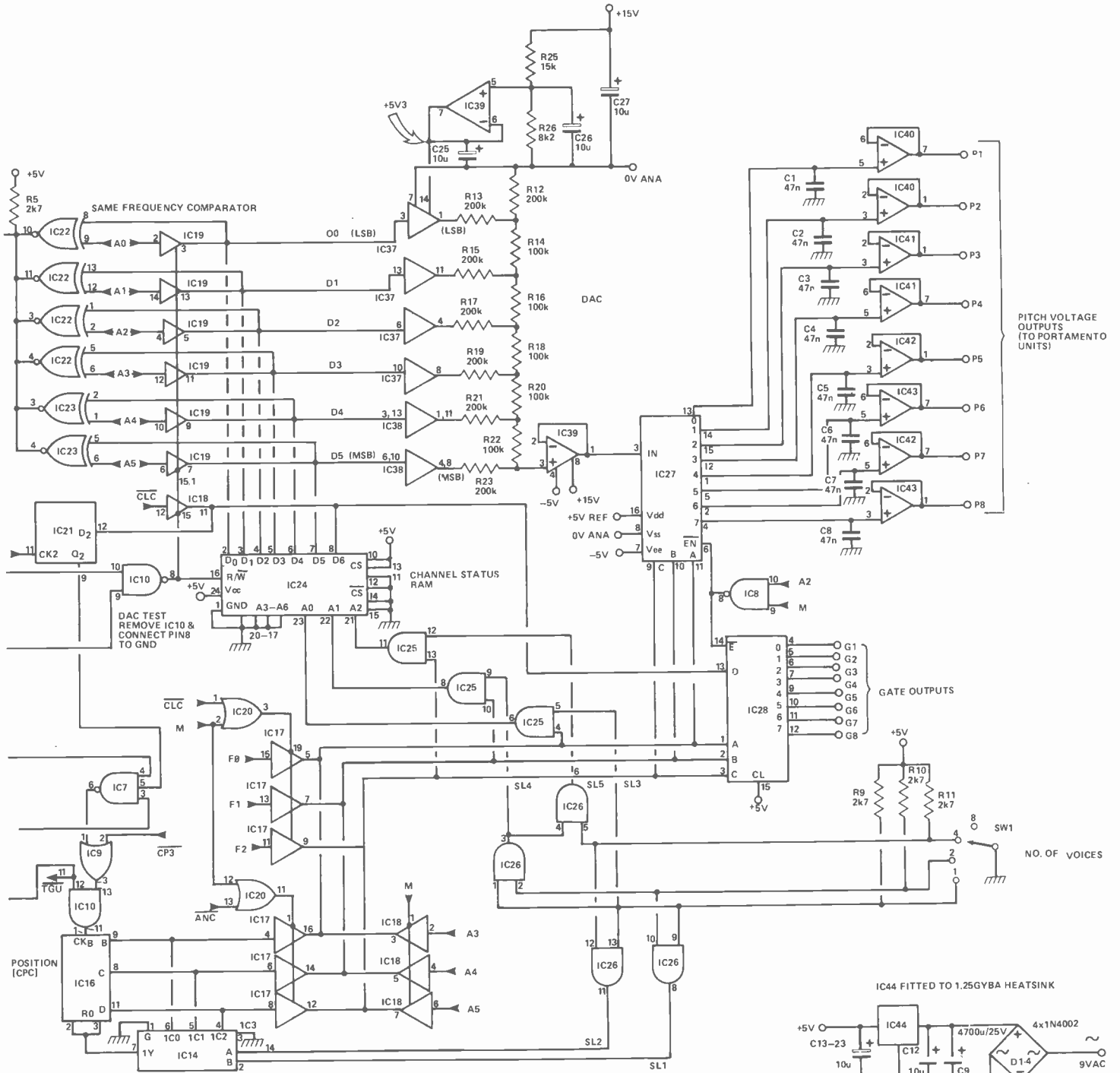


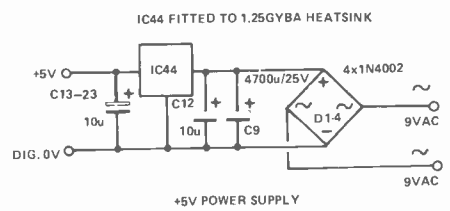
Fig.1 Board-to-board connections. The voice boards (PS7) simply plug into the mother board (PS4) using Molex connectors.

Fig.2 Circuit diagram of PS3, the digital board. In this and other diagrams there is a central overlap to make things easier to follow.





NOTE:
 IC1 IS 75107
 IC2 IS 74LS175
 IC3, 15, 21 ARE 74LS74
 IC4 IS 2102
 IC5, 8 ARE 74LS00
 IC6, 35 ARE 74LS04
 IC7 IS 74LS10
 IC9, 12, 20, 34 ARE 74LS32
 IC10, 25, 26 ARE 74LS08
 IC11 IS 7425
 IC13 IS 74LS193
 IC14 IS 74LS153
 IC16, 30, 31, 32 ARE 74LS93
 IC17 IS 74LS244
 IC18, 19 ARE 73LS367
 IC22, 23 ARE 74LS266
 IC24 IS 6810
 IC27 IS 4051B
 IC28 IS 74LS259
 IC29 IS 74LS13
 IC33 IS 74LS42
 IC36 IS 7407
 IC37, 38 ARE 4041B
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 IC40, 41, 42, 43* ARE TL082
 IC44 IS 7805
 D1-4 ARE 1N4002
 *IC42, 43 ONLY REQUIRED IN EIGHT-VOICE SYSTEM



TYPICAL POWER DEMAND +5V 400mA
 -5V 20mA
 +15V 20mA

HOW IT WORKS : DIGITAL CONTROL PS1, 2, 3

The synthesiser decides which notes are being played by digitally scanning the keyboard and analysing the received data. A high frequency oscillator (Fig.2, IC29 pin 6) generates the master timing for the system, which is then divided down by a 12 stage divider (IC30,31,32). The signals generated by this section are used to construct various timing waveforms. A0 to A5 are sent to the keyboard scan circuitry, PS1,2 (Fig.4). This is a 49-way multiplexer. The six bit code can address 64 locations, but as the keyboard only has 49 notes the other 15 locations remain unused. The bottom part of the code (A0,1,2) addresses each eight bit multiplexer whilst the top three bits (A3,4,5) are decoded by IC8. The outputs of IC8 then enable each of the seven multiplexers in turn so that a complete keyboard is produced. When a note is unpressed it generates -5V and when it is between contacts it is an open circuit.

Figure 5 shows a typical keyboard scan output. The unused top 15 addresses have been arranged to generate a key unpressed signal. A power clear circuit has been included to clear the system when the machine is powered up.

The keyboard output is fed to a voltage comparator, IC1, Fig.2. In-

tegrated circuits IC1,2,3,4,5 form a circuit block that decides when to assign a new channel to a voice (ANC) or to clear an existing one (CLC). The problem of channel assignment is very complex.

The synthesiser has only four voices, so the question to be answered is 'what should happen if more than four keys are pressed at once? Should the system ignore the extra keys or should it reassign voices to the extra notes? If reassignment (referred to as note stealing) is to be used, then which notes should be taken, the first or last note played, or the highest or lowest in pitch?

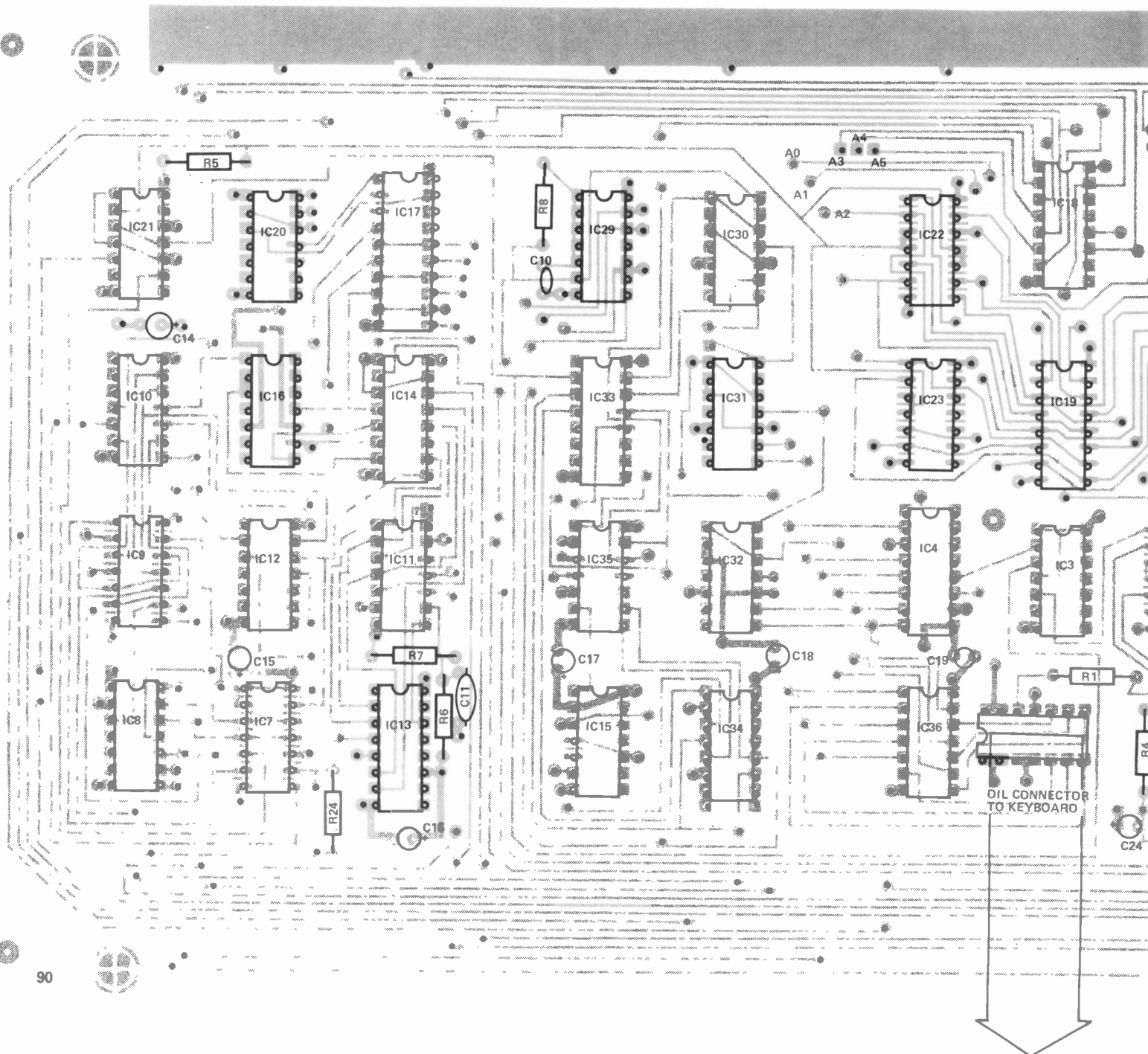
There is no 'correct' solution other than a voice per note.

Two modes of operation have been provided. Mode A permits note stealing, where the oldest channels are reassigned to new notes, when the selected number of notes is exceeded on the keyboard. Mode B does not allow more than the selected number of notes to be assigned. Extra notes are ignored.

The digital electronics is best considered as consisting of a series of modules.

The 'Total Gate Counter' is used to keep count of the number of channels in use at any point in time.

Fig.3 Component overlay of the master clock/timing generator. Dots indicate through-board connections on the double-sided PCB.



HOW IT WORKS : DIGITAL CONTROL PS1, 2, 3

The 'Channel Position Counter' decides which will be the next channel to be assigned. In mode B, if a channel is already in use, then it will skip it and continue on until it finds a free one. In mode A, the channel position counter indicates the oldest channel which will then be reassigned if no free channel is available.

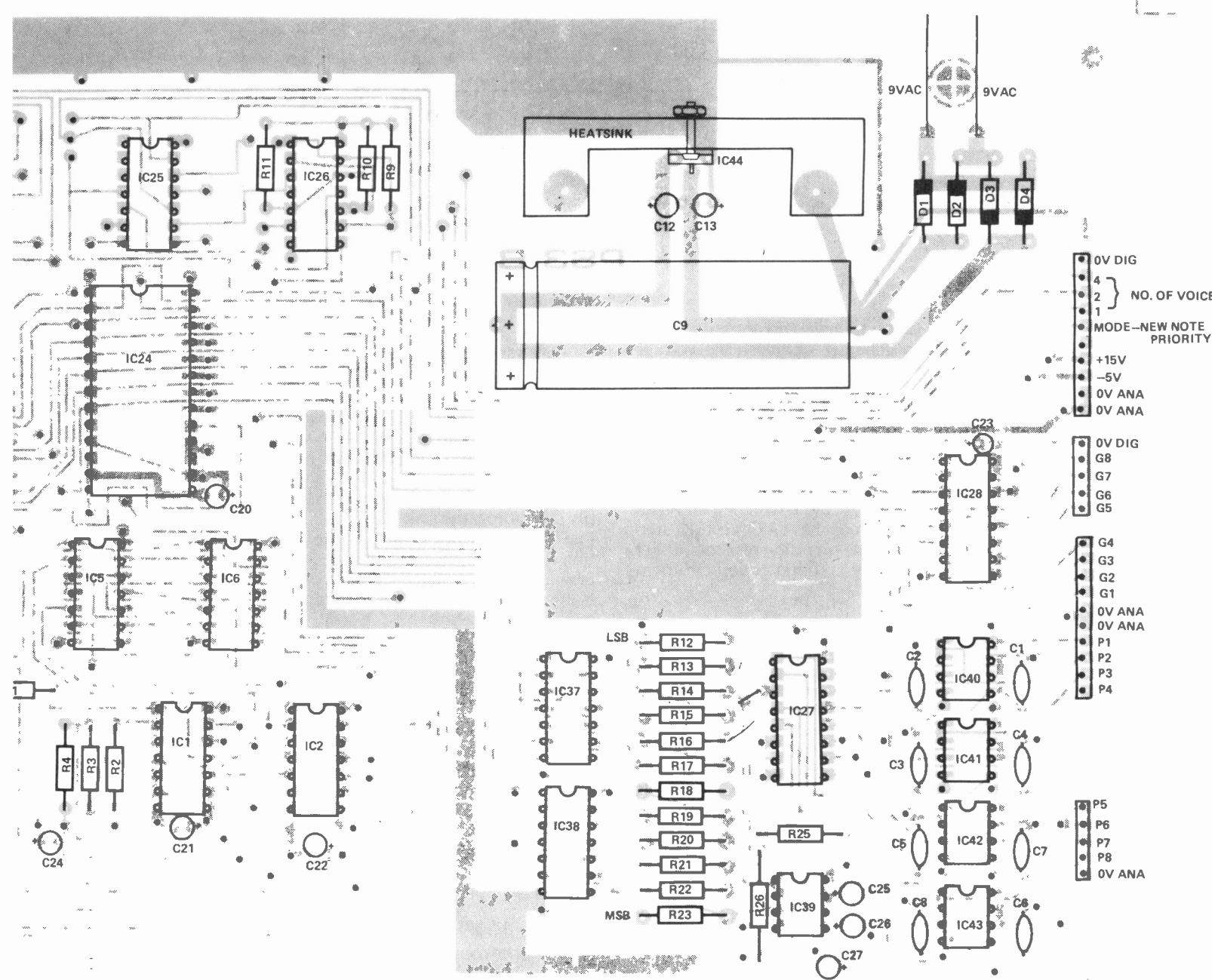
The 'Channel Status RAM' stores the pitch and gate parameters, the number of parameters stored being determined by the selector switch SW1. Data bits D0 to D5 generate pitch and bit D6 is the gate signal. The 'Same Frequency Comparator' comes into operation when a note is released. When this occurs, the circuit removes the gate signal from the respective memory location but rewrites the pitch data which would otherwise be cleared!

The electronics in Fig.2 generate gate and pitch signals which are fed to the synthesiser voices. Some typical waveforms are shown in Fig.9 for a four note selection. Each note pressed generates a gate and pitch signal and assigns a voice channel. When a note is released the gate signal is lost, but the pitch value remains until the channel is reassigned. The gate signals are distributed via an eight way addressable latch, IC28. The pitch signals are distributed via an eight way multiplexer driving

eight sample and hold units (IC27,40,41,42,43). In a four voice system IC42,43 are omitted.

The pitch data is generated by a precision DAC (IC37,38,39). This converts the six bit code into an analogue voltage using an R/2R network.

A typical DAC error is shown in Fig.11. When the MSB of the code changes from 0 to 1 the step size is too small, which results in an error for all codes where the MSB is 1. Generally the worst errors are generated at the changeover point of the high bits of the code, Fig.12. The synthesiser is exceptionally sensitive to errors of this nature and so the DAC must be accurate to ten bits even though it is only converting six bits. A ten bit accuracy will give a worst error of 1 part in 32 (3% of a semitone) per step, which is only likely to occur when bits D5 and/or D4 change state. To obtain this performance 0.1% tolerance, 25 ppm/°C metal film 100k and 200k resistors are used. For superior performance the resistors can be matched for a 2 to 1 ratio using the best matched pairs at the MSB end of the DAC. Using this technique worst step errors of about 1.5% can be obtained. The DAC is powered from a +5V3 reference voltage, which results in a +1V/octave output.



PARTS LIST : PS1, 2

Keyboard Multiplexer

Resistors all ¼ W 5%

R1,2	100k
R3	1k0
R4	5k6
R5	4k7
R6-18	2k7

Capacitors

C1-5 10u 16 V tantalum

Semiconductors

IC1-7	4051
IC8	74LS42
Q1	BC212L
D1	1N4148

Miscellaneous

PCBs PS1 and PS2, 8 off 16 pin DIL sockets, 14 pin DIL socket, 49-note keyboard, 49 keyboard contacts (single pole), full length bus bars, self-adhesive cable clamp.

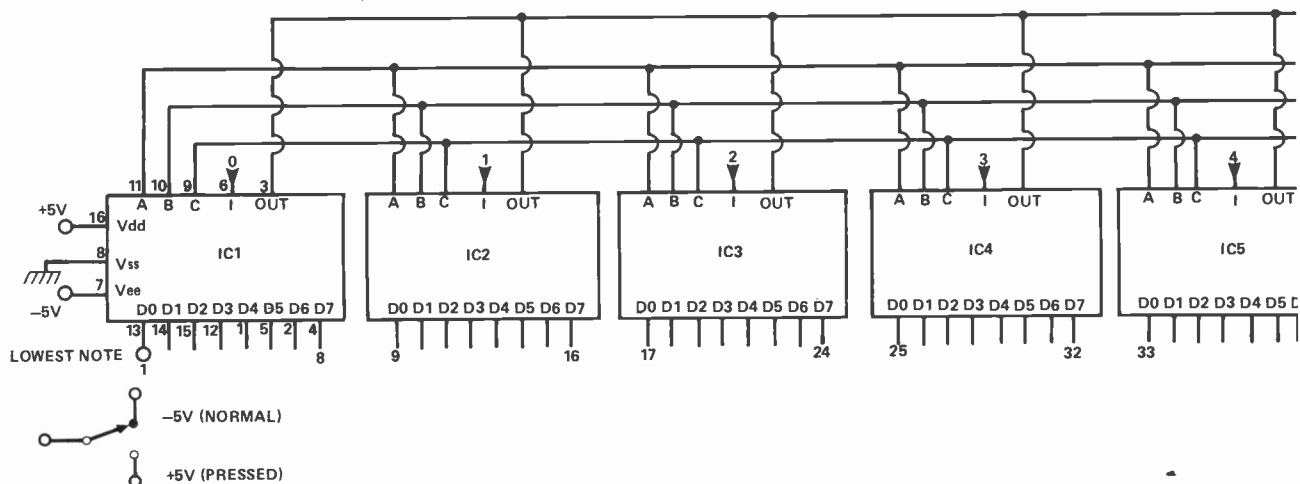


Fig.4 Circuit diagram of the keyboard multiplexer. (PS1 and PS2).

Testing the DAC

Set the number of voices to one and measure pitch voltage one. Use note C to generate octaves. The voltage should be $1\text{ V} \pm 2\%$ per octave. If possible measure the voltage for each note of the keyboard, using a $4\frac{1}{2}$ digit DMM. The semitone step change should be $83.3\text{ mV} \pm 3\%$. Repeat for pitch outputs two, three, four. If you are unable to do this you can rely upon a musical ear when driving the voice modules!

Another test is to remove IC10 and link pin locations 7 and 8 with a piece of wire. The DAC (IC39, pin 1) will then draw out a full range ramp (64 steps) which must have NO VISIBLE step errors. Be careful when inserting the precision resistors. Don't bend them too close to their body and don't overheat them when soldering them in.

Keyboard Construction

Bend the end wire on the contact blocks as shown in Fig.13. Thread the 49 contact blocks onto the two bus bars, making certain that the contact wire is between the two bars. Use a clean cloth for handling them to avoid grease contamination.

Glue the blocks into position on PS1 and 2 and then solder the bent wire ends into position. When the assembly is mounted on the keyboard adjust each wire contact so that there is a 1 mm clearance between it and the plunger.

The Mother Board

The mother board distributes the common and independent synthesiser parameters from the panel boards to the individual voices, which plug into the 50-way voice slots. It also

houses the power supply, LED drivers, portamento circuits and output volume control.

Power Supply

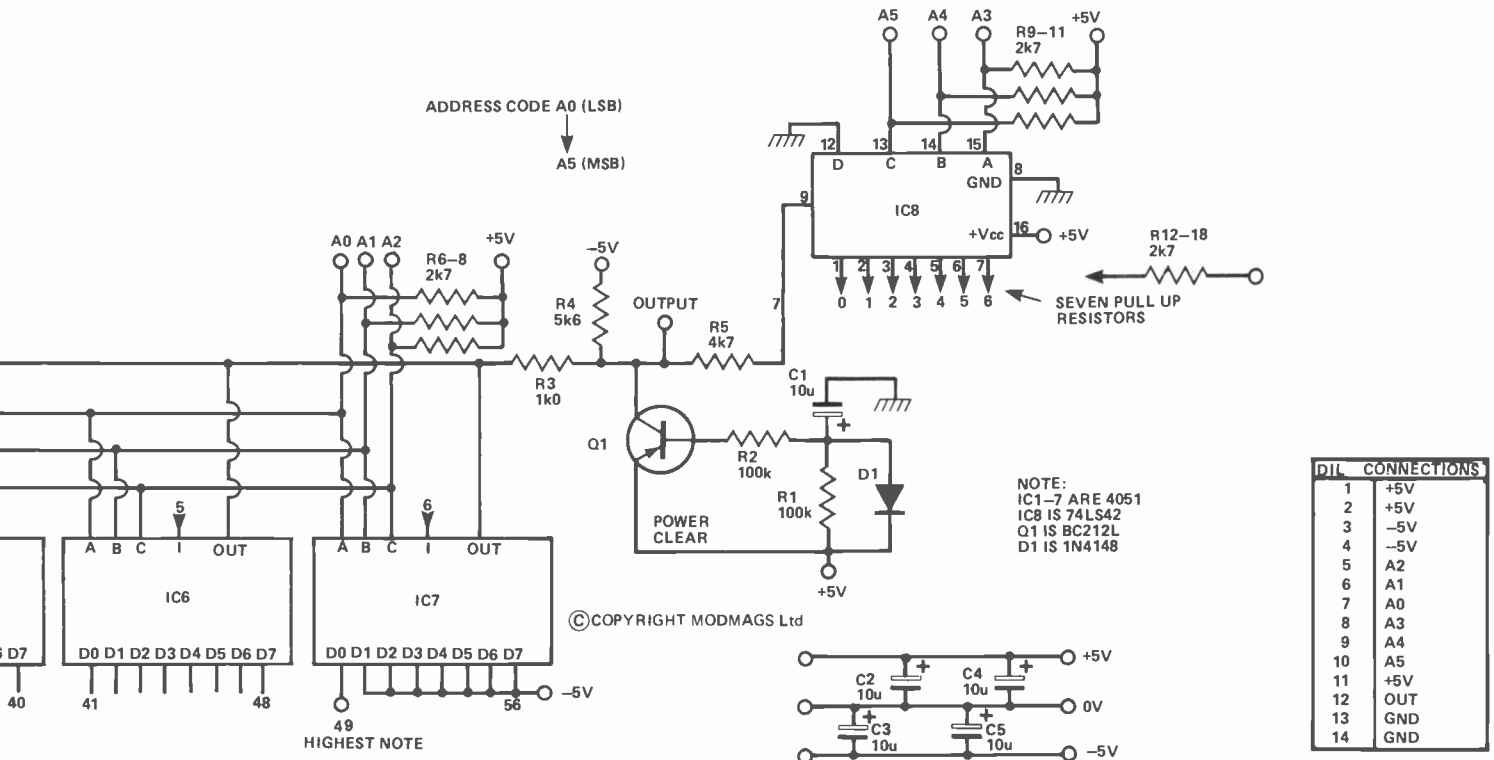
The power supply produces $\pm 15\text{ V}$ and -5 V . The positive rail is generated by a precision voltage regulator (IC1, Q4, Fig.7) which is mirrored by IC2, Q2, Q3 to produce the negative rail. The positive rail should be set to $+15\text{ V}$ ($\pm 10\text{ mV}$) by adjusting PR1, with no voices plugged in. Check that the negative rail is $-15\text{ V} \pm 75\text{ mV}$ and that the -5 V rail is $-5\text{ V} \pm 200\text{ mV}$. Now plug in the voices and recheck the supply rails. Allow the unit to 'burn in' for 24 hours and then readjust the positive rail to $+15\text{ V}$ if necessary. Lock PR1 into position with a small blob of nail varnish. All the oscillator frequencies and pitch spreads depend on the power supply being stable and so if PR1 is altered then the tuning of the whole machine will be lost!

LED Drivers

The LED drivers (IC4, IC5 Fig.8) buffer the TTL gate signals from PS3 to the voice LEDs on PS6. These LEDs can be used to test the digital control section. Set the 'Nos. of voices switch' to four. A new LED will come on, in sequence, as notes on the keyboard are held down. The LEDs will go off when the respective notes are released. Repeatedly tap a single note. This will cause an illuminated LED to cycle around the four voices. If you tap two or three notes, then two or three LEDs respectively will cycle around. Now switch to two voices.

Voices 1 and 3 turn on and off together and so do voices 2 and 4.

Switch to one voice. Now all the LEDs will act in unison. Next switch to eight voices and repeatedly tap a note. The four



PARTS LIST : PS3

Resistors all 1/4 W 5% unless otherwise stated

R1,6,7,8	1k0
R2,3,4,5,9,10,11,24	2k7
R12,13,15,17,19,21,23	200k 0.1% metal film
R14,16,18,20,22	100k 0.1% metal film
R25	15k 1% metal film
R26	8k2 1% metal film

Capacitors

C1-8	47n polycarbonate
C9	4700u 25 V electrolytic
C10	1n0 ceramic
C11	22n polycarbonate
C12-27	10u 16 V tantalum

Semiconductors

IC1	75107
IC2	74LS175
IC3,15,21	74LS74
IC4	2102
IC5,8	74LS00
IC6,35	74LS04
IC7	74LS10
IC9,12,20,34	74LS32
IC10,25,26	74LS08

IC11	7425
IC13	74LS193
IC14	74LS153
IC16,30,31,32	74LS93
IC17	74LS244
IC18,19	74LS367
IC22,23	74LS266
IC24	6810
IC27	4051B
IC28	74LS259
IC29	74LS13
IC33	74LS42
IC36	7407
IC37,38	4041B
IC39	1458
IC40,41,42,43*	TL082
IC44	7805
D1-4	1N4002

*IC42,43 only required in eight-voice system

Miscellaneous

PCB PS3, 5 off 8 pin DIL sockets, 28 off 14 pin DIL sockets, 9 off 16 pin DIL sockets, 20 pin DIL socket, 24 pin DIL socket, DIL connectors and ribbon cable, Redpoint 1.25GYBA heatsink, cable clamp.

LEDs will come on in sequence and then there will be a four note gap whilst the unit addresses the other four voices that live in the expander module.

Now the mode selection. Select four voices and mode A. Play and hold down a four note chord with the left hand. Now press four notes at once with the right hand, and then release the right hand. The LEDs will go out, indicating that the right hand 'stole' the four voices and then released them, in doing so turning them off. Repeat this procedure in Mode B. The LEDs will remain on.

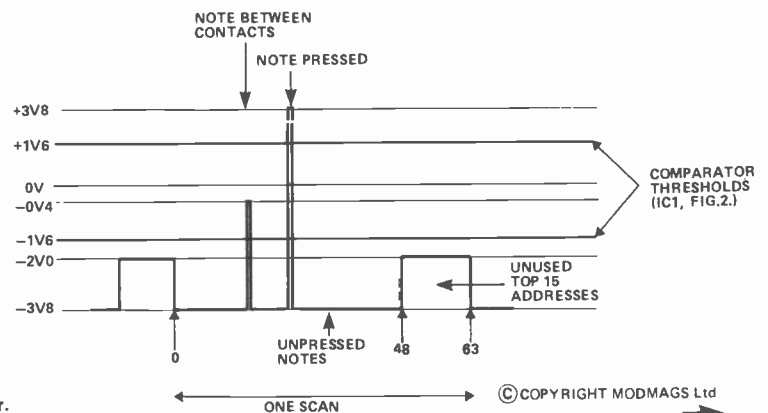


Fig.5 Output of keyboard multiplexer.

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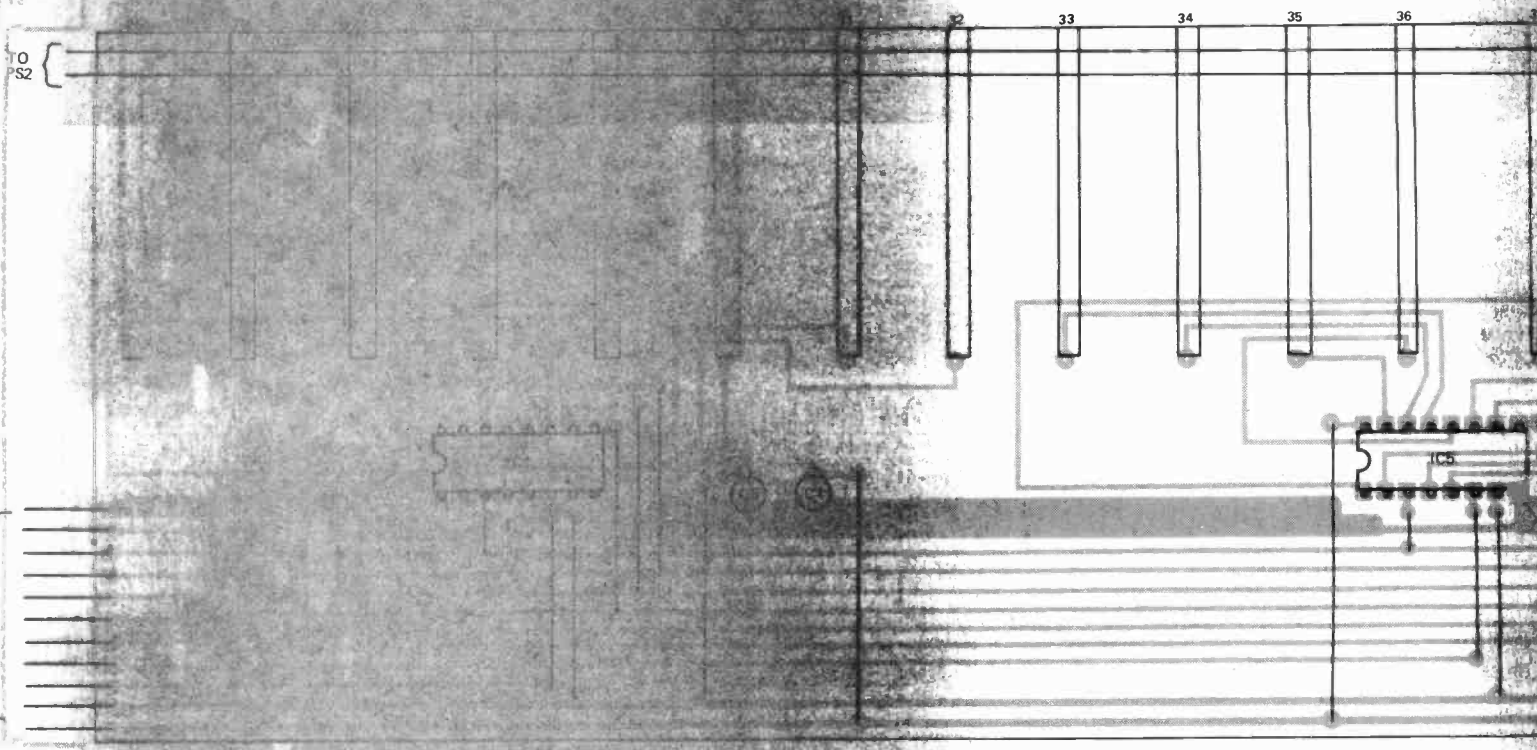
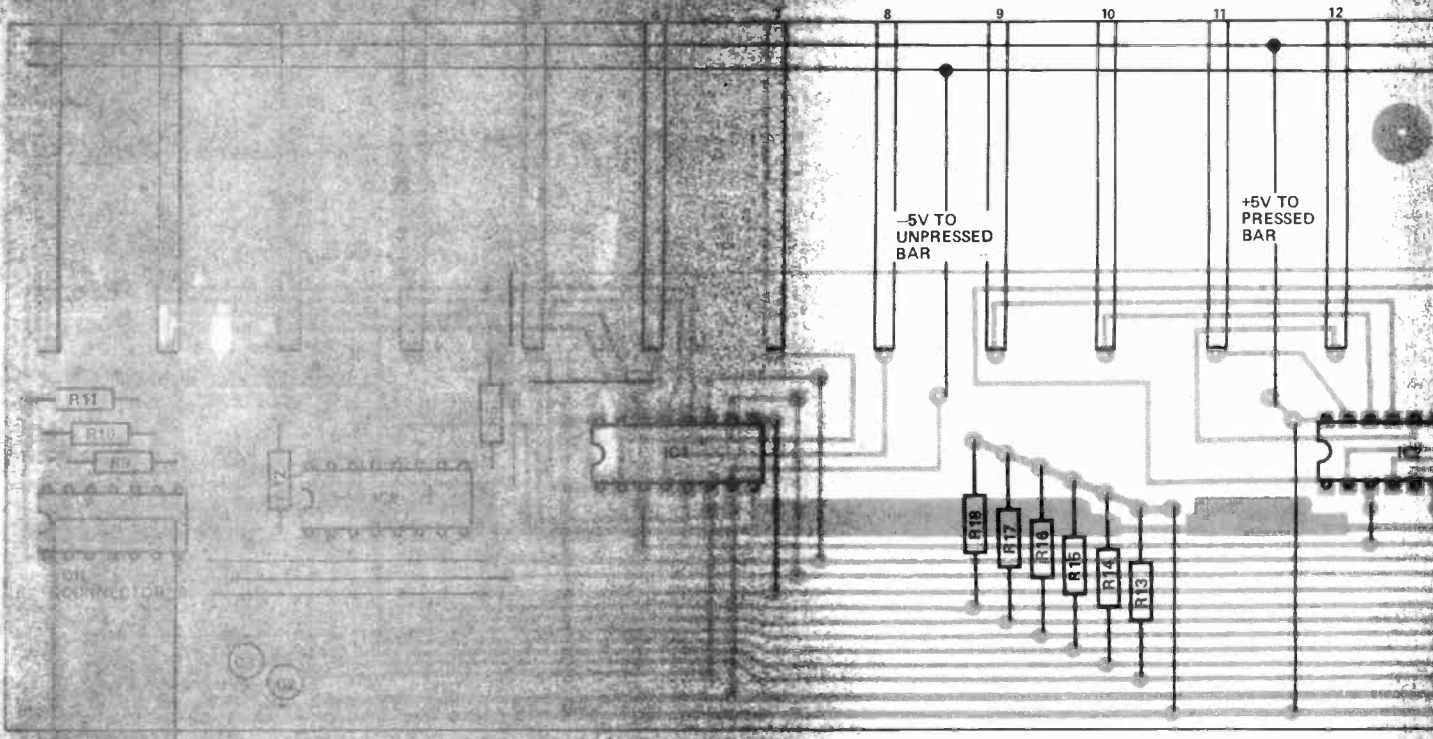
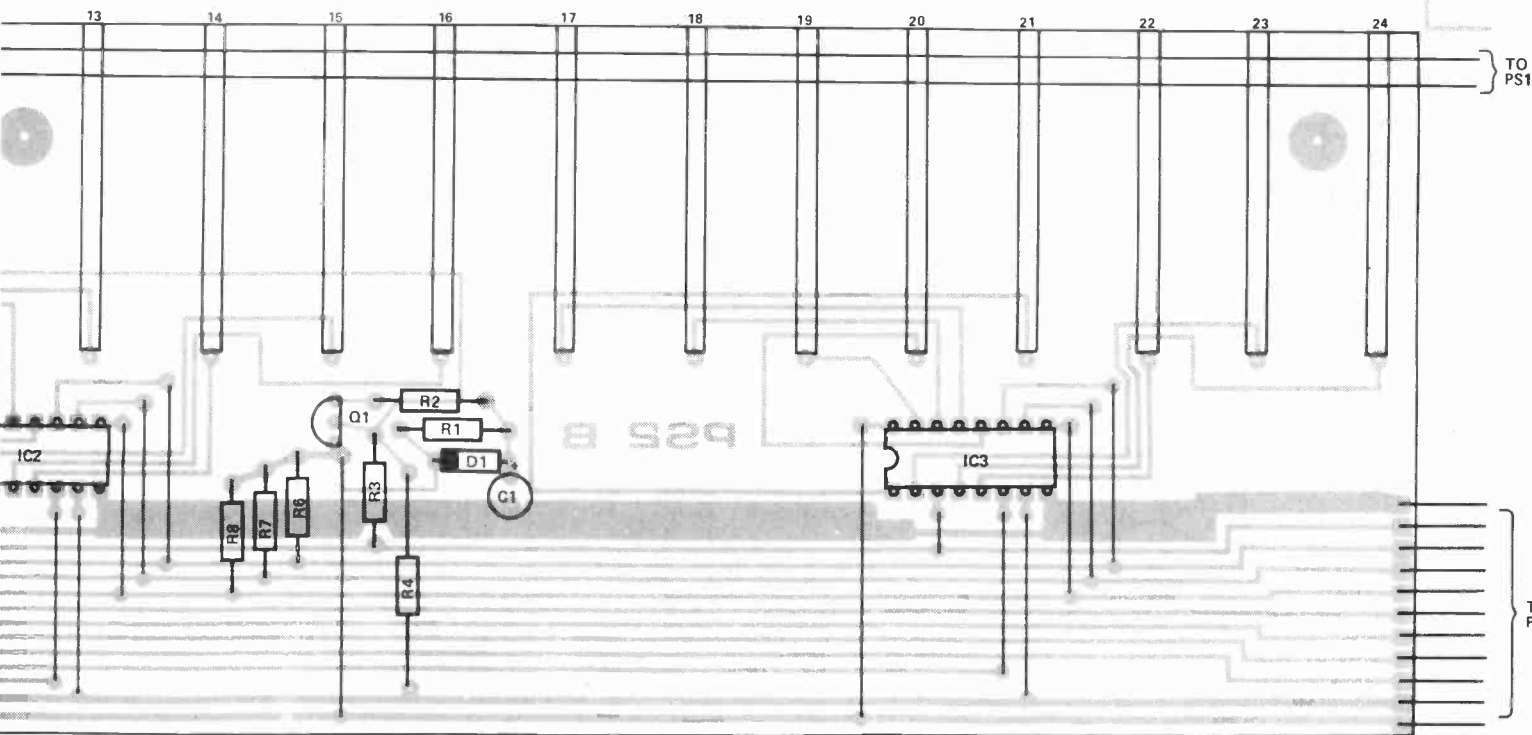
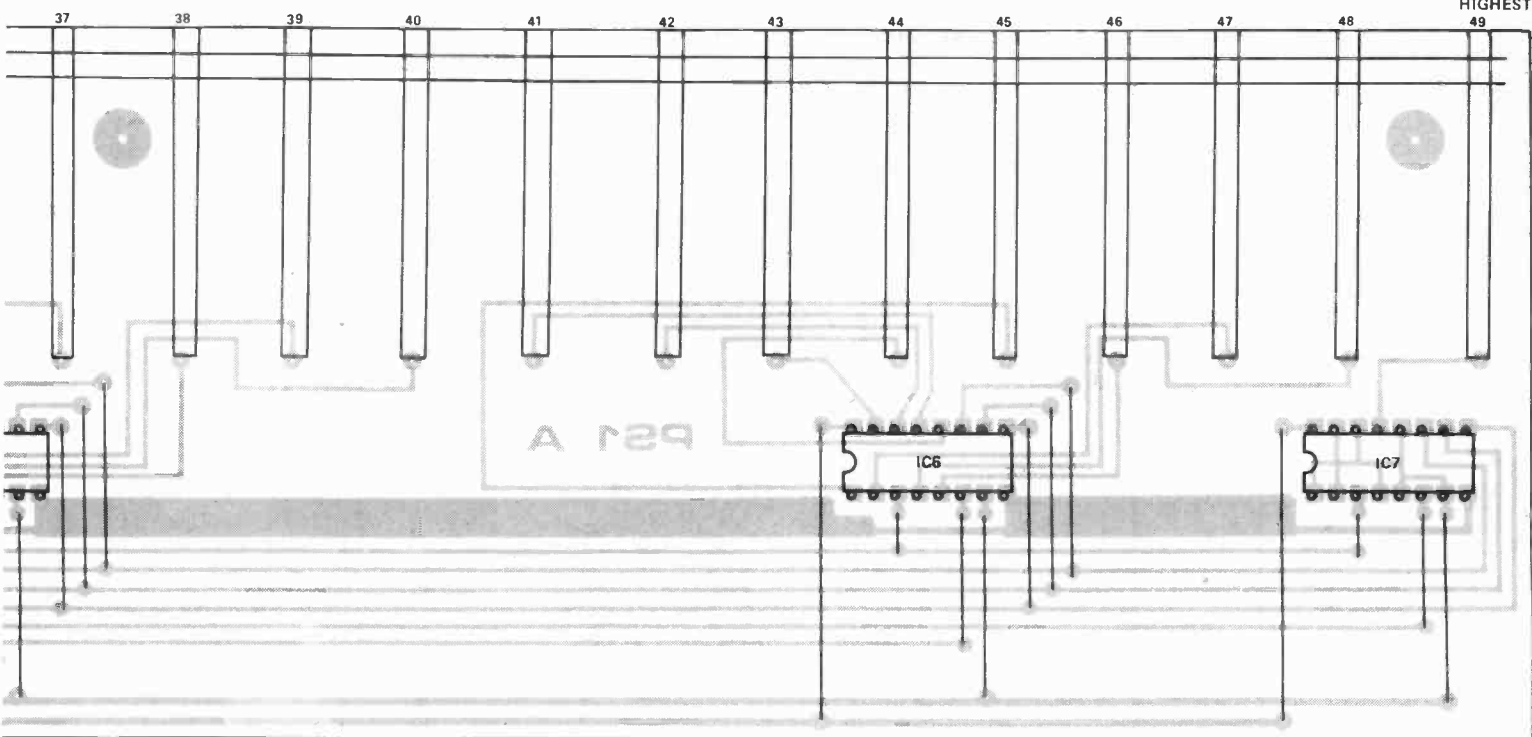


Fig 5 PS1 labels of all PS2010s together form the multi-pin PS2 keyboard



HIGHEST NOTE



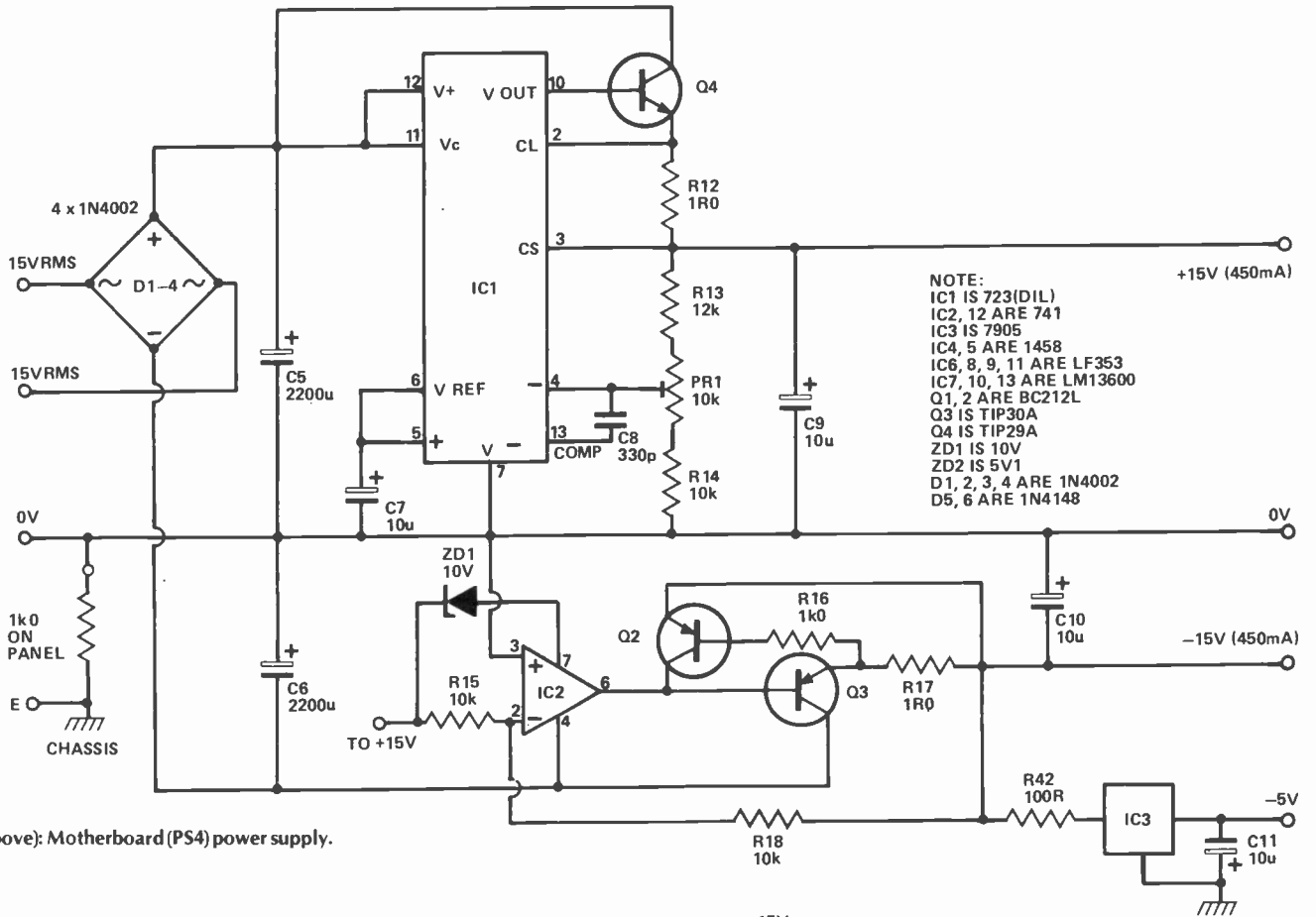


Fig.7 (above): Motherboard (PS4) power supply.

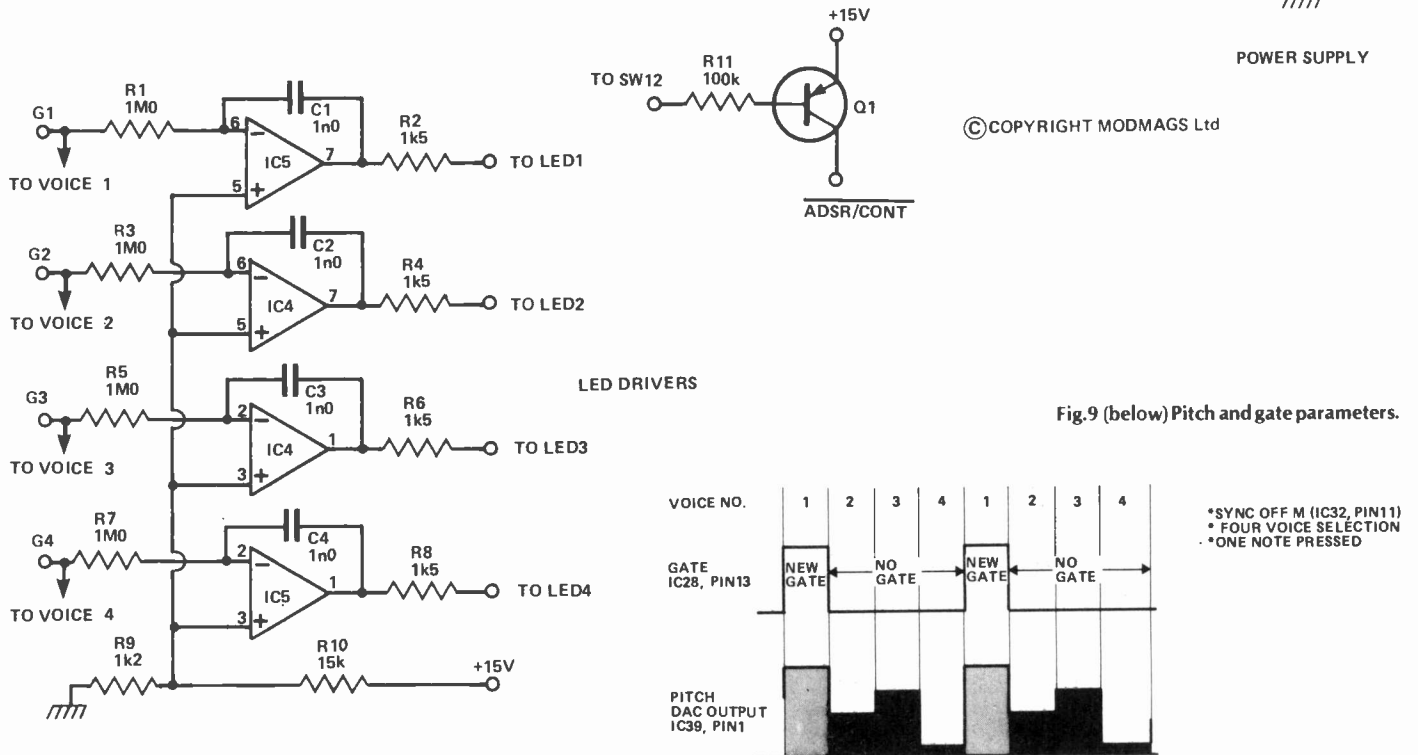
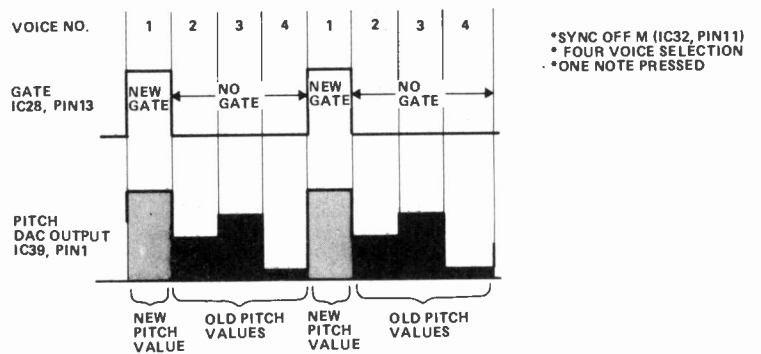
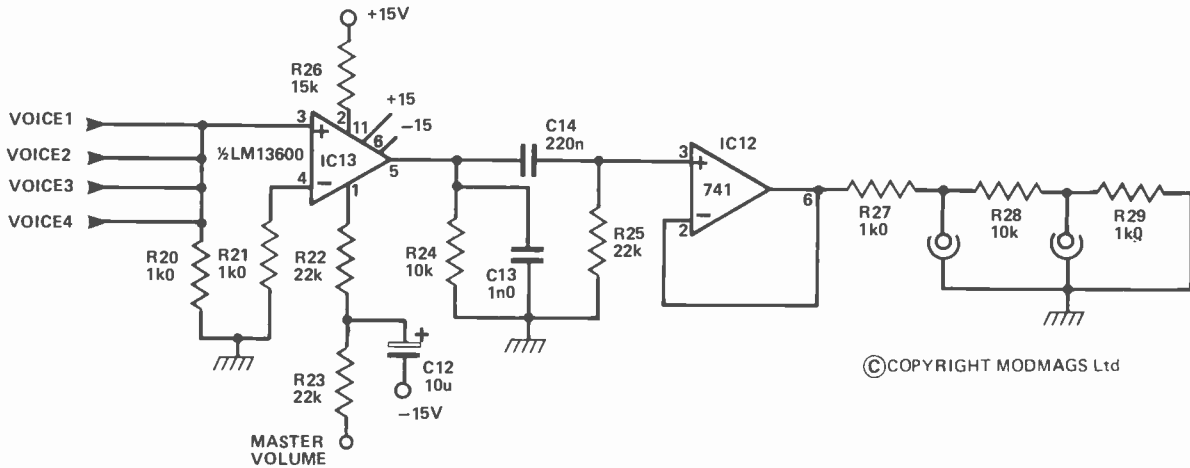


Fig.8 Motherboard LED drivers.

Fig.9 (below) Pitch and gate parameters.

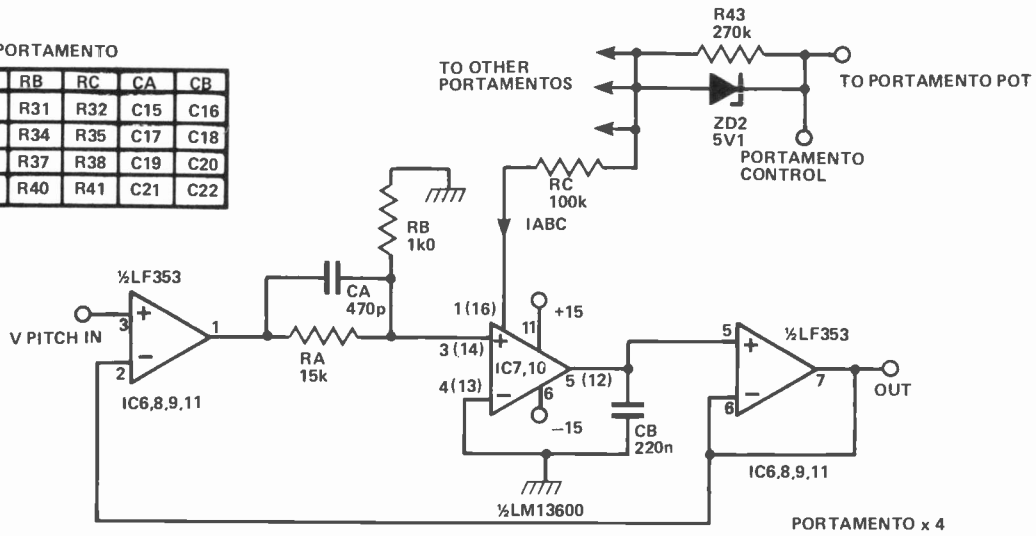




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PORTAMENTO

	RA	RB	RC	CA	CB
1	R30	R31	R32	C15	C16
2	R33	R34	R35	C17	C18
3	R36	R37	R38	C19	C20
4	R39	R40	R41	C21	C22



PORTAMENTO x 4

Fig.10 Motherboard portamento, master volume and pitch bend controls.

BUYLINES

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- 2 voices £368
- 4 voices £464
- 4 voice expansion kit £275

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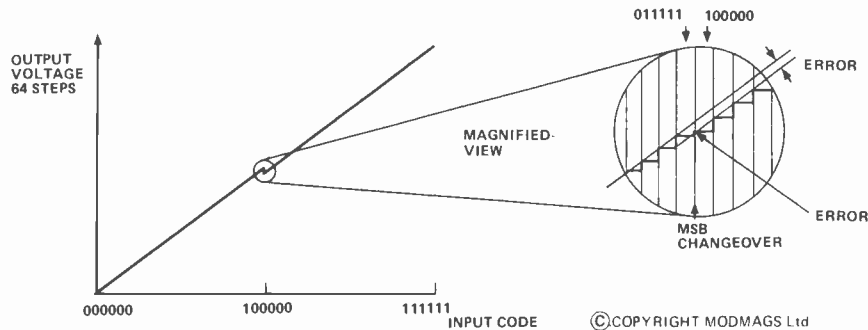
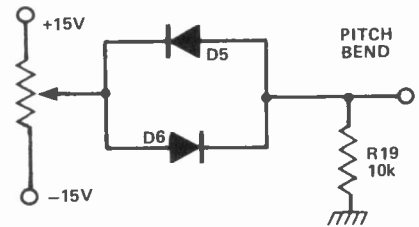


Fig.11 (left) Typical DAC error.

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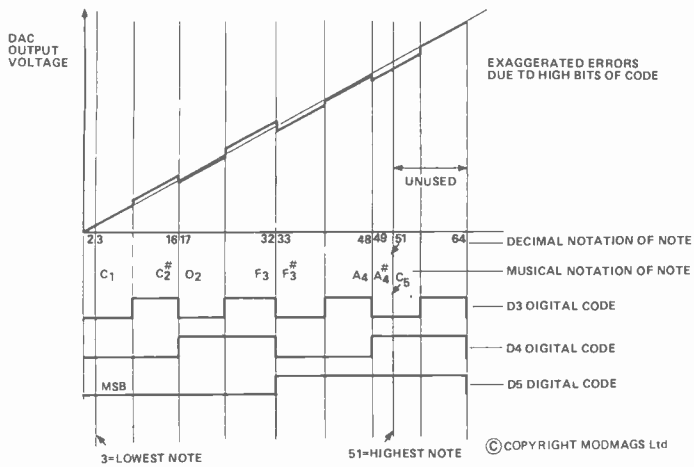
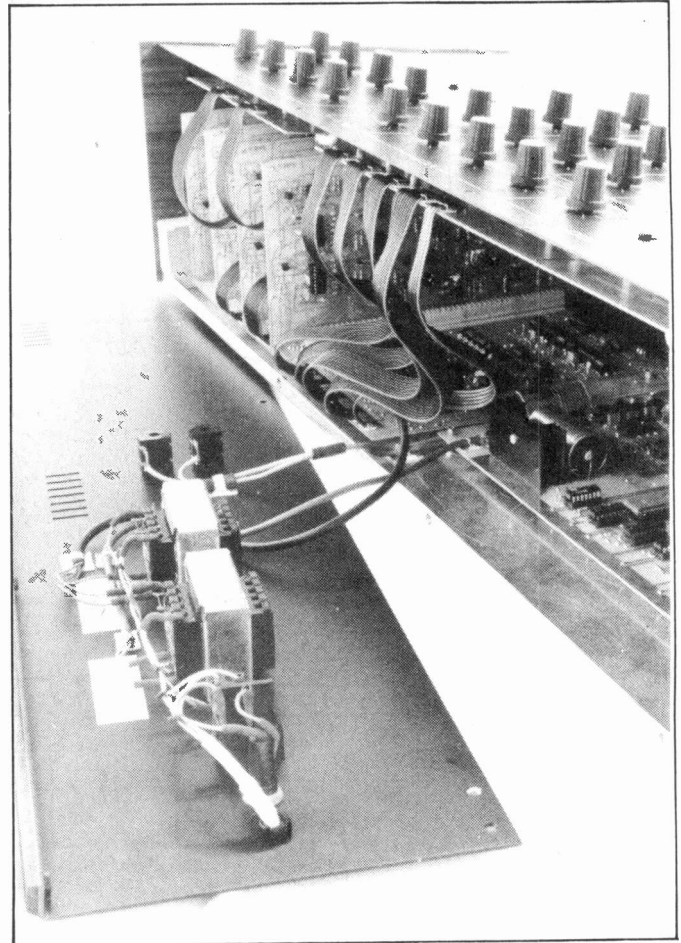


Fig.12 Points of worst error in the DAC



The power supply is mounted on the rear panel.

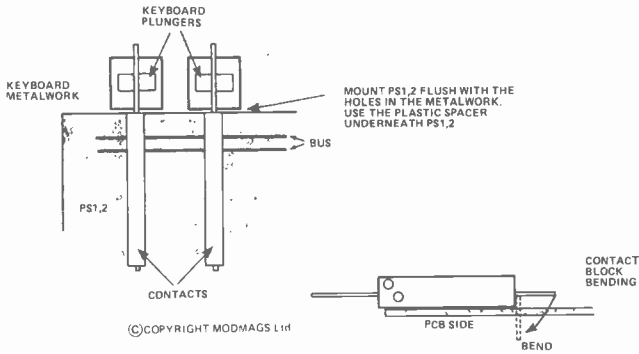


Fig.13 Mechanical assembly of keyboard plungers.

ADJUST FOR 1mm CLEARANCE WITH KEY NOT PRESSED USING LONG NOSED PLIERS.

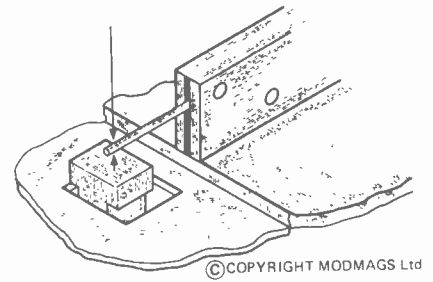
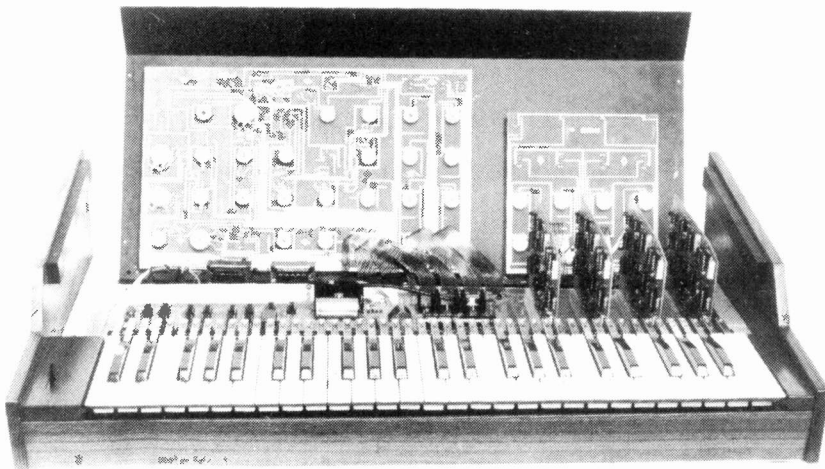


Fig.14 Adjustment of 1mm gap above keyboard plunger.



The top panel can be raised to show control board PS5 and PS6.

Next month we conclude the Polysynth project with details of the control and voice boards. (PS5, 6 and 7).

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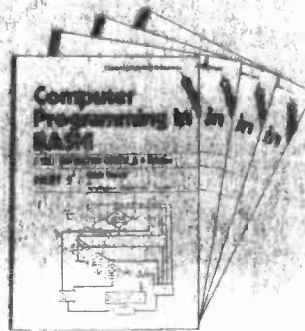
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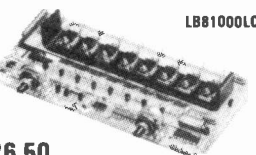
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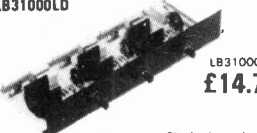
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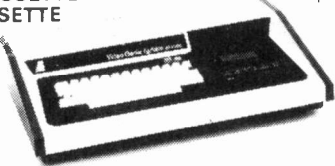
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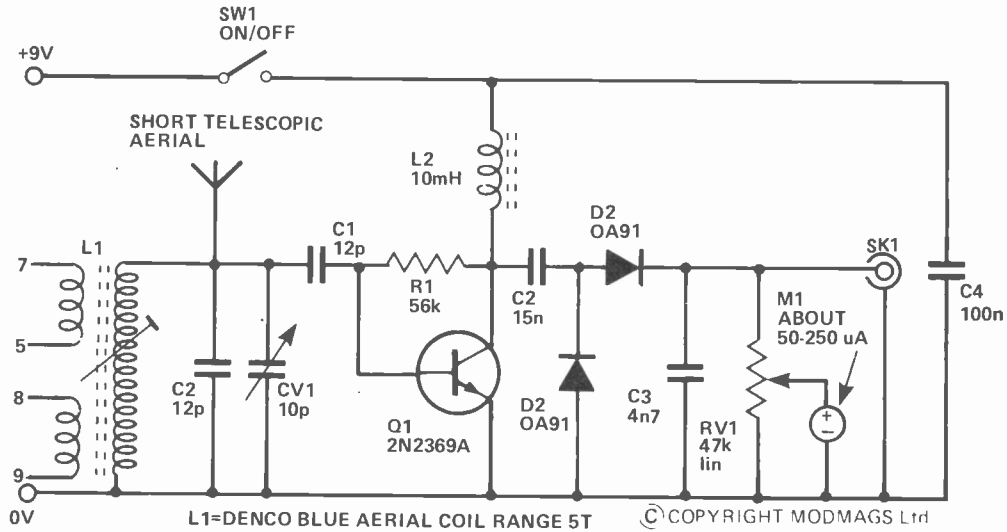
A radio control monitor such as that described here is invaluable when setting up a radio control transmitter. This circuit has good sensitivity and it is unnecessary to have the monitor in very close proximity to the transmitter in order to obtain a signal of adequate strength even when it is used with a low power transmitter.

The signal picked up by the telescopic aerial is coupled directly into the tuned circuit. The core of L1 is adjusted so that CV1 is able to tune the monitor to any frequency within the 27 MHz radio control band. The setting of this core is not too critical, since the unit covers somewhat more than the entire band.

Q1 is used as a common emitter amplifier with L2 as its collector load and R1 to provide base biasing. C1 couples the signal in the tuned circuit to

the input of the amplifier. The value of C1 is chosen to give optimum signal transfer. The high impedance signal in the tuned circuit is matched to the low input impedance of Q1 by a sort of capacitive divider action (the input capacitance of Q1 forming the other section of the capacitive divider).

C2 couples the output of Q1 to a straightforward rectifier and smoothing circuit. This produces a positive bias voltage which is roughly proportional to the strength of the received signal. This bias voltage is used to drive M1, which gives a comparative indication of received signal strengths. An inexpensive meter is perfectly suitable for use in the unit due to the arbitrary scaling. RV1 can be used to reduce the sensitivity of the unit, if necessary. The modulation signal of the transmitter (if it is an AM type) can be monitored using a crystal earphone connected to SK1. Current consumption is approximately 10 mA.



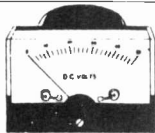
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MU1	0 - 1 MA	
MUVU	"VU"	

Dims:- 60 x 47 x 33mm. Require 38mm dia. cut out

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T23	0 - 500 U.A.	
T24	0 - 1 MA	
T25	0 - 5 MA	
T26	0 - 10 MA	
T27	0 - 50 MA	
T28	0 - 100 MA	
T29	0 - 500 MA	
T30	0 - 1 AMP	
T31	0 - 2 AMP	
T32	0 - 25 Volts	
T33	0 - 50v AC	
T34	0 - 300v AC	
T35	"VU"	
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T40	50 - 0 - 50 U.A.	£4.75 + 15% VAT P&P 35p 10 plus 10% Discount
T41	100 - 0 - 100 U.A.	
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T43	0 - 30v DC	
T43	0 - 30v DC	

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MS1	0 - 1 MA	
MSVU	"VU"	

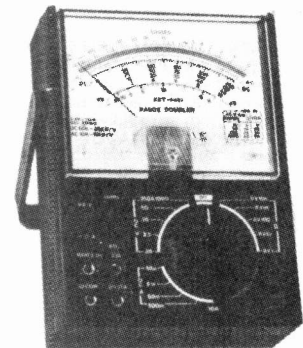
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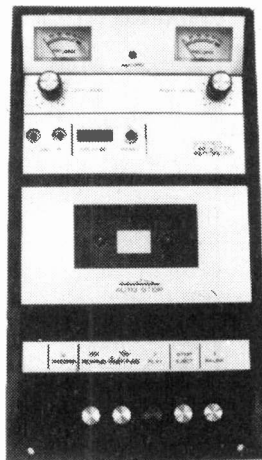
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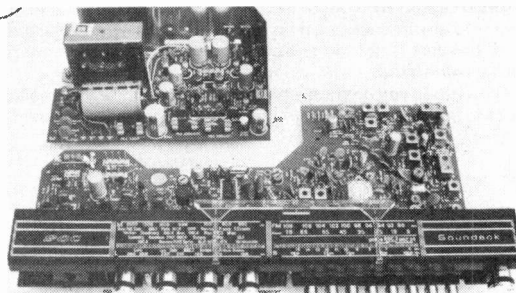
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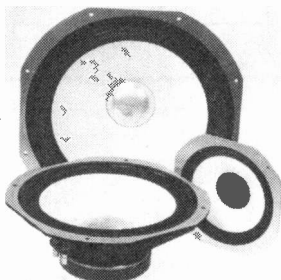
STEREO CASSETTE TAPE DECK ASSEMBLY. Comprising of a top panel assembly and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. Brand new, ready built and tested. **Features:** Pause, control, auto stop, 3 digit tape counter, illuminated twin VU meters with individual record, level controls, secondary inputs for twin microphones. **Input Sensitivity:** 6 MV (with level control set at max). **Input Impedance:** 47 kOhms. **Output Level:** To both left and right hand channels 150 MV. **Output Impedance:** < 10k. **Signal to noise ratio:** 45 dB nominal. **Power Supply Requirements:** 12V AC at 300M/A. **Connections:** All connections to the unit are via a wander lead terminated with a nine pin plug (socket provided). **Dimensions:** Top panel — 11 1/2in x 6 1/2in. Mechanism fits through a cut out 5 3/4in x 10 1/2in. Clearance required under top panel 2 1/4in. Supplied complete with circuit diagram etc. **Price £30.50** plus £2.50 postage and packing. Suitable mains 12-volt transformer. **£3.00.**



GEC AM/FM STEREO TUNER AMPLIFIER CHASSIS. Originally designed for installation into a music centre. Supplied as two separate built and tested units which are easily wired together. **Note:** Circuit diagram and interconnecting wiring diagrams supplied. **Rotary Controls:** Tuning, on/off volume, balance, treble, bass. **Push-button controls:** Mono, Tape, Disc., AFC, FM (VHF), LW, MW, SW. **Power Output:** 7 watts RMS per channel, at better than 2% THD into 8 ohms. 10 watts speech and music. **Frequency Response:** 60Hz-20kHz within ± 3dB.

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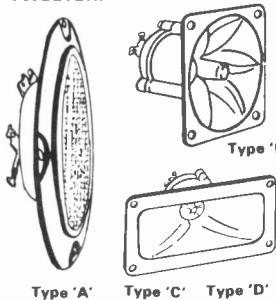
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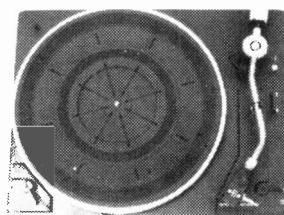
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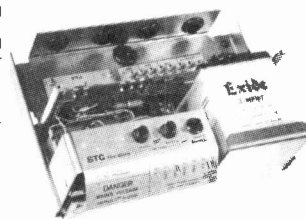


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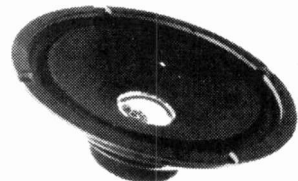
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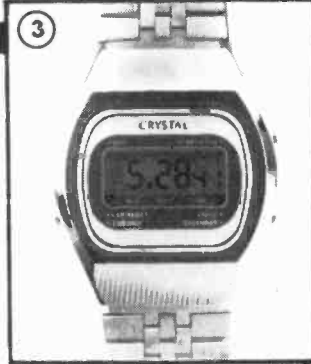
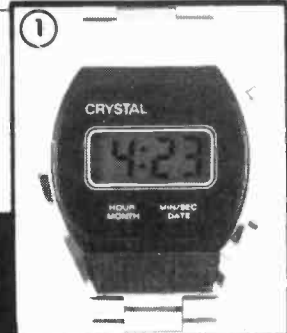
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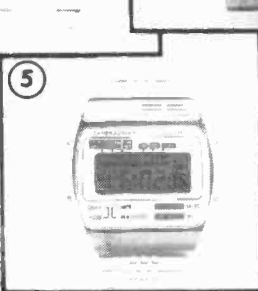


6

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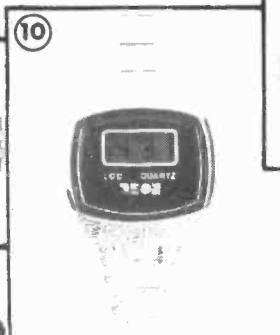
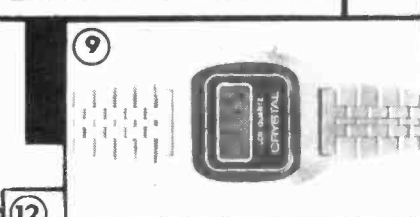


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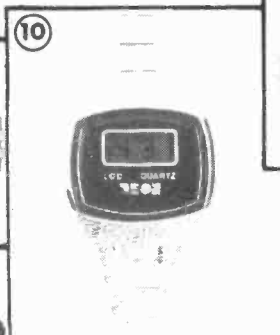
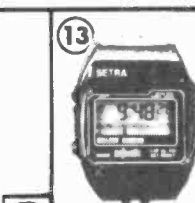
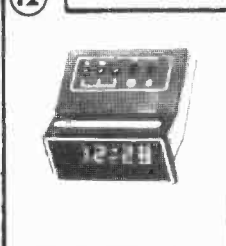


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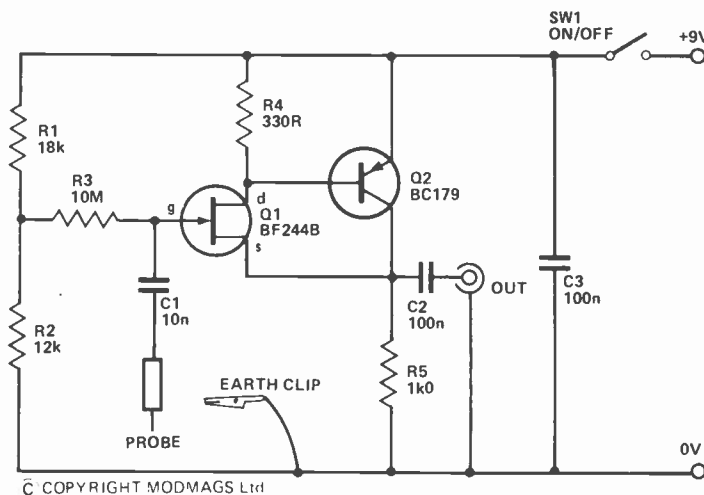
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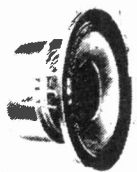
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The obvious choice for a circuit of this type would at first seem to be a FET used in the source follower mode as this can provide a high input impedance, low input capacitance, low output impedance and nominally unity voltage gain. The problem with such a circuit is that the true voltage gain is only about 0.9 to 0.95, which would obviously have an adverse effect on the accuracy of any form of calibration fitted to the 'scope. Therefore, the circuit finally devised uses Q1 as a common source amplifier, which directly drives common emitter amplifier Q2. There is a 100% negative feedback loop from the collector of Q2 to the source of Q1 and this gives the circuit almost precisely unity voltage gain. This arrangement retains the attributes of a source follower stage and gives good results in other respects as well. Gate biasing for Q1 is provided by R1-3 while DC blocking at the input and output is provided by C1 and C2 respectively. Current consumption of the unit is about 5 mA.



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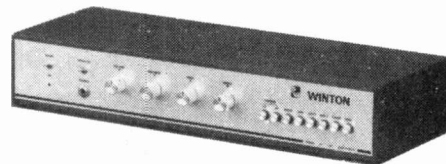
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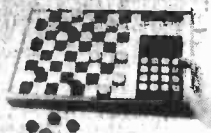
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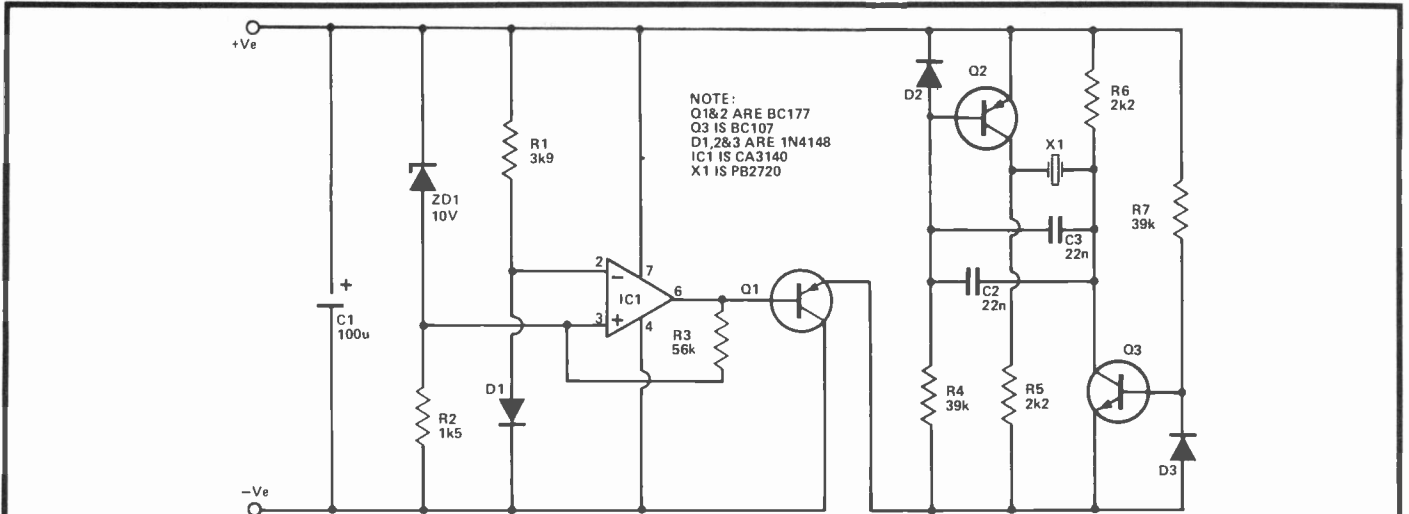


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IC1 and its associated circuitry form a voltage detector circuit; IC1 is used here as a voltage comparator rather than an operational amplifier. R1 and D1 provide a stabilised potential of about 0V7 to the inverting input of IC1. The voltage supplied to the non-inverting input is equal to the supply voltage minus the nominal 10 V dropped through zener diode ZD1. Thus the potential at the non-inverting input will normally be about 2 V or more and since this is higher than the voltage fed to the other input the output assumes the high state. Therefore Q1, an emitter follower buffer stage, becomes cut off and no power is fed to the audio alarm circuit at its output.

If the supply voltage falls below about 10V7, then the voltage fed to the non-inverting input falls below the reference level at the other input and IC1's output goes low. Q1 is then switched on and power is connected to the alarm circuit fed from its output. Due to imperfections in the performance of practical zener diodes, the actual voltage at which the alarm is triggered is a little lower than the theoretical one and is typically a fraction over 10 V (or 11 V if preferred, by using an 11 V component in the ZD1 position). R3 is used to introduce a small amount of positive feedback which ensures that the unit switches cleanly from one state to the other and prevents erratic operation.

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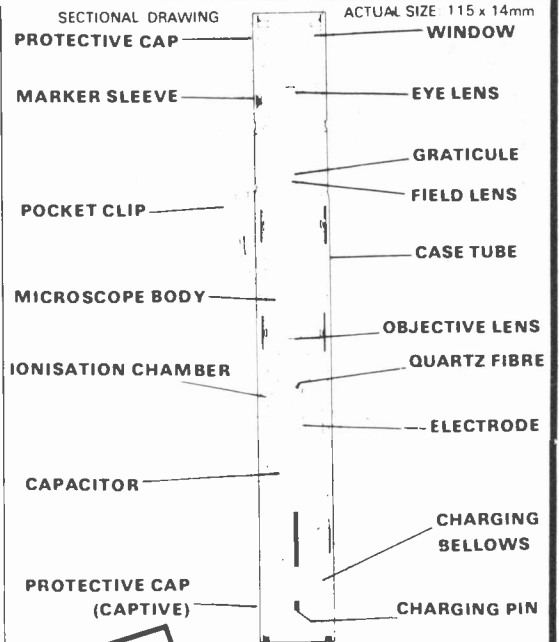
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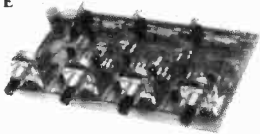
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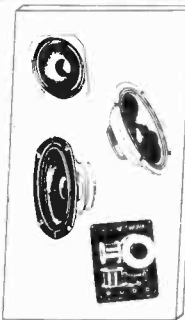
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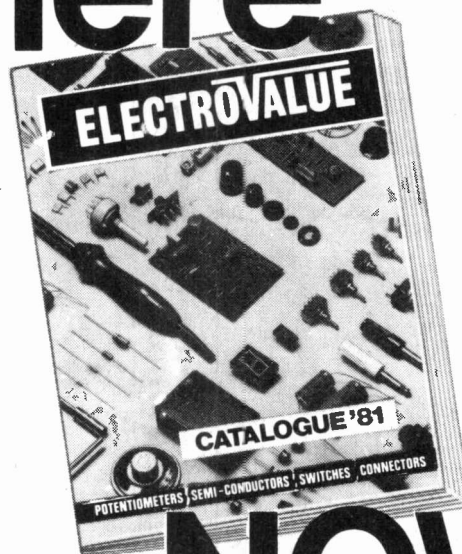
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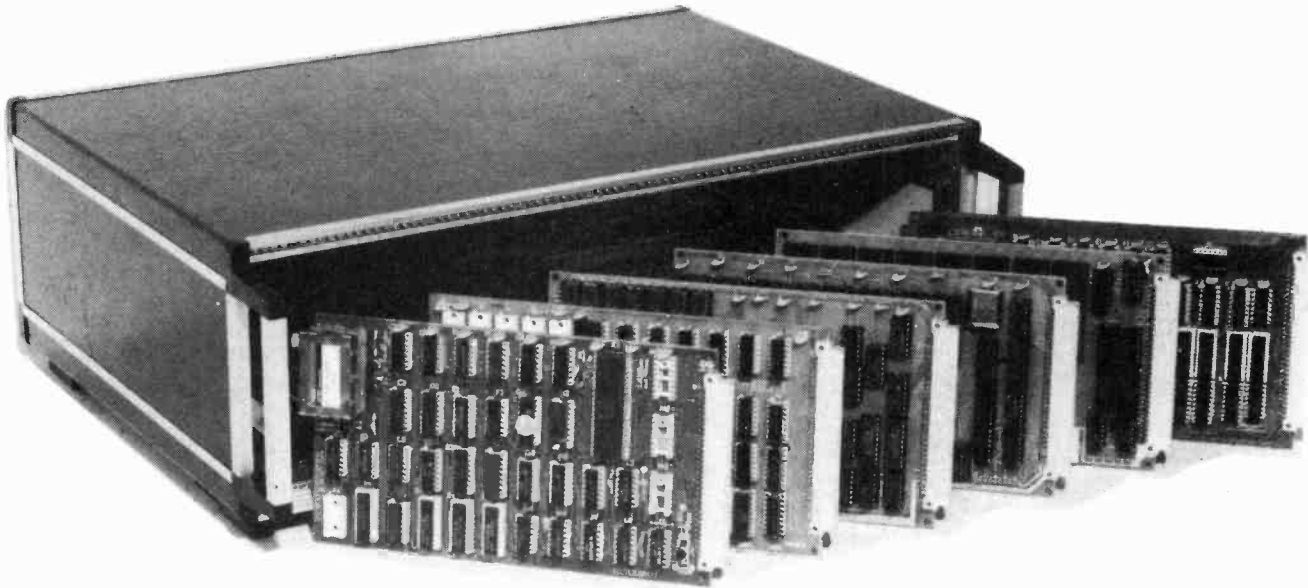
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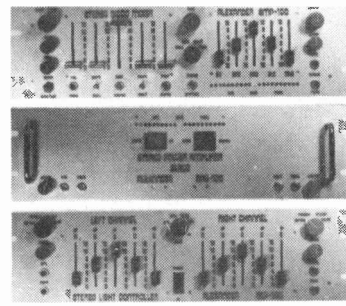
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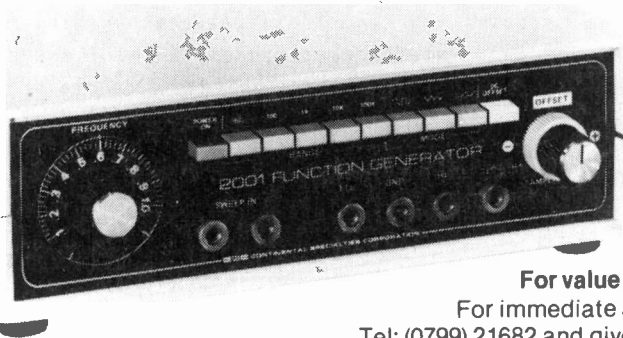
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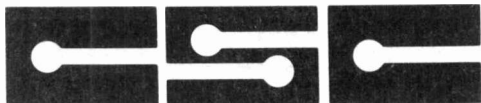
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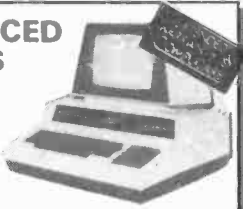
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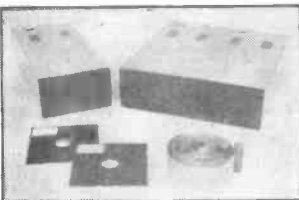
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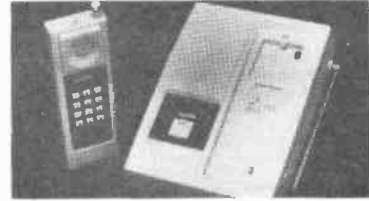
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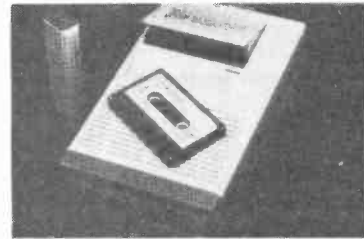
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DC SERVO MOTOR 110V 2.5Amp continuous. Double shaft. Brand new 4 wire. 4 brush **£25** ea. Plus carriage.
PC Mount POTS, Wire wound with knob 200 ohm & 10ohm. **10p**
CAPACITORS at **5p** ea — 0.1 or 400V Small rec. block PC Mount German Class 3300pf, 220nf 250V Capacitor 0.1mfd 250V AC — **10p** ea.
4 DIGIT 7 SEGMENT per digit plus a figure one to the left plus a centre minus sign to the left of the figure one with decimal places between digits. Good brilliance at 1.5V, 15 connections **£2.50**

709 DIL 14-PIN OPERATIONAL AMPLIFIERS
 at **8p** each
 100 off 25% discount.

MINIATURE KEYBOARD
 Push contacts, marked 0-9 and A-F and 3 optional function keys. **£1.75** each. P&P **65p**.

MAGNETOS
 — Brand New, Boxed
 Ex-Ministry

Originally for Ministry aircraft, therefore finest quality — very reliable.
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North American Phillips, 5 volt 3.3 Amp operation. 2 wire PPS 0-200 revs per min 0-250 used. Tested **£16** each. P&P **£1.50**.

MUST CLEAR POLARAD SPECTRUM ANALYSER

5" Display. These are supplied with STU 2 plug-in. 1 to 45 GHZ.
£95 each

TRANSISTOR INVERTOR

115V AC 1.7 Amp Input. Switching is at 20KHz. Output windings from Pot Core. Can be rewound to suit own purpose or unit can be broken for host of components. Circuits supplied. **£1.25** each. P&P **£2**.

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770R used tested **£95** each
730/10 used tested **£77.50** each
940 24V inverter version. Special Government Quality vgc **£165** each

TANTALUM BEAD CAPACITORS. 4.7uf 25V. 10 off **£1**; 100 off **£7.50**. 330uf 6.3V 15p ea.

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 Fit a push button **CIRCUIT BREAKER** Small, compact, 3 ratings 0.8, 1.8 and 10Amp. State which one when ordering. **75p** each.
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1 1/4" diameter. Requires single low current 3KV to 6KV supply. Individually boxed. With data.
£12.50 each P&P **75p**
 Infra Red Lamps also advertised

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Size 3x2 1/2 x 2 1/2" high with 12 Alma Reed Switches. Blue keys marked in green 0-9 and a star with one blank.
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High Quality Electronic Musical Instruments under the personal supervision of Specialist Designer A. J. BOOTHMAN.

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Six and 7 1/4 Octave Electronic Pianos with unique Touch Sensitive Action as used in the P. E. JOANNA, which electronically simulates piano key inertia — a feature not available in any other design. Build this widely acclaimed professional instrument, for either Domestic or Stage use, from our top quality Component kits.

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The versatile String Synthesizer with a fantastic sound at an economic price. Split Keyboard facility with a range of impressive voices.

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All Keyboards are easily cut to provide your required length and compass. Quantity enquiries welcome.

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C20	10 Min. slide switch	130p	J10	20 0.2in. red LEDs	170p
C30	10 Push to make sw.	130p	J15	50 0.2in. red LEDs	400p
C31	10 Push to break sw.	170p	J20	100 0.2in. red LEDs	750p
C40	Pair Ultrasonics	350p	J30	20 0.2in. green LEDs	280p
C32	Submin. SPST toggle	60p	J50	20 0.2in. yellow LEDs	280p
C33	Submin. DPDT toggle	80p	J80	4 FND500 CC displays	350p
C50	20 Texas 8 pin sockets	170p	K5	5 741 op amps.	90p
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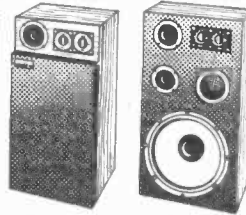
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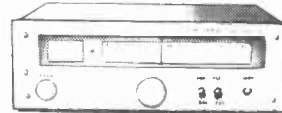
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On Demonstration to callers.



SCOTT T516 STEREO FM/AM TUNER

HIGH QUALITY STEREO FM/AM TUNER BY SCOTT OF USA.

Overall size 5" x 14 1/2" x 12". Brand new and fully guaranteed at a special low price. (C/P £1.55)

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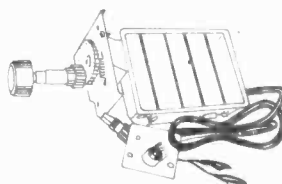


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JVC TURNTABLE WITH FREE AUDIO TECHNICA AT100 STEREO CARTRIDGE.

- * S' shaped tone arm
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(As reviewed in 'Popular Hi-Fi' July 1979) £8.50

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8 ohm



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Clean sound, very low distortion tweeters. No crossover required. Suitable up to 100 watts — more in series.

- 1 Mid range horn for disco/pa/groups £6.95
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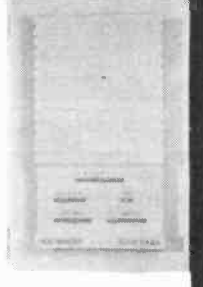
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MUSICAL



DOOR BELL
This is a computerised doorbell. You can set it to play any one of 24 tunes (27 tune model is also available). It runs on batteries and has controls for volume and tempo. There is a test button as well. It can be easily connected to your existing bell push and there is facility for connecting a second bell push (back door) which plays different tunes to that of front door.

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COMPUTE-A-TUNE
Compute-a-tune actually memorises tunes (up to 32 notes), played on its 2 octave keyboard and replays them with added effects. It has four pre-programmed tunes and a jack socket for playing through external amplifier.

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ULTRA SLIM DUAL-TIME MELODY ALARM
Super slim dual-time musical alarm and 1/10th sec chronograph with lap time. Only 5mm case thickness. Normal display is hours, minutes, seconds or date, day of the week, alarm and p.m. indication. Plays "Yellow Rose of Texas." (Chrome colour)

A208S £13.50

ULTRA SLIM ALARM CHRONOGRAPH
WITH 12/24 HOUR DISPLAY
Only 6.5mm thick including a special battery hatch. Normal display is hours, minutes, seconds, day of the week and p.m. indication. Display mode can be either 12 or 24 hour cycle. Other features include 24-hour alarm, 1/10th second chrono with lap time and backlight. (Chrome colour)

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LADIES MUSICAL ALARM
Ladies' 6-digit Musical Alarm. Plays "Jesu Joy of Man's Desiring." Normal display is hours, minutes, seconds, day of the week and alarm indication. Other features include 4-year auto calendar, backlight and fully adjustable stainless steel bracelet. (Chrome colour)

A207S £11.95

DUAL TIME ALARM CHRONOGRAPH
Incredible value for money. Sold elsewhere for £19.95. Normal display is hours, minutes, seconds or date, day of the week, p.m. and alarm indicator. Other features include, 2nd time zone, 1/10th sec. chrono, backlight and 24-hours alarm. Buy now while the stock lasts. (Chrome colour)

LM20 £10.95

MUSICAL ALARM CHRONOGRAPH
Normal display is hours, minutes, seconds, day of the week and alarm indicator. Other features include, 1/10th sec chronograph with lap time facility, month, date, backlight, 24-hours musical alarm. Plays "FUR ELISE"

A205S £13.50

LADIES' SNOOZE ALARM
Exceptionally good value for money. Normal display is hours, minutes, p.m. and alarm on indications, other features include 4-year auto calendar, backlight, 24-hour alarm with Snooze facility, fully adjustable, stainless steel bracelet. (Chrome colour)

LM102 £8.50

MEMORY CALENDAR ALARM-CHRONO
Memory calendar to year 2009. 24-hour alarm with 10 minute snooze facility, 1/100th sec. chrono with split and lap time. Displays hours, minutes, seconds or date, day of the week, flag and alarm indicator. It has fully-adjustable stainless steel bracelet. (Chrome colour)

LM73 £14.95

GENT'S 6 DIGITS ALARM WITH DAY OF THE WEEK
Normal display is hours, minutes, seconds, day of week, p.m. indicator and alarm indicator. (Model A203L has extra large digit for better readability). It has a very useful 24-hour repeat alarm and 4-year auto calendar. (Chrome colour)

A203S £7.95

LADIES' SUGAR COATED DRESS WATCH
Ladies' 9 function LCD watch. Hours, minutes, seconds, month, date, backlight Auto date/time display mode, 4-year auto calendar. This watch has an optional auto date/time display mode. In this mode time and date is alternatively displayed every 2 seconds. (Chrome or gold)

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MOTORS. 1.5V Model motors 22P. Sub. min. Big inch. 115V DC 3 rpm motor 32p. Replacement 8 track 12V DC motors 55p. Geared mains motors. 2 1/2 rpm. 75p. 115V AC 4 rpm motor 95p. Cassette motors. 5-8V DC ex. equip. 70p. 9V DC Cassette motors 95p. 6V Cassette motors. new standard jap. type £1.25.

BUZZERS. Miniature solid state type. 33x17x15mm. 70db at 3 foot 15ma drain. operates 4-15V DC 75p. each. LDUO 12 volt buzzer 50x30mm. 63p. Carriers 12V DC Miniature alarm sirens £7.55. 12V DC SIREN all metal rotary type. high pitched wail. £8.50. Rotary alarm siren. 12V DC. red plastic unit with mounting bracket. 58x75mm. £4.50.

RELAYS. 2 types both operate on 12V DC. sealed plastic case types. 1-350 ohm with 2 make 5 amp contacts 75p. 2-1,000 ohm with 2 changeover 1 amp contacts 75p.

SPECIAL OFFER SEMICONDUCTORS. 2N5062 SCR 18p. 8X5D4 opto isolator 25p. CA3130 95p. CA3020 45p. TDA1151 25p. 741 22p. 723 35p. NE555 24p. NE556 50p. CD4069 15p. IN4005 10 for 35p. BD238 28p. BD439 28p. 7415 35p. 74414 75p. TIL305 alpha numeric display £2.50. MAX93A 3mm LED displays 45p. Min. LDRs 30p. LEDs 0.2" CLEAR 15p. GREEN 12p. RED 10p. Infra-red clear LED 30p. MPU131 PUTs. 40V. 200ma. 375mW 15p. 2N3773 £1.70. Texas R1038 [T03] Power trans. 50p. TAG4443 SCR 45p.

NEW STOCK ITEM - We are now stocking Expo mini hand-held drills. these are a precision British-made tool, ideal for P.C. board drilling, model makers etc. They operate on 12V DC. Drill kit supplied in plastic hinged case, with drill and 21 accessories, drills, sanders, reamers, buffers, etc. complete kit only £14.25. Drill only £7.25. Dr.H stand to suit vertical drill press £12.95 (postage 60p).

RECORDING TAPE. Low noise mylar. supplied unboxed: 7" 1200' £1.00. 7" 1800' £1.75. 10" 3500' £5.00.

JACKSONS C804 50 PF variable tuning condensers. Standard 1/4" spindle. 50p each.

TOOLS. SOLDER Sucker, good section, lellon nozzle. £4.99. Side cutters 5" £1.45. Pliers 5" £1.45. NEON DRIVER 8" LONG 50p. MIYAMA 16 pin IC test clip £1.85. 5 PIECE precision screw and driver sets. individual handles. £1.05. JUMPER TEST LEAD SETS 10 pairs of leads with insulated crabs each end 90p. CRIMPING TOOL, a combination type for crimping red, blue and yellow terminations also incorporates a wire stripper (6 gauges) and wire cutter. insulated, handles. only £2.30.

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SPECIAL OFFER DEC TYPE BREADBOARDS. Micro DEC "A" with 2 16 pin DIL carriers £3.95. Approximately half original selling price.

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SWITCHES. Sub. min. Toggle. SPST 8x5x7mm. 42p. DPDT [8x7x7] 55p. DPDT Centre off [12x11x9mm] 77p.

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16 pin D.I.I. SWITCHES only 42p each.

RIBBON CABLE 8-way single core miniature 22p per metre.

INCAOS. AA size 1.2 volts 500ma £1.10 each.

MOTOROLA PIEZO ELECTRIC TWEETERS
3" direct radiating type £3.65

PIEZO TWEETERS, require no crossover and can be used with systems up to 100 watts. Frequency response 3.8 to 28kHz.

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TRANSUDERS. REC/SENDER. 40KHZ 13.50 pair.

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TRIAc XENON PULSE TRANSFORMERS. 11 [6P0 style] 32p. 11p15 1 sub. mm. pcb mounting 65p.

PROJECT BOXES. Sturdy ABS black plastic boxes with brass inserts and lid. 75x55x35mm 55p. 95x7x35mm 75p. 115x9x37mm 87p.

VERO HAND HELD BOX. White ABS. 24in x 3.7 in tapered. with screws 68p each.

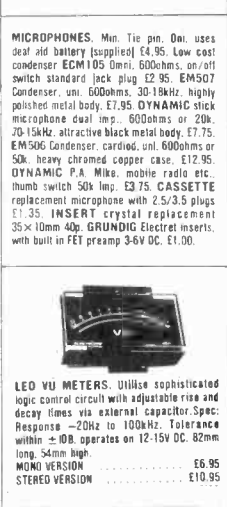
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16 pin D.I.I. SWITCHES only 42p each.

RIBBON CABLE 8-way single core miniature 22p per metre.

INCAOS. AA size 1.2 volts 500ma £1.10 each.

TRANSFORMERS. All 240V DC primary (postage per transformer is shown in brackets after price). MINIATURE RANGE 6-0-6 100ma. 9-0-9 75ma. 12-0-12 50ma all 79p each [15p]. 12V 200ma 75p [15p]. 0-6-0 5 280ma £1.20 [20p]. 6V 500ma £1.10 [22p]. 12V 2A £2.35 [45p]. 12-0-12 2A £2.75 [50p]. 15-0-15 1A £2.25 [45p]. 30-0-30V 1A £2.85 [54p]. 20-0-20V 2A £3.65 [54p]. 0-12-15-20-30V 2A £4.75 [54p]. 20V 2.5A £2.35 [54p].

TRIAc XENON PULSE TRANSFORMERS. 11 [6P0 style] 32p. 11p15 1 sub. mm. pcb mounting 65p.

PROJECT BOXES. Sturdy ABS black plastic boxes with brass inserts and lid. 75x55x35mm 55p. 95x7x35mm 75p. 115x9x37mm 87p.

VERO HAND HELD BOX. White ABS. 24in x 3.7 in tapered. with screws 68p each.

VERO POTTING PLASTIC Boxes with lid and screws 70x50x20mm. black. 43p each.

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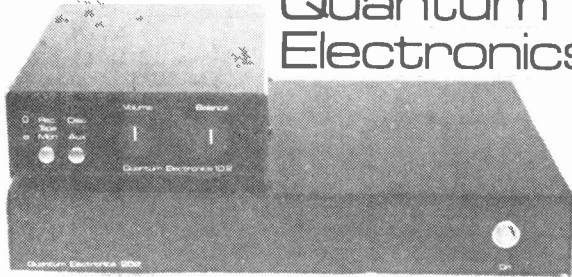
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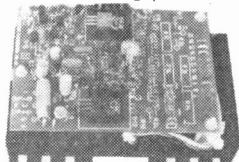
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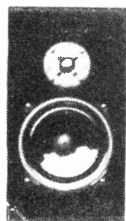
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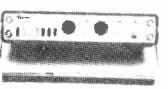
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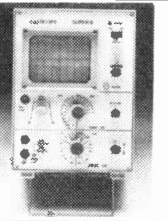
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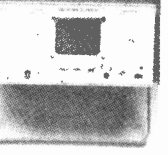
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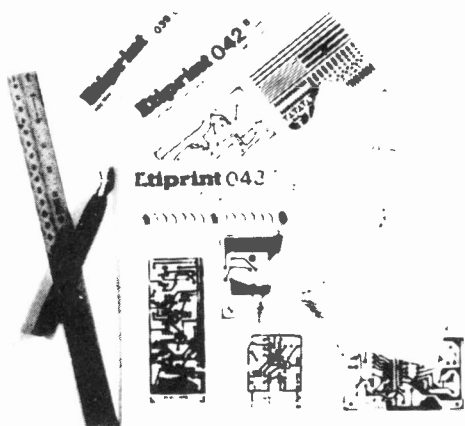
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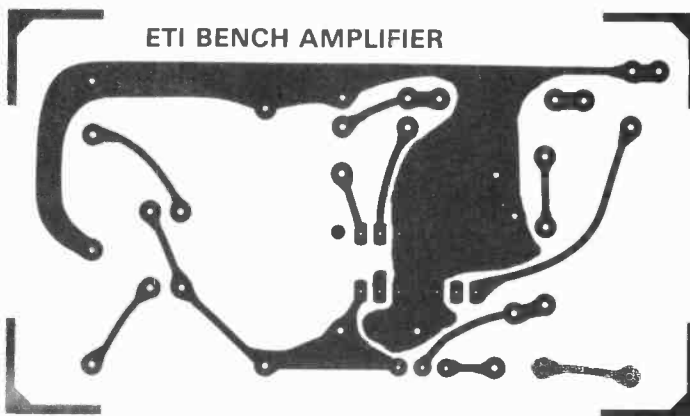
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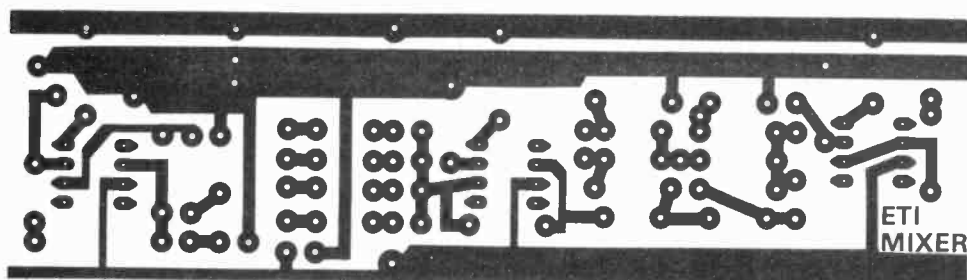
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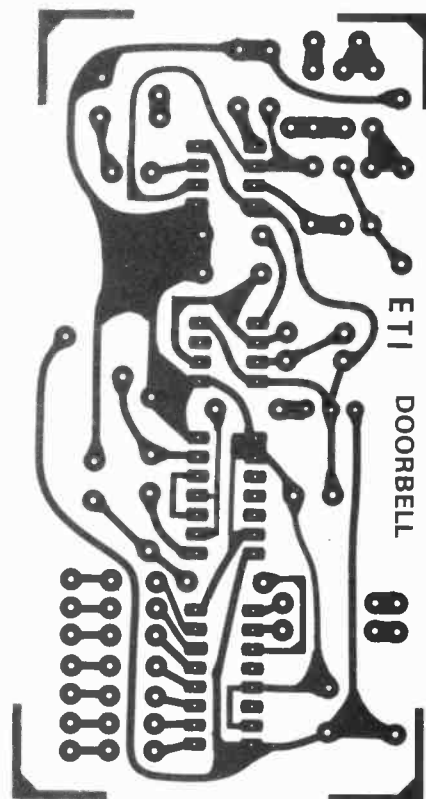
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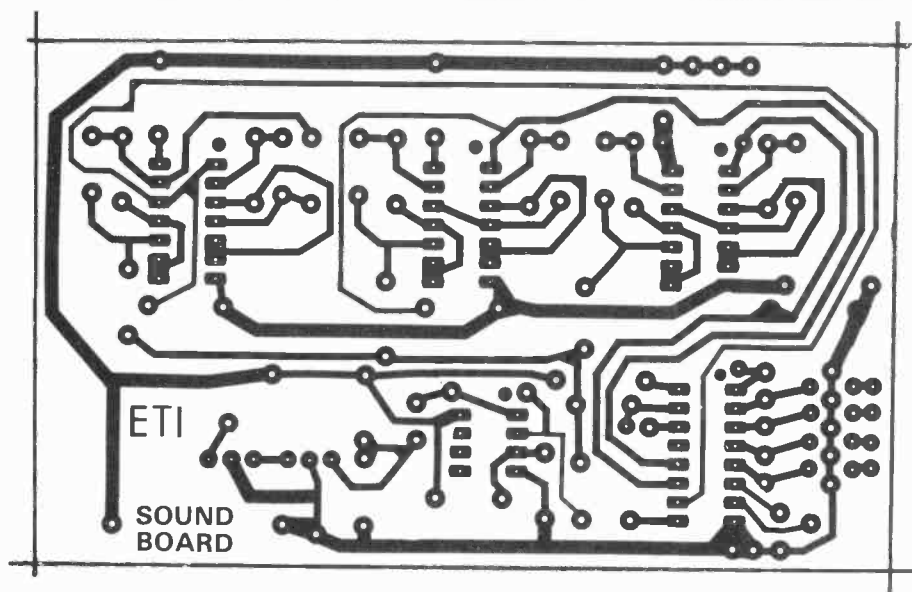


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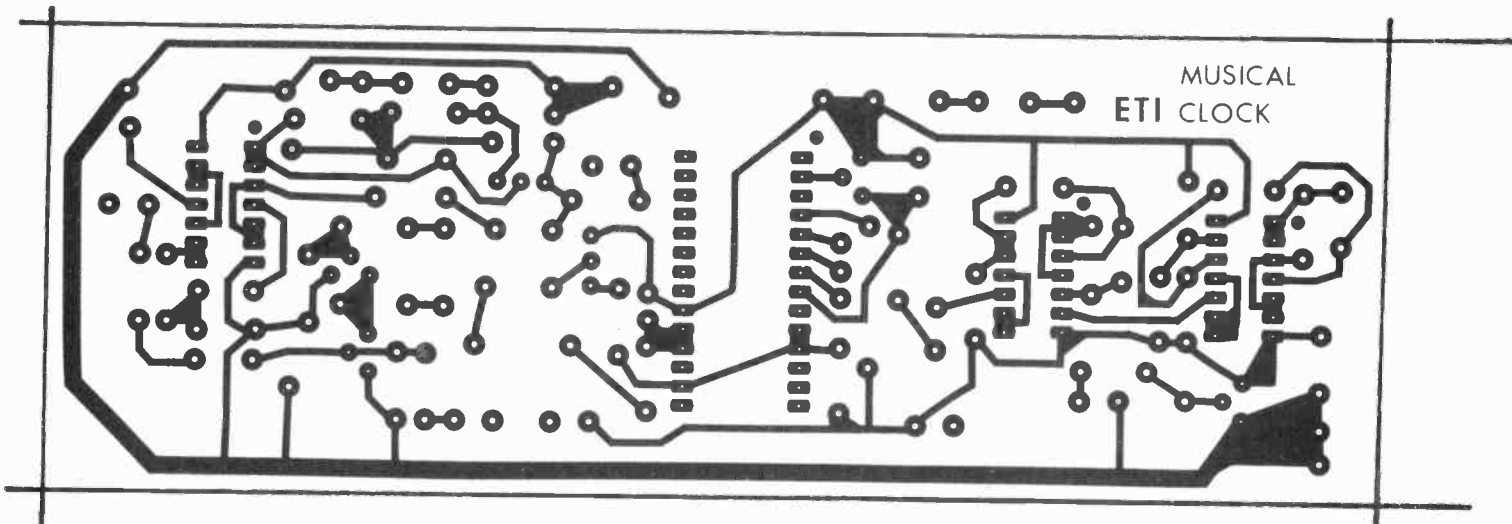


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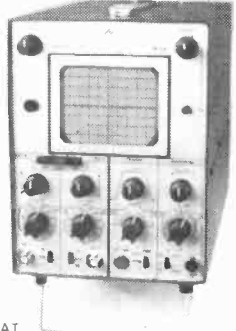
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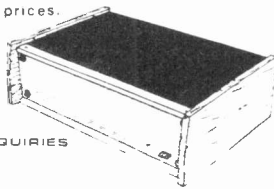
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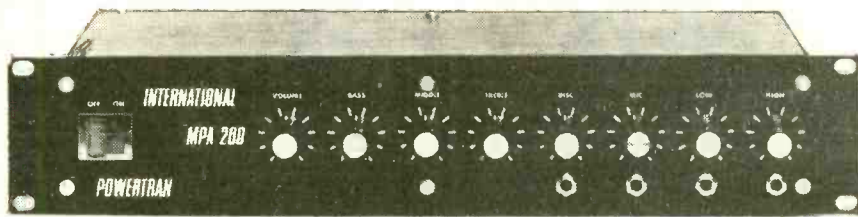
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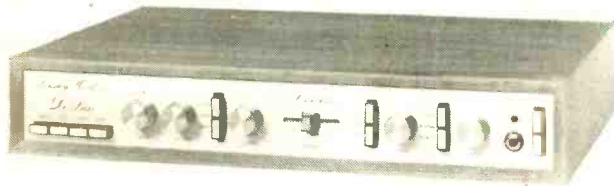


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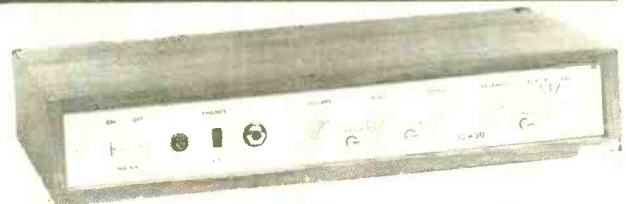
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