ISSN 0142-6192

electronics today INTERNATIONAL

FEBRUARY 1980

60p

Modular Synthesiser
Multi-Option Constructional Design

CMOS 555 Circuits
Major Experimenters Feature

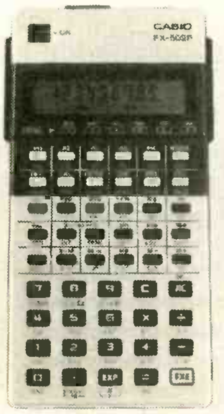
Active Filter
Signal Tracer
Casio FX502P

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

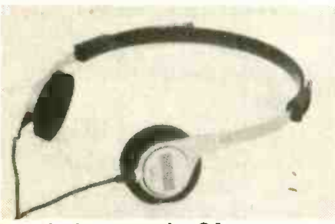
electronics today INTERNATIONAL

FEBRUARY 1980 Vol. 9 No. 2

synth a module p.62



button box p.23



~~~volution sound p.84

FEATURES

PROJECTS

INFORMATION

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ABC

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QUARTZ LCD 5 Function

Hours, mins, secs, month, date, auto calendar, back light, fully adjustable bracelet to fit all wrists.

£6.65

Guaranteed same day despatch.

Very slim, only 6mm thick

M1

SOLAR QUARTZ LCD 5 Function

Genuine solar panel with battery back-up
Hours, mins, secs
Day/date
Fully adjustable bracelet
Back-light
Only 7mm thick

£8.65

Guaranteed same day dispatch

M2

QUARTZ LCD 11 Function SLIM CHRONO

6 digit, 11 functions. Hours, mins., secs., day, date, day of week. 1/100th, 1/10th, secs.; 10X secs, mins. Split and lap modes. Back-light, auto calendar. Only 8mm thick. Stainless steel bracelet and back. Adjustable bracelet

Metac Price

£10.65 Thousands sold!

Guaranteed same day dispatch

M3

QUARTZ LCD ALARM 7 Function

Alarm
Hours, mins., secs.
Month, date, day.
6 digits. 3 flags plus continuous display of day and date or seconds
Back-light
Only 9mm thick

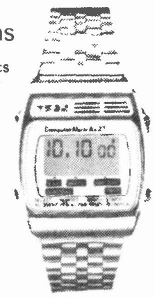
~~£12.65~~
£9.95

Guaranteed same day dispatch

M4

MULTI ALARM 6 Digits 10 Functions

* Hours mins secs
* Month date, day
* Basic alarm
* Memory date alarm
* Timer alarm with dual time and 5 country zone
* Back light
* 8mm thick

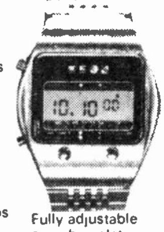


£18.65

M5

FRONT-BUTTON ALARM Chrono Dual Time

6 digits, 5 flags, 22 functions. Constant display of hours and mins. plus optional seconds or date display. AM/PM indication Month, date. Continuous display of day Stop-watch to 12 hours 59 9 secs in 1/10 second steps Split and lap timing modes. Dual time zones. Only 8mm thick Back-light



Fully adjustable open bracelet.

~~£22.65~~ £18.95

Guaranteed same day dispatch.

M6

SOLAR QUARTZ LCD Chronograph with Alarm Dual Time Zone Facility

6 digits, 5 flags, 22 functions. Solar panel with battery back-up. 6 basic functions stop-watch to 12 hours 59.9 secs in 1/10 sec. steps. Split and lap timing modes. Dual time zones Alarm 9mm thick Back-light. Fully adjustable bracelet.

~~£27.95~~ £19.95

M7

ALARM CHRONO with 9 World Time Zones

* 6 digits, 5 flags
* 6 basic functions
* 8 further time zones
* Count-down alarm
* Stop-watch to 12 hours 59.9 secs in 1/10 sec. steps
* Split and lap timing modes
* Alarm
* 9mm thick
* Back-light
* Fully adjustable bracelet

~~£29.65~~ £24.95

M8

SOLAR QUARTZ LCD Chronograph

Powered from solar panel with battery back-up 6 digit 11 functions Hours mins secs day date day of week 1/100th 1/10th secs 10X secs mins Split and lap modes Back light Auto calendar Only 8mm thick Stainless steel bracelet and back Adjustable bracelet

Metac Price

£13.65 Guaranteed same day dispatch

M9

LADIES DAY WATCH
QUARTZ LCD

Ladies Day Watch only 25×20mm and 6mm thick. Hours, minutes, seconds, day, date, backlight and auto calendar. Elegant metal bracelet in silver or gold fully adjustable to suit very slim wrists. State colour preference.

£9.95 Guaranteed same day despatch

M15

LADIES FASHION WATCH
QUARTZ LCD

Lady's Fashion Watch. Elegant bracelet in bronze/gold finish or silver colour. Hours, minutes, seconds, day, date, backlight and auto calendar. Adjustable for the slimmest of wrists.

State colour preference.

£14.95

Guaranteed same day despatch

M17

LADIES COCKTAIL WATCH
QUARTZ LCD

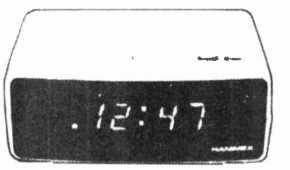
Lady's Cocktail Watch
Highly functional watch which also suits those special occasions. Beautifully designed with a very thin bracelet which retains strength as well as elegance. Hours, mins., secs., day, date, backlight and autocalendar. Bracelet fully adjustable to suit slim wrists. State gold or silver finish.

£19.95

Guaranteed same day despatch

M18

HANIMEX Electronic LED Alarm Clock



Features and Specification
Hour/minute display Large LED display with p.m. and alarm on indicator 24 Hours alarm with on/off control. Display flashing for power loss indication Repeatable 9-minute snooze Display bright/dim modes control Size. 5.15" x 3.93" x 2.36" (131mm x 11mm x 60mm) Weight 1.43 lbs (0.65 kg)

£10.20 Thousands sold!

Mains operated.

Guaranteed same day despatch.

M13

Special Offer EXECUTIVE ALARM WATCH

6 functions plus alarm. Conference signal, 5 minute snooze alarm. Conference signal sounds 4 secs. before main alarm to give advance warning and option to cancel. Snooze sounds 5 mins. after main alarm and is always preceded by the conference signal.

~~£14.95~~ **£9.95**

M60

MACY QUARTZ ANALOGUE

Automatic calendar day and date, infinite bracelet. This man's watch has elegance as well as the robust appearance provided by a watch with traditional features. Accuracy is provided by a quartz crystal powered by a long life miniature battery.

£24.95

M21

HOW TO ORDER

Payment can be made by sending cheque, postal order, Barclay, Access or American Express card numbers. Write your name, address and order details clearly, enclose 40 pence per single item for post and packing or the amount stated in the advert. All products carry 1 year written guarantee and full money-back 10 day reassurance. Battery fitting and electronic calibration service is available to customers at any Metac shop All prices include VAT currently at 15%.

Metac Wholesale:

Trade enquiries — send for a complete list of prices for all the goods advertised plus many more not shown, also minimum order details.

Telephone orders Credit card customers can telephone orders direct to Daventry (03272) 76545 or Edgware Road 01-723 4753 24 hours a day.

Service Enquiries: 03272-77659

CALLERS WELCOME. Shops open 9.30am-6.00pm.

Metac price breakthrough for an Alarm Chronograph with Dual Time

~~Only £16.95~~

Only £14.50

OUTSTANDING FEATURES

* **DUAL TIME.** Local time always visible and you can set and recall any other time zone (such as GMT). Also has a light for night viewing
* **CALENDAR FUNCTIONS** include the date and day in each time zone
* **CHRONOGRAPH/STOPWATCH** displays up to 12 hours, 59 minutes and 59.9 seconds. On command, stopwatch display freezes to show intermediate (split/lap) time while stopwatch continues to run Can also switch to and from timekeeping and stopwatch modes without affecting either's operation
* **ALARM** can be set to any time within a 24-hour period At the designated time, a pleasant, but effective buzzer sounds to remind or awaken you!

Guaranteed same day despatch

M16

Metac ELECTRONICS & TIME CENTRES

North & Midlands
67 High Street, DAVENTRY
Northamptonshire
Telephone: 03272 76545

South of England
327 Edgware Road
LONDON W.2
Telephone: (01) 723 4753

DIGEST

Open Ears

If you find earphones a pain in the neck, try this dangler from JVC. You hang it over your shell-like instead of wedging it inside.

The TP-1E weighs only 13g without its three metres of cord. It's designed for people who find conventional earphones uncomfortable. Secretaries in Readerland could use it to listen in on Radio 1 (or music, if you prefer) without driving the boss round the twist.

I would also recommend it whole-heartedly to insomniacs. While all about you are deep in dreamland, tune into your favourite middle-of-the-night music without starting a riot.

The TP-1E from JVC should be available for around £4.60 including VAT.

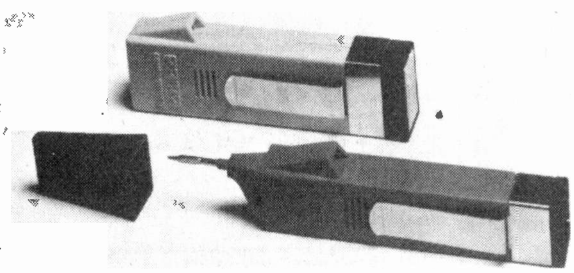
Opticom

A 96 kms experimental optical communications system has been set up by Philips Research Laboratories in Holland. It is believed to be the longest in the world.

The glass fibre connection consists of 16 reels of cable, each made of six separate strands. The reels are connected in two sections of eight kilometres each.

The signal is passed down one strand in the cable, through a repeater at each eight kilometre section, through the second eight kilometre section, then through a further repeater before returning up the cable via a second strand. This sequence is repeated via all six strands and eleven repeaters until the signal emerges at the end of its 96 kms journey. Attenuation is a mere 4 dB/km, including the joints every kilometre. Hence the need for repeaters at only eight kilometre intervals (conventional copper cable links need repeaters every two to four kilometres).

Japan isn't far behind the Dutch achievement. The Nippon Telegraph and Telephone Corporation have succeeded in transmitting an 800 Mbit/S signal through 30 kms of fibre-optic cable with an error rate of less than 10^{-12}. At the source wavelength (1.3 um from an indium-gallium-arsenide-phosphide laser at room temperature) the attenuation is such that the loss in the cable is only 0.73 dB/km (including losses in the splicing, every 2 kms).

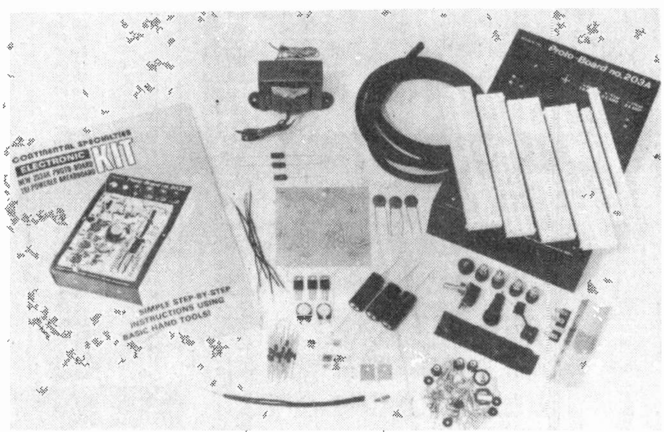


Combi 'n' Poly

Arm yourself with a Combi-Sensor and you're ready to detect AC or pulsating DC voltage, faulty connections to ground in electrical appliances, leakage to ungrounded metal cases or breaks in insulated conductors. Live cables laid on the surface or under plastic panels can be checked and traced without any need for stripping the cable. The Combi-Sensor has no test leads and so is safe to use. The condition of cables and connections under test is indicated by light and sound.

With the Poly-Tester you can test continuity, neutral and ground terminals in power outlets, semiconductors and voltages. There are no test leads to connect — the Poly-Tester has only one integral test probe, with a protective cover. It can also be used as an ordinary screwdriver-type voltage tester with the added advantage of being unaffected by induction. Connection to the user's body is by a metal pocket clip. Like the combi-Sensor, test indication is by sound and light.

The Combi-Sensor and Poly-Tester are £7.60 each plus VAT from C. Lord, 61 Forknell Avenue, Wyken, Coventry CV2 3EN.



Bread Power

Continental Specialties Corporation has introduced a kit of parts for a solderless breadboard system with three regulated DC power supplies.

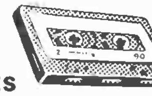
The Proto-Board PB203AK kit comes complete with all the electronic components, case and breadboard modules, nuts, bolts, connecting wire and solder. Step by step instructions are also included. The finished Proto-Board has three large breadboards plus four-long busbars and one shorter one, giving a constructional area sufficient for 24 ICs in 14 pin packages. Terminal posts also allow connection to earth and +5A, 1A and ±V, 0.5A power supplies. The supplies are independent and fully regulated. The ±15V supplies can be adjusted internally over 7 to 18 volts. The three supply rails allow the Proto-Board to be used with TTL and CMOS logic.

The PB203AK, supplied with a robust earthed metal case (248×168×83mm) and designed to be powered from 240V AC mains, is available for £59 plus VAT from Continental Specialities Corporation, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

Great 1980 Sale

SPECIAL OFFER

SUPER SOUND
SAVING!
DINDY
LOW NOISE CASSETTES



SJ30 10 C30 15 min per side	£2.00
SJ55 10 C46 23 min per side (LP)	£2.50
SJ31 10 C90 45 min per side	£3.50
SJ32 10 C120 40 min per side	£4.50

ALL REDUCED!

CAPACITOR PAKS

16201	18	electrolytics	4.7uF-10uF
16202	18	electrolytics	10uF-100uF
16203	18	electrolytics	100uF-680uF

All 3 at SPECIAL PRICE of £1.30

16160	24	ceramic caps	22pF-82pF
16161	24	ceramic caps	100pF-390pF
16162	24	ceramic caps	470pF-3300pF
16163	24	ceramic caps	4700pF-0.047pF

All 4 at SPECIAL PRICE of £1.80

RESISTOR PAKS

Order No.		
16213	60¼W	100ohm-820ohm
16214	60¼W	1K-8.2K
16215	60¼W	10K-82K
16216	60¼W	100K-820K
16217	40½W	100ohm-820ohm
16218	40½W	1K-8.2K
16219	40½W	10K-82K
16220	40½W	100K-820K

All 4 at SPECIAL PRICE of £1.80

IC SOCKET PACKS

SJ36	14	8 pin
SJ37	12	14 pin
SJ38	11	16 pin
SJ39	8	18 pin
SJ40	7	20 pin
SJ41	6	22 pin
SJ42	5	24 pin
SJ43	4	28 pin
SJ44	3	40 pin

ALL AT ONLY £1.00 each

F.E.T.s

2N3819	£0.17
2N5458	£0.18
2N4220	£0.28
2N4860	£0.25

(PROGRAMMABLE UNIJUNCTION)

2N6027	£0.25
BRY56	£0.25

VOLTAGE REGULATORS

Cast TO220

Positive		Negative	
uA7805	£0.65	uA7905	£0.70
uA7812	£0.65	uA7912	£0.70
uA7815	£0.65	uA7915	£0.70
uA7818	£0.65	uA7918	£0.70
uA7824	£0.65	uA7924	£0.70

uA723 14 pin DIL	£0.35
LM309K TO3	£1.10

OPTOELECTRONICS
DISPLAYS

1510	707	LED	Display Price each	£0.70
1511	747	LED	Display Price each	£1.50
1512	727	LED	Display Price each (dual)	£1.55
LEDs				Price each
SJ78	.125	LED	Diffused RED	£0.08
SJ79	.2	LED	Diffused RED	£0.08
S120	125	LED	Bright RED	£0.09
S121	.2	LED	Bright RED	£0.09
1502	.125	LED	Diffused GREEN	£0.11
1505	.2	LED	Diffused GREEN	£0.11
1503	.125	LED	Diffused YELLOW	£0.11
1506	.2	LED	Diffused YELLOW	£0.11
SJ80	.2	LED	Bright YELLOW	£0.14
SJ82	.2	LED	Clear illuminating RED	£0.10
SJ83	.125	LED	Clear illuminating RED	£0.10

2nd QUALITY LED PAKS

1507	10	Assorted colours & size	£0.65
S122	10	.125 RED	£0.50
S123	10	.2 RED	£0.50
1508/.125		125	5 for £0.10
1508/.2		.2	5 for £0.12
SJ81		1 Infra RED emitter — Fairchild FP100	£0.25
SJ98		5 Photo Detector MEL11 + Data	£1.00
ORP12		NORP12 Cad Cell	£0.45
SJ99		4 ITT 5870 ST Nixie Tubes	£1.00

SJ29 Texas NPN silicon transistors 2S503 = BC108 TO-18 metal can — perfect & coded

50 off **£2.50** — 100 off **£4.00** — 1,000 off **£35.00**

NICKEL CADMIUM RECHARGEABLE BATTERIES

S128 3500D Cell size — U2 **£2.50**

SUPER DUPER COMPONENT BOX

Min. 3lbs in weight consisting of a fantastic assortment of Electronic Components — Pots, Resistors, Condensers, Switches, Relays, Board-Semiconductors, Wire, Hardware, etc, etc, etc.
*This is a large box and is sent separate to your order.
S140 **£2.50** including P&P

CALCULATOR CHIP

GOM2-C500 24 pin MOS £0.50

IC INSERTION EXTRACTION TOOL

2015 £0.35 each

TRANSISTORS

Type	Price	Type	Price	Type	Price
AC107	£0.20	BC251	£0.10	OC29	£0.56
AC126	£0.14	BC261	£0.14	OC35	£0.55
AC127	£0.16	BC327	£0.12	OC36	£0.60
AC128	£0.15	BC328	£0.12	OC42	£0.18
AC128K	£0.24	BC337	£0.12	OC44	£0.20
AC176	£0.16	BC338	£0.12	OC45	£0.18
AC171K	£0.24	BC440	£0.25	OC71	£0.12
AC187	£0.16	BC441	£0.25	OC72	£0.16
AC187K	£0.26	BC460	£0.28	OC75	£0.18
AC188	£0.16	BC461	£0.28	OC81	£0.20
AC188K	£0.26	BC477	£0.15	TIP29	£0.30
AD161/162MP		BC478	£0.15	TIP29A	£0.30
	£0.65/pr	BC479	£0.15	TIP29B	£0.32
AD140	£0.50	BC547	£0.08	TIP29C	£0.34
AD149	£0.53	BC548	£0.08	TIP30	£0.30
AF239	£0.35	BC549	£0.08	TIP30A	£0.30
BC107	£0.06	BC557	£0.10	TIP	£0.32
BC107A	£0.06	BC558	£0.09	TIP30C	£0.34
BC107B	£0.07	BC559	£0.19	TIP31	£0.30
BC107C	£0.08	BCY70	£0.13	TIP31A	£0.30
BC108	£0.06	BCY71	£0.13	TIP31B	£0.32
BC108A	£0.06	BCY72	£0.13	TIP31C	£0.34
BC108B	£0.07	BD115	£0.45	TIP32	£0.30
BC108C	£0.08	BD131	£0.30	TIP32A	£0.30
BC109	£0.06	BD132	£0.30	TIP32B	£0.32
BC109B	£0.07	BD135	£0.28	TIP32C	£0.34
BC109C	£0.09	BD136	£0.28	TIP41	£0.34
BC113	£0.10	BD239A/		TIP41A	£0.34
BC114	£0.12	BD240A/MP		TIP41B	£0.36
BC116	£0.16		£0.80/pr	TIP41C	£0.38
BC118	£0.10	BF115	£0.20	TIP42	£0.34
BC140	£0.20	BF167	£0.20	TIP42A	£0.34
BC141	£0.20	BF173	£0.20	TIP42B	£0.36
BC142	£0.18	BF195	£0.09	TIP42C	£0.38
BC147	£0.07	BF195	£0.08	TIP2955	£0.50
BC148	£0.07	BF196	£0.08	TIP3055	£0.45
BC149	£0.07	BF197	£0.10	ZTX107	£0.08
BC157	£0.08	BF257	£0.22	ZTX108	£0.08
BC158	£0.09	BF258	£0.22	ZTX109	£0.09
BC159	£0.08	BF259	£0.24	ZTX300	£0.10
BC169C	£0.08	BFR39	£0.20	ZTX301	£0.10
BC170	£0.06	BFR40	£0.20	ZTX302	£0.12
BC171	£0.07	BFR79	£0.22	ZTX500	£0.12
BC172	£0.07	BFR80	£0.22	ZTX501	£0.10
BC173	£0.08	BFT84	£0.20	ZTX502	£0.12
BC177	£0.13	BFT85	£0.20	2N696	£0.10
BC178	£0.13	BFX29	£0.20	2N697	£0.10
BC179	£0.13	BFX84	£0.20	2N706	£0.09
BC182	£0.07	BFY50	£0.15	2N706A	£0.10
BC182L	£0.07	BFY51	£0.15	2N708	£0.10
BC183	£0.07	BFY52	£0.15	2N1302	£0.15
BC183L	£0.07	BIP19/20MP		2N1303	£0.15
BC184	£0.07		£0.70/pr	2N1613	£0.18
BC184L	£0.07	MJE340	£0.60	2N1711	£0.18
BC207	£0.08	MJE2955	£0.75	2N1893	£0.25
BC208	£0.08	MJE3055	£0.50	2N2218	£0.18
BC209	£0.09	MPSA05	£0.15	2N2218A	£0.20
BC212	£0.07	MPSA06	£0.15	2N2219	£0.18
BC212L	£0.07	MPSA55	£0.15	2N2219A	£0.20
BC213	£0.07	MPSA56	£0.15	2N2221	£0.18
BC213L	£0.07	OC25	£0.50	2N2221A	£0.20
BC214	£0.07	OC26	£0.45	2N2222	£0.18
UC214L	£0.07	OC28	£0.60	2N2222A	£0.18

DIODES

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BA173	£0.13	OA90	£0.08	IN4007	£0.09
BAX13	£0.05	OA91	£0.08	IN5400	£0.12
BAX16	£0.06	OA95	£0.08	IN5401	£0.13
OA200	£0.06	IN34	£0.08	IN5402	£0.15
OA202	£0.07	IN60	£0.07	IN5404	£0.15
BY100	£0.18	IN4148	£0.05	IN5406	£0.19
BY126	£0.12	IN4001	£0.04	IN5407	£0.23
BY127	£0.14	IN4002	£0.04	IN5408	£0.28
OA47	£0.06	IN4003	£0.05	IS44	£0.03

LINEAR

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LM381	£1.35	TAA521A	£1.80	uA711	£0.26
LM3900	£0.50	TBA120B	£0.60	741P	£0.16
MC1310P	£0.65	TBA641A	£1.10	TAA661	£1.25
NE555	£0.18	TBA800	£0.75	TAA661B	£1.25
NE556	£0.55	TBA810	£0.85		

THYRISTORS

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THY3A/50 3 Amp 50v TO64	£0.25
THY3A/200 3 Amp 200v TO64	£0.32
THY3A/400 3 Amp 400v TO64	£0.40
THY5A/50 5 Amp 50v TO66	£0.25
THY5A/400 5 Amp 400v TO66	£0.40
THY5A/600 5 Amp 600v TO66	£0.50
C106/4 6 Amp 400v TO220	£0.42

DIACS TRIACS SCR's

SJ84 8Amp 400v TO220 Plastic (non isolated tab)	£0.80
BR100	£0.15
D32	£0.15

COMPONENT PAKS

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• SJ18 20 Tantalum bead capacitors mixed	0.50
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SJ26 100 Silicon PNP transistors, all perfect and coded — mixed types and cases data and equivalent sheet	2.50
SJ27 50 Assorted pieces of SCR's diodes and rectifiers incl. stud types, all perfect — no rejects, fully coded — data incl.	2.50
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• SJ33 PC Board — mixed bundle PCB fibreglass/paper, single and double sided — super value!	0.75
SJ34 200 sq in (approx) copper clad paper board, single sided	0.80
SJ35 100 sq in (approx) copper clad fibre glass, single sided	0.80
SJ49 8 Dual gang carbon pots log and lin mixed values	1.00
SJ50 20 Assorted slider knobs — chrome/black	1.00
SJ51 1 Switchbank 5 way incl. silver knobs	0.50
SJ52 1 Pack of vero board approx 50 sq. ins., mixed	1.00
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SJ64 Instrument knob — black/silver aluminium top (17 x 15mm), ¼'' standard screw fit	0.12
SJ68 30 ZTX300 type transistor NPN pre-formed for P/C Board colour coded blue — all perfect	1.00
SJ69 30 ZTX500 type transistor PNP pre-formed for P/C Board colour coded white — all perfect	1.00
SJ70 25 BC107 NPN TO106 case perfect transistors, code C1359	1.00
SJ71 25 BC177 PNP TO106 case perfect transistors, code C1395	1.00
SJ72 4 2N3055 silicon power NPN transistors TO3	1.00
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16187 30 Meters stranded wire mixed colours	0.50
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SJ56 6 100K lin 40mm slider pots	0.50
SJ57 6 100K log 40mm slider pots	0.50
SJ58 6 1K lin 40mm slider pots	0.50
SJ59 6 5K lin 40mm slider pots	0.50
SJ60 4 5K log 60mm single	0.50
SJ61 4 100K log 60mm single	0.50
SJ62 5 15mm chrome knobs standard push fit	0.50
SJ95 8 Silicon bridge rectifiers up to 4 Amp 200v + Data	1.50
SJ96 1 Battery holder to take 6 x HP7's	0.10

METAL CASE DUAL SLIDER POTS: 45mm travel

SJ65 10K log, each	0.25
SJ66 100K lin, each	0.25
SJ67 Chrome slider knobs to fit, each	0.10

SPECIAL OFFER ON ELECTROLYTICS:

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SJ100 12v electric drill 7,500 RPM for all your PCB drilling complete with 2 drills .1 and .15	5.00
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SJ134 2 magnets suitable for reed switches	0.10

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Cat Corner

Let's kick off with the Vero contribution to Cat Corner. The new edition of the Vero Electronics Complete Packaging Catalogue is now available. The 300 page catalogue is divided into 23 separate sections covering Vero's extensive range of electronics packaging products. The product section and a copy of the latest price list are included in a smart ring binder. You can get your copy from the Sales Literature Department. Vero Electronics Ltd, Industrial Estate, Chandler's Ford, Hampshire SO5 3ZR.

Hamlin Electronics have a 24 page manual covering solid state relay applications with device specification and selection information and a guide to troubleshooting relay-based circuits. Typical circuits are included to illustrate different applications. Each type of relay is defined and described in detail as are all the relevant electrical parameters. If you're a bit confused by relay lingo, don't worry, there's even a glossary of terms. This handy little relay bible is available from Hamlin Electronics Europe Ltd, Diss, Norfolk IP22 3AY,

From Cyril With Love

We know from our mail bag that the UK edition of ETI is read all over the world. Recently we received our first fan letter from Russia (a red letter day?). The demand for ETI behind the Iron Curtain is so great that the USSR National Public Library for Science and Technology have asked us to send them a copy every month. I wonder if they have an ulterior motive. 'Here is the news for 1999 — this morning five thousand String Things swept across the Central German Plains, dessimating Nato forces. British Centurion tanks were no match for Soviet air to ground flash triggers. Ground troops had been thoroughly trained on Ambush simulators. We believe their operations co-ordination computer is called Triton.' Just a joke, comrades.

In return for a monthly Moscow air-lift of ETIs, the library have kindly offered us our choice of over 500 Soviet periodicals. They are all listed in a handy handbook . . . in Russian. Now, we're not devastating decoders of Cyrillic script at the best of times, so, to put it bluntly (Anthony who?), Houston, we have a problem.

СПИСОК СОВЕТСКИХ ИЗДАНИЙ,

предлагаемых Государственной публичной научно-технической библиотекой СССР по обмену

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Breadboard '79

To all of you who came along to the grand electronics extravaganza — thanks for visiting our stand. To those of you who didn't — why didn't you? Try to get along to see us next year.

ETI was hard to miss. Together with Computing Today and Hobby Electronics we occupied the biggest stand in the show, much to the dismay of one of our competitors who was displaying its wares from a cupboard opposite us.

We did a brisk trade in magazines. In fact we couldn't stock up the stand quickly enough to keep pace with demand. Apologies to anyone who wasn't able to get the back number of his choice on the day.

Did you see the Hobby Electronics' HEBOT going through its paces? Shame on you if you didn't. Notice how Remcon (from whom you can get everything except the electronic components) killed two birds with one stone by using HEBOT to carry information leaflets round the gathered throng. In fact, there was a profusion of throngs of all shapes and sizes throughout the week at all of the stands. Throng members could be seen spending their pennies and flashing their cheque cards for bags of components, HEBOTS, radiometers (I bought one myself), breadboards and books.

Rule Britannia . . . .

Read any good mags lately?

Like to buy a HEBOT . . .?

Jackanory, Jackanory . . .

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74151A	70p
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74154	100p
74155	90p
74156	90p
74157	70p
74159	190p
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74161	100p
74162	100p
74163	100p
74164	120p
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74LS161	100p
74LS162	140p
74LS163	100p
74LS164	120p
74LS165	160p
74LS166	180p
74LS173	110p
74LS174	110p
74LS175	110p
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74LS190	100p
74LS191	100p
74LS192	100p
74LS193	100p
74LS195	140p
74LS196	120p
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74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	195p
74LS245	250p
74LS247	140p
74LS248	140p
74LS249	140p
74LS251	140p
74LS253	140p
74LS257	120p
74LS258	160p
74LS259	160p
74LS266	100p
74LS273	175p
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4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4036	295p
4037	115p
4038	120p
4039	295p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	40p
4050	49p
4051	80p
4052	80p
4053	80p
4054	150p
4055	125p
4056	135p
4059	600p
4060	115p
4063	120p
4066	55p
4067	450p
4068	22p
4069	20p
4070	30p
4071	22p
4072	22p
4073	22p
4075	22p
4076	107p
4081	22p
4082	22p
4086	72p
4089	138p
4093	80p
4094	250p
4095	95p
4096	95p
4097	340p
4098	107p
4099	200p
40100	220p
40101	132p
40102	180p
40103	180p
40104	99p
40105	99p
40106	60p
40107	80p
40108	470p
40109	100p
40110	300p
40114	250p
4411	1100p
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4510	99p
4511	150p
4512	80p
4514	265p
4515	300p
4516	110p
4518	100p
4520	100p
4521	250p
4526	108p
4527	150p
4528	100p
4538	120p
4543	180p
4553	450p
4556	72p
4560	250p
4569	250p
4572	40p
4583	90p
4584	90p
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9322	150p
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9370	200p
9374	200p

VEROBOARDS

	0.1	0.15
(copper clad)		
2.5×3.75"	48p	43p
2.5×5"	57p	51p
3.75×3.75"	57p	—
3.75×5"	64p	64p
3.75×17"	222p	194p
4.75×17.9"	290p	—
Pkt of 100 pins		50p
Spot face cutter		86p
Pin insertion tool		118p
Vero Wiring Pen + 2 wire spools + combs		370p
Combs		7p

LINEAR I.Cs

AY1-0212	600p
AY1-1313	668p
AY1-1320	320p
AY1-5050	140p
AY3-1270	840p
AY5-1224A	240p
AY5-1315	600p
AY5-1317A	775p
CA3019	80p
CA3046	70p
CA3048	225p
CA3080E	72p
CA3086	48p
CA3089E	225p
CA3090AQ	375p
CA3130E	90p
CA3140E	100p
CA3160E	100p
CA3161E	140p
CA3162E	450p
CA3189E	400p
DAC1408-8	200p
FX209	750p
ICL7106	850p
ICL8038	340p
ICM7555	80p
LF356P	95p
LF358P	75p
LM10C	425p
LM301A	30p
LM311	120p
LM318	200p
LM319	225p
LM324	50p
LM339	75p
LM348	95p
LM377	175p
LM380	75p
LM381AN	160p
LM709	36p
LM710	50p
LM725	350p
LM733	100p
LM741	18p
LM747	70p
LM748	35p
LM2917	250p
LM3900	70p
LM3909	70p
LM3911	130p
LM3914	250p
LM4136	120p
MC1310P	150p
MC1458	48p
MC1495L	350p
MC1496	100p
MC3340P	120p
MC3360P	120p
MK50398	750p
MM57160	620p
NE531	160p
NE555	22p
NE556	70p
NE561B	425p
NE562B	425p
NE565	130p
NE566	155p
NE567	175p
NE571	425p
RC4151	400p
SAD1024A	1250p
SFF96364	£11
SN76003N	175p
SN76013N	140p
SN76013ND	120p
SN76023N	140p
SN76023ND	120p
SN76477	200p
SP8515	750p
TAA621	275p
TBA641B11	225p
TBA651	200p
TBA800	90p
TBA810	100p
TBA820	90p
TCA940	175p
TDA1004	300p
TDA1008	320p
TDA1010	225p
TDA1022	600p
TDA1024	120p
TDA1034B	250p
TDA1170	250p
TDA2002V	325p
TDA2020	320p
TL071	50p
TL072	95p
TL074	150p
TL081	45p
TL082	95p
TL084	130p
TL170	50p
UAA170	200p
UAA180	200p
UDN6118	320p
UDN6184	320p
ULN2003	100p
XR2206	400p
XR2207	400p
XR2211	600p
XR2216	675p
XR2240	400p
ZN414	90p
ZN419C	POA
ZN424E	135p
ZN425E	400p
ZN1034E	200p
95H90	800p
11C90	1400p

VOLTAGE REGULATORS

Fixed Plastic TO-220

1A	+ve		-ve	
5V	7805	60p	7905	70p
12V	7812	60p	7912	70p
15V	7815	60p	7915	70p
18V	7818	60p	7918	70p
24V	7824	60p	7924	70p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K	135p
LM317T	200p
LM323K	550p
LM723	37p
TBA625B	120p
78HGKC	725p
78HO5KC	625p
78MGT2C	135p
78P05	900p

OPTO-ELECTRONICS

2N5777	45p
OCP71	130p
ORP12	90p
ORP60	90p
ORP61	90p
TIL78	70p

OPTO-ISOLATORS

IL074	130p
MCT26	100p
MCS2400	190p
TIL111	90p
TIL112	90p
TIL116	90p

LEDS

0.125"		0.2"	
TIL32	75p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	MV5491 TS	120p
TIL216 Red	18p	Clips	3p

DISPLAYS

3015F	200p
DL704	140p
DL707 Red	140p
707 Gr	140p
DL747 Red	225p
747 Gr	225p
FND357	120p
FND500	120p
FND507	120p
MAN3640	175p
MAN4640	200p
NSB5881	570p
TIL311	600p
TIL312/3	110p
TIL321/2	120p
TIL330	140p
7750 60	200p

DRIVERS

9638	200p
9370	200p
UDN6118	320p
UDN6184	320p

TRANSISTORS

AC126	25p
AC127/8	20p
AC176	25p
AC187/8	25p
AF116	50p
AD149	70p
AD161/2	45p
AU107	200p
BC107/8	11p
BC109	11p
BC117	20p
BC147/8	9p
BC149	10p
BC157/8	10p
BC159	11p
BC169C	12p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	16p
BC337	16p
BC338	16p
BC461	38p
BC477/8	30p
BC516/7	50p
BC547B	16p
BC548C	9p
BC549C	18p
BC557B	16p
BC559C	18p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD135/6	54p
BD139	56p
BD140	60p
BD189	60p
BD232	95p
BD233	75p
BD235	85p
BD241	70p
BD242	70p
BDX53B	150p
BDY56	200p
BF200	32p
BF244B	35p
BF256B	70p
BF257/8	32p
BF259	36p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFX29	30p
BFX30	34p
BFX84/5	40p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	30p
BFY51/2	30p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	20p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU205	200p
BU208	200p
BU406	145p
E300	50p
E308	50p
E310	50p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJE340	50p
MJE2955	100p
MJE3055	70p
MPF102	45p
MPF103/4	40p
MPF105/6	40p
MPS6531	50p
MPS6534	50p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSU06	63p
MPSU07	90p
MPSU45	90p
MPSU65	78p
OC28	130p
OC35	130p
R2008B	200p
R2010B	200p
TIP29A	40p
TIP29C	55p
TIP30A	48p
TIP30C	60p
TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP54	160p
TIP120	120p
TIP122	130p
TIP142	180p
TIP147	160p
TIP2955	78p
TIP4055	70p
TIS43	34p
TIS93	30p
ZTX108	12p
ZTX300	13p
ZTX500	15p
ZTX502	18p
ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N698	45p
2N706A	20p
2N708A	20p
2N918	45p
2N930	18p
2N1131/2	20p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	30p
2N2369A	16p
2N2484	30p
2N2646	45p
2N2904/5	25p
2N2906A	24p
2N2907A	30p
2N2926	9p
2N3053	30p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
2N3565	30p
2N3584	250p
2N3643/4	48p
2N3702/3	12p
2N3704/5	12p
2N3706/7	14p
2N3708/9	12p
2N3773	300p
2N3819	25p
2N3820	50p
2N3823	70p
2N3866	90p
2N3902	700p
2N3903/4	18p
2N3905/6	20p
2N4037	65p
2N4058/9	12p
2N4060	12p
2N4061/2	18p
2N4123/4	27p
2N4125/6	27p
2N4401/3	27p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5179	90p
2N5191	83p
2N5194	90p
2N5245	40p
2N5296	55p
2N5401	50p
2N5457/8	40p
2N5459	40p
2N5460	80p
2N5485	44p
2N5875	250p
2N6027	48p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2N6292	65p
2SC1172	150p
3N128	120p
3N140	100p
3N141	110p
3N201	110p
3N204	100p
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DPDT	70p
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Push to make	15p
break	25p
Push latching SPCO	60p
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ROCKER SPST	28p
WAFER	
1P/12W	45p
3P/4W	45p
4P/3W	45p
2P/6W	45p

CRYSTALS

100KHz	300p
1MHz	370p
1.008MHz	370p
3.2768MHz	350p
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8.867237MHz	400p
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(The above boards are suitable for all DIL ICs.)

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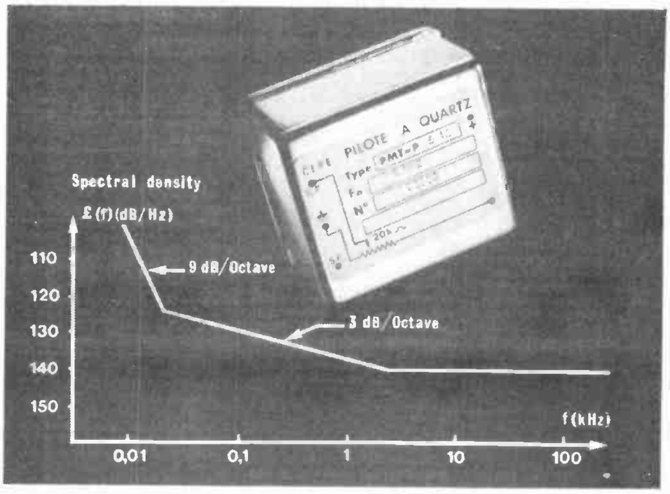
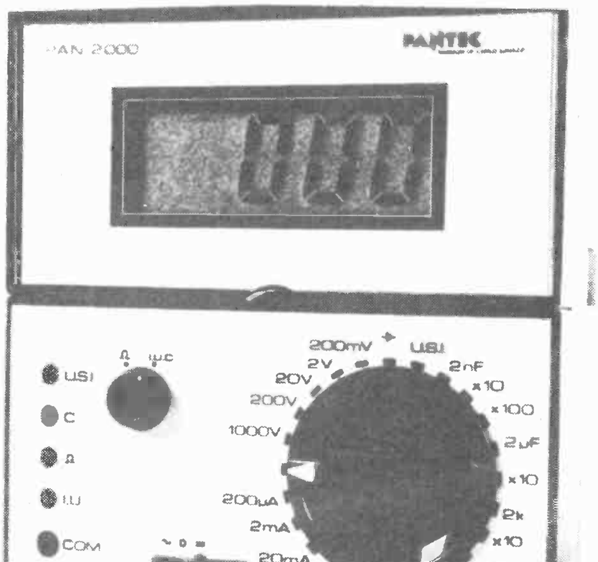


Standard Crystals

Thomson-CSF can now offer ovened crystal oscillators, type PMT P5, with ageing rates as low as ±5 x 10^{-10} at any frequency between 4 MHz and 12 MHz. You can choose the operating temperature and stability to suit the application.

The oscillators each weigh 180 g, measure 67 x 60 x 40 mm and are PCB mounting. Frequency adjustment is by external potentiometer or an externally applied voltage. The oscillators feature a very low signal to single sideband phase noise ratio at the output, the typical noise floor being –150dB/Hz. The initial power consumption, with a 12 V ±5т, negative earth supply is initially 8.4 watts, but falls to about two watts steady state at 25°C.

The range of oscillators is available from Thomson-CSF Components and Materials Ltd, Ringway House, Bell Road, Daneshill, Basingstoke RG24 0QG.

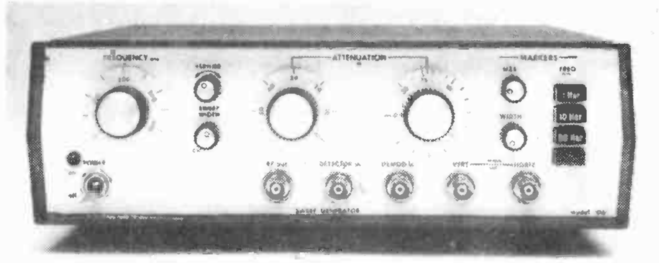


Pil Pan

For about £90 you could have an LCD digital multimeter with 30 ranges, including five capacitance ranges and a temperature range using an optional temperature probe — namely the PAN 2000.

Other features include automatic polarity and overload display. A nine volt battery brings 150 hours of digital viewing. With the half kilo package you can test 100uV to 1000V and 100uA to 2A DC, 100uV to 750V and 100uA to 2A AC, 2k to 20M, 1p to 20u and —50°C to 125°C. 30kV DC is also available.

The PAN 2000 is availble from Precision Instrument Laboratories, Instrument House, 727 Old Kent Road, London SE15.



Mini Hertz Box

New from Electroplan, the Labgear CM7044 is a miniature frequency meter with a bandwidth of 10 MHz to 500 MHz. The portable CM7044 also has a small antenna, enabling measurement of transmissions to be made without physical connection to the transmitter. Frequency readings are presented on the seven digit LED display in two ranges, 50 MHz and 500 MHz.

The Wavetek model 1061, also from Electroplan, can be used as a carrier wave generator or can be made to sweep any part of its 1 to 400 MHz bandwidth. Crystal controlled markers are available in the sweep mode at intervals of 1, 10 or 50 MHz. Maximum output is +10 dBm from 50 ohms with a flatness of ± 0.25 dBm over the instrument's range. The 1061 also features a built-in RF detector and demodulator and a horizontal drive for an oscilloscope.

The Labgear CM7044 frequency meter and the Wavetek 1061 sweeper are both available from Electroplan Ltd, PO Box 19, Orchard Road, Royston, Herts SG8 5HH.

OOPS!

The Beast (Nov.)

Some readers have experienced difficulty in winding the required 77 primary turns on the coil of track-cleaner transformer TI when using 22 s.w.g. enamelled wire. In case of such difficulty, 24 s.w.g. wire can be used instead.

We are presently aware of no other corrections pertaining to this project.

MCC Preamp (Jan.)

In January's issue we wrongly stated that the case for the Moving Coil cartridge project was available from Boss Industries. It is, in fact, supplied by West Hyde Developments. Pease use order code Classic II AJD.

Deep Space Probes (Jan.)

Due to poor printing, page 87 of the Deep Space Probes feature last month is difficult to read. If you have an unreadable copy, tear out page 87 and send it to us. We will send back a fresh copy.

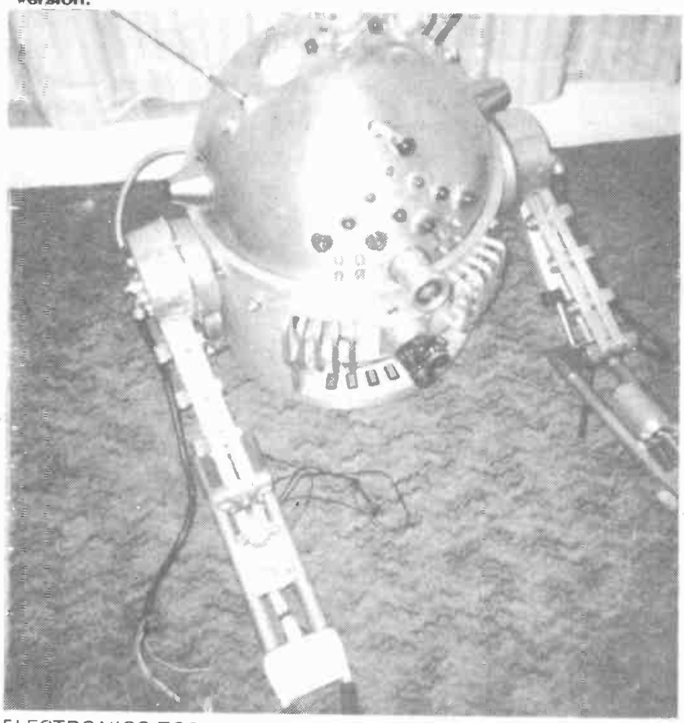
ROBOT PIN~UPS

The response to our recent rallying call to the robot-makers of the UK has been truly astounding. Photos and detailed descriptions of the electronic entities have been pouring through our letterbox ever since.

Necessity, being the mother of invention, seems to have been responsible for the creation of metal men to cope with all those tedious yet absolutely essential jobs — from cutting the grass to frightening cats.

Here are a few of the ingenious creations that have come to our attention so far. Keep sending them in, with as many snaps as your Brownie can manage. Even if your system isn't finished yet, let us know what you're up to.

The Grass Hopper made its television debut in April on Tomorrow's World. Designed by Frank Carver, it's an admirably practical robot for armchair gardeners — it cuts grass. The design team, from Farnborough 6th form college have since produced a Mk 2 CMOS version.



UR700 is equipped with six channel radio and light seeking and line following functions. It can 'feel' its way around using a tactile sensor band around the base.

UR370 started life as a two channel Futaba radio and a pound of splintered balsa wood. Both the UR 700 and its brother, the UR 370 are designed by Joe Gillespie.

◄ This car battery and lawn mower motor powered butler is built from just about everything bar the kitchen sink. It incorporates a lampshade and three huge stewpots. Cyclops 2's arms are driven by six inch hydraulic rams and his nether regions spin round and flash. Cyclops 2 was designed by Steven Brooks.

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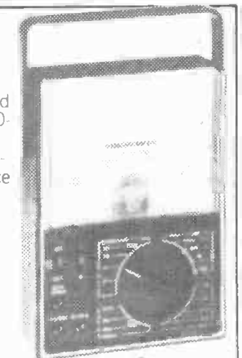

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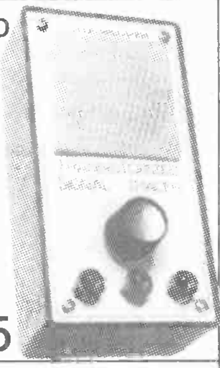

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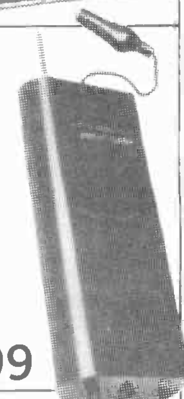

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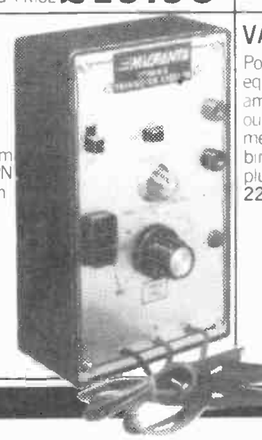

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CASIO FX 502/FA1

Whatever you call this Casio marvel - computer or calculator - it's an attractive little beast! Beguiled by boundless buttons, bewitched by beautious boxes, belaboured Ron Harris reports.

IT is considered good form to be able to define precisely what you are reviewing, before sitting down to churn out the hackneyed prose which will enrage the manufacturer and baffle the consumer. In this case, however, I must confess that I transgress. Why?

Consider this: a computing system with ten program registers, 100 user labels (10 per program), LCD alphanumeric display, cassette dumping, full conditional branching, random number generation, dynamic display control (one second 'PAUSE' delay-stackable) and an excellent number crunching facility. Sounds like whatever it describes is well on the way to being a good micro system does it not?

No, it does not. It sound exactly like the Casio FX502P/FM1, however. (Else why would it be in this review anyway?). Apart from all that the same machine is an excellent scientific calculator and is packed and presented so superbly that I can foresee large numbers of collar and tie impulse buyers trooping home to the missus, wondering how best to explain £100 spent on this calculator set-up that they just *happened* to pick up . . . . . .

The Casio cosmetics inspire one to heights for avarice hitherto reserved for expensive trifles such a cars, hi-fi and precious metals! ▶

Below: the complete Casio package. The two phantom keyboards to the right of the FA1 are the overlays for programmable and music playing usage. Note that the FA1 is an optional extra and you don't get it free with the 502P (shame shame . . .)

Left: the calculator nicely settled into its FA1 tape adaptor. Two slots in the holder engage the black lugs along the calculator sides to ensure a good alignment between the (gold plated) plug and socket.

Big Steps For Man, 256 Steps For...

Before the 502P Casio used their own little FORTRAN based programming language. That is now gone to join the Dodo, and there won't be many mourners I think.

They have returned to a more straightforward assembler type approach, but have an operating system which puts them clear ahead of the opposition. The total 256 steps of program memory is divisible into ten routines, PO-P9, and each can be called as a subroutine within another program, up to four deep.

Puttig a program into memory could not be easier. Set the mode to write — display shows which programs are free — designate (choose PO-P9) and enter just as you would if carrying out the calculation via the keyboard. SINCE there is no absolute addressing, all jumps must be labelled. Most of my programs began with 'LBL 1' just in case . . . . As you've got ten lables per program to play with — splash 'em all over! Correcting listings is easier than ever, the 502 can step forward and backward, single step or fast, and can delete or insert steps and automatically renumber the rest accordingly!

Whats In It For...

The 502 comes with two keyboard overlays — one for program use, one for music use (of which more later) — a program library covering such diverse topics as Surveying and Transistor Amplifier Design (but precious few games), an Operating Manual which is all one has come to expect and detest in such publications and a very smart wallet-type carrying case.

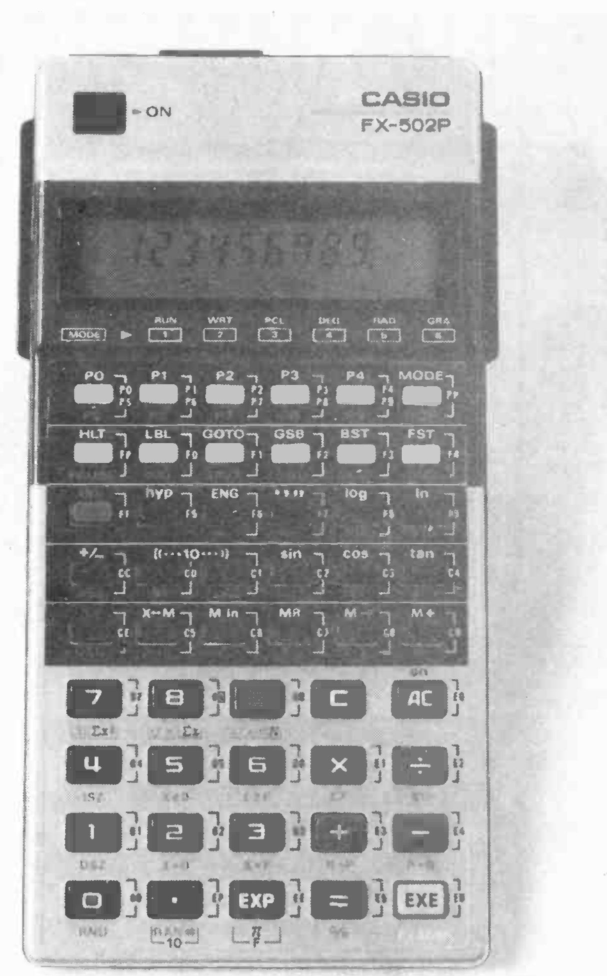
The FA1 cassette adaptor also has a carrying case, manual and short-form operating guide. The construction quality of cassette and adaptor is very high indeed. All in all eleven out of ten for presentation, Casio.

As a scientific the 502P has just about all the functions you are ever likely to consider using. Such statistical creations as standard deviation, mean square sum and data number are all hanging around beneath a key somewhere too, as are 22 non-volatile memories.

Mains operation of the 502P is not possible at all, but battery life is somewhere around 1300 hours (of operating time) and an auto-switch off will turn off the calculator if you leave it on, unused, for more than a quarter of an hour. Eat your heart out Electricity Board.

The display is nothing short of superb. Normally it shows ten digits with two digit exponent, but can be rounded to any number of digits, or switched to scientific, engeering or sexaouesimal (degree) mode. Neat little alpha-numeric prompts appear in the lowest 1/3 of the display to keep you mindful of what you are doing with all this power.

Ten out of eleven as a scientific, Casio.



Right: a 502P fully dressed in its programming overlay. The little numbers beside each key are the check codes used by the machine (and you) in the compliation of a listing. The bottom half of the overlay is clear, to enable the multi-function keys to be read.

Conditional jumping is most comprehensivelyprovided. Six tests can be made — x = 0; X > F; X < F; ISZ; DSZ — and jumps made or not as required. The last two are "increment and decrement jump if zero" commands which are particularly useful.

At each step the display gives last step-number and check code for key pushed at that point. Tis check code is alpha-numeric and corresponds to the programming overlay: After a few times through you get used to most of the codes and things (as always) improve with practise.

If the conservative 256 steps are not enough for you then the FA1 allows you to dump programs into a cassette player. Load times are pretty short so that over 100 programs could be lumped onto a C-60, PER SIDE!

Measure Of Tape

The FA1 terminates in a set of twin jacks, which should fit most portable cassette players, but will require an adaptor to fit most hi-fi decks. A few minutes with the soldering-iron might be preferable, though.

Programs are given three digit file numbers for both SAVE and LOAD operations and the machine will search the tape until it finds the required number to load. The really nice touch about this is that programs and data are stored separately, so that different data can be run through the same program, and sub-routines extracted to be added to existing listings within the calculator. Frighteningly flexible.

This brings me on to the music playing facility of the 502/FA1 combination. I cannot ignore it any longer, I suppose. All I shall say is that I consider it an insult to the intelligence of anyone buying such a calculator. What does it sound like, you may ask. Horrendous I might say. Is it entertaining, you might ask. Boring, I might say.

Thus we could deal with the thing in one paragraph. Yeuk!

I found no problems loading and saving programs from the FA1 at all, and consider it a good system. Keep the volume turned up full on the tape through.

Summing It All Up

Overall then the new Casio has a lot going for it. A beautifully elegant programming system and a good scientific ability. Coupled to a tape through the FA1 it becomes an unequalleld way to get some real computing power into your life at a reasonable price. Also an excellent way to earn basic programming techniques, as the machine steers you toward modular programming almost instinctively.

Against it stands the monument to ineptitude that is the Instruction Manual. Please Casio, you sell yourselves short here. The 502P is a magnificent piece of work but why why why why why make it rise against a manual like this?

Other minor quibbles — although the display has alpha-numeric capability (it shows the check codes doesn't it) the user is denied access to anything but numbers. Why not let us loose upon the full ASCII set, eh? Make for much more interesting programs. And since we have a *little* brother (FX501P) with 128 steps, can I request a world conquering FX-503P with 1000 steps and absolute addressing please?

Our thanks to TEMPUS of Cambridge for supplying the review machines to us. Prices for the FX502P and FA1 are £74.95 and £19.95 respectively, although for a limited time TEMPUS will sell you the pair plus a Masterpack — a software pack of 150 programs on cassette — for £99.90 all inc. Tempus, Beaumont Centre, 164-167 East Road, Cambridge CB1 1DB.

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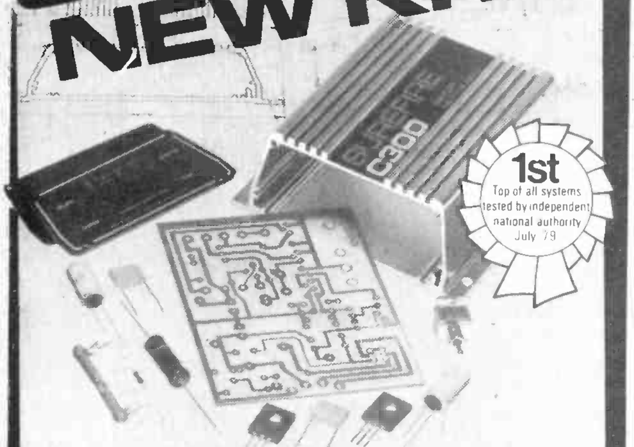

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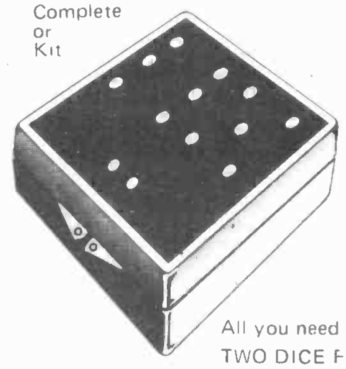

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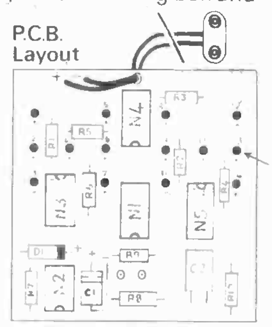

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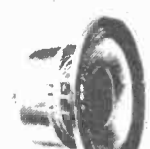

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1. They can be used in any class of operation (A to D) due to the advantages of enhancement-mode operation.

2. They have excellent linear transfer characteristics. Fifth order inter-modulation distortion figures are typically eight to ten dB better than bipolars.

3. The drain temperature coefficient has a negative characteristic which prevents thermal runaway. VMOS devices may be easily paralleled and will current share automatically.

4. VMOS devices have no minority carrier storage time thus allowing efficient class D operation as switching times are up to 200 times faster than bipolar devices and there are no switching transients.

5. They are, by virtue of their construction, protected against infinite VSWR problems.

6. They have a high source-drain breakdown voltage.

7. They have low gate-drain feedback capacitance. This characteristic particularly suits VHF/UHF operation.

8. Low noise figure: 2.5dB is typical. A power amplifier can be used as a low-level amp as well

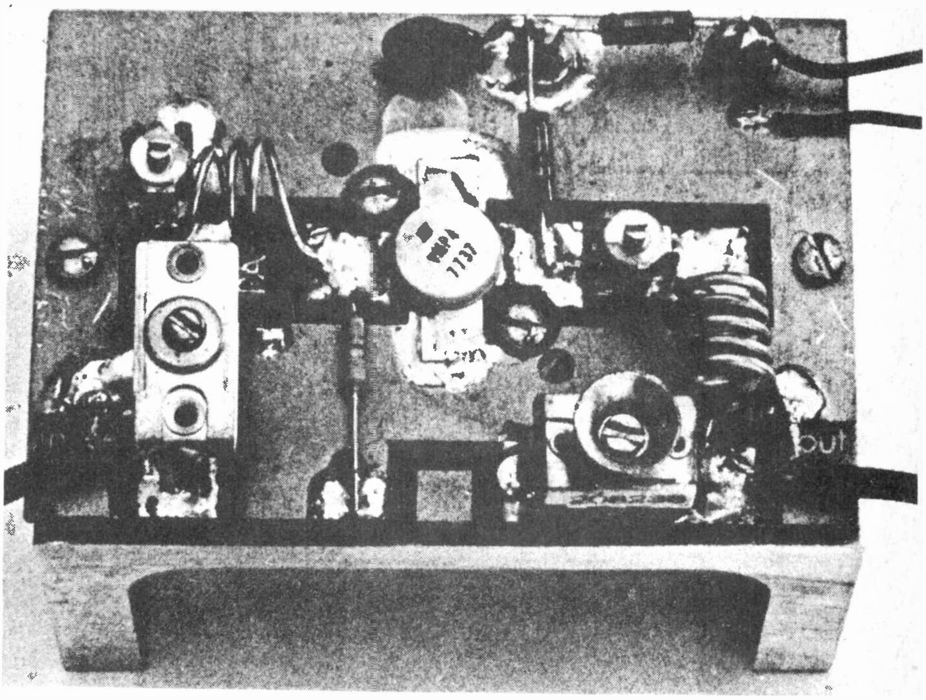
9. Wide bandwidth and uniformity of characteristics across frequency range.

10. Higher gain than bipolars of equivalent power dissipation rating.

SPECIFICATION

Saturated output power:	**Vd of 24 volts – 16 watts (13.5 watts specified)**
	Vd of 36 volts – 22 watts (21 watts specified)
Power Gain:	**Vd of 24 volts – 11.2 dB at 10 watts output (10 dB @ 200 MHz specified)**
	Vd of 36 volts – 11 dB at 18 watts output.
Efficiency:	**53%**
Input VSWR:	**less than 1.5:1.**

The prototype was unconditionally stable without neutralisation.



HOW IT WORKS

The amplifier described here will produce 10 watts output on the amateur two-metre band from a drive of less than one watt, using a 24 volt dc power supply It can be operated in either class AB or C modes for SSB or FM applications. At a supply voltage of 36 volts (recommended maximum) the prototype delivered 22 watts of RF power driven by around two watts.

The amplifier was unconditionally stable and required no neutralisation, although the manufacturer recommended it. Typical efficiency should be greater than 50%, comparable to bipolar designs for this power level.

The device used is a Siliconix VMP-4, the circuit is shown in Figure 1. Conventional matching was employed with values calculated from data given in reference 1. Input and output impedances of the VMP-4, S_{11} and S_{22} respectively, were taken from the manufacturer's data sheet.

The neutralisation circuit, as recommended by Siliconix, shown in the circuit, was found to be unnecessary on the prototype and could probably be left out in many cases. If your amplifier proves to be unstable it may be added after construction and testing as it is quite a simple matter.

For class AB operation, bias is applied from a simple zener regulator through a pot. and resistor to the base (no messy base chokes!).

In class C operation, the 4k7 base resistor is simply earthed. RF Chokes RFC1-RFC2 are 1 uH miniature moulded chokes.

The VMP-4 is an SOE (stripline opposed-emitter) package device with flange, rather than stud, mounting.

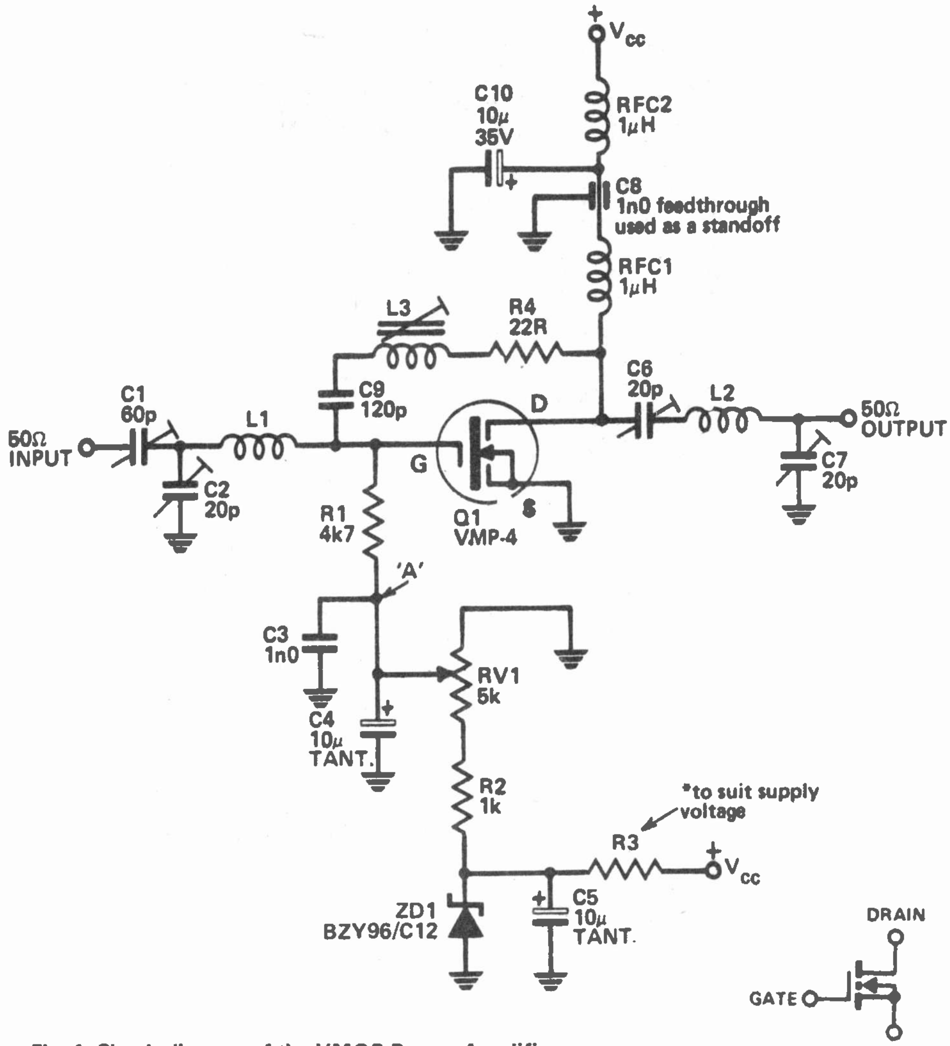
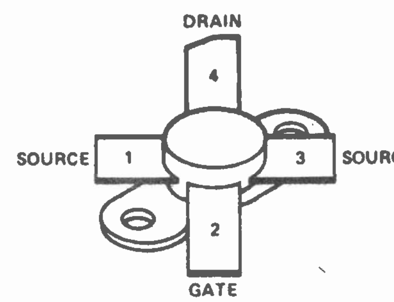


Fig. 1. Circuit diagram of the VMOS Power Amplifier.



	Characteristic	Min	Typ	Max	Unit
BV_{DSS}	Drain-Source Breakdown	60			V
$i_{D(on)}$	ON-State Drain Current	400	600		mA
g_{fs}	Forward Transconductance	170	240		m℧
C_{oss}	Common-Source Output Capacitance			34	37
C_{iss}	Common-Source Input Capacitance		32	35	pF
C_{rss}	Reverse Transfer Capacitance		4.8	6.5	
G_{ps}	Common-Source Power Gain	10			
NF	Small Signal Spot Noise Figure		25		dB

11. Input and output impedances generally higher than equivalent bipolar devices making matching easier.

High power MOS devices were pioneered in the mid-1960's by RCA laboratories who managed to produce an amplifier that delivered up to 14 watts at 10 MHz. The Russians next achieved 1 watt at frequencies up to 100 MHz.

Recently DMOS (double-diffused MOS) was developed in Japan and commercially produced by Signetics.

The performance of these early types of MOS technology has been surpassed by VMOS which can offer higher power levels by virtue of its inherent improved thermal transfer in the chip construction.

Several companies have developed VMOS devices for communications applications. These are: Westinghouse, Siliconix and the Communications Transistor Corporation. Other companies, such as Fairchild, have confined their interests to fast switching devices.

Construction

Commence construction by drilling two holes diagonally opposite the transistor mounting hole, as shown in figure 2 and the photograph, to clear the mounting bolts for the transistor flange. A small file should be used to elongate the holes.

Drill two holes in the heatsink to accommodate the transistor flange securing bolts.

Next, carefully solder the VMP-4 to the copper side of the PC board taking care that the orientation is correct:

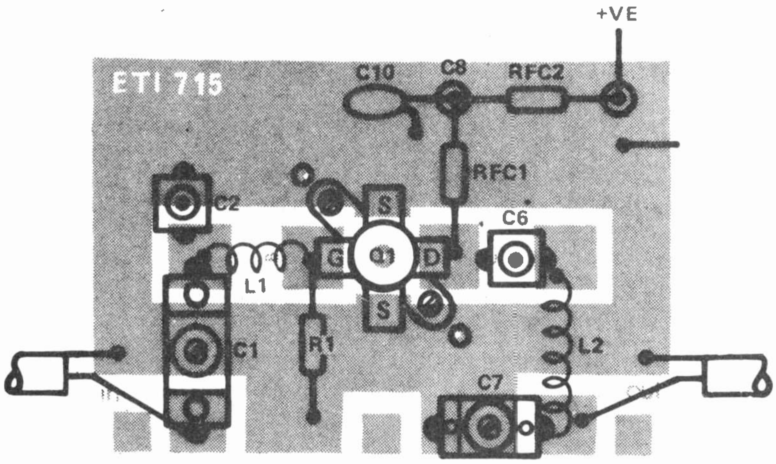


Fig. 2. Component Overlay.

NOTE: The bias and neutralisation components are not shown on the overlay. Neutralisation was not found to be necessary on the prototype.

If bias is required for linear operation R1 should be fed to the bias supply and this point by-passed through C3.

Coil Winding Details

L1	5 turns 18 B+S (19 SWG) tinned copper wire 6mm inside dia. 10mm long.
L2	3 turns 18 B+S (19 SWG) tinned copper wire 6mm inside dia. 6mm long.
L3	4 turns 26 B+S (27 SWG) enamelled wire wound on Neoside L1010 former with F29 slug.

BUYLINES

The only component liable to tax the intending constructor is the VMP4. All the rest are fairly standard stuff, and people like Catronics, for example, will have stocks.

The VFET itself is available from P. Rimmer at 367 Green Lane, N4 1DY or Ambit International. Check with them for prices before ordering.

PARTS LIST

Resistors All ¼W, 5% unless stated	
R1	4k7
R2	1k0
R3	to suit supply voltage
R4	22R
Potentiometer	
RV1	5k linear
Capacitors	
C1	60p mica compression trimmer, or miniature film trimmer
C2	20p miniature film trimmer
C3	1n0 ceramic
C4,5	10u tantalum
C6,7	20p mica compression trimmer or miniature film trimmer
C8	1n0 feedthrough, used as standoff
C9	120p ceramic
Semiconductor	
Q1	VMP-4 (Siliconix)
Miscellaneous	
RFC1,2	1u miniature moulded RF chokes
heatsink to dissipate 20W nuts, bolts, wire, etc.	

gate to the input side, drain to the output side.

All the minor components may then be soldered to the board. Wind and mount the two coils L1 and L2 last.

Take care when mounting the board assembly to the heatsink. Secure the VFET flange-mounting bolts first. These could be tapped into the heatsink (as we did with the prototype) or secured by nuts through the other side of the heatsink.

The board should be secured, and at the same time grounded to, the heatsink by two bolts. These were placed at each end of the board, simply for convenience, and a suitable number of washers placed between the board and the heatsink so that the board was firmly secured without placing strain on the VFET leads.

Input and output switching, if required, may be effected by diode switching or a carrier-operated-relay circuit.

Tune Up And Test

Once construction is completed, and you have checked that all is correct, testing can commence.

A variable supply with a current limiting facility is suggested for initial test and tune up. Bias is not necessary at this stage.

Connect the output to a dummy load and some RF power measuring device. Apply supply voltage and then drive power. Tune for maximum RF output! This should correspond with a peak in drain current. If 'funny' things happen here then suspect positive feedback and install neutralisation.

It's dead simple. However, take care not to grossly overdrive the device — VFETS do not take kindly to this sort of abuse. Becoming the owner of a four-legged stripline fuse can be a chastening experience!

For class AB linear operation, bias should be set to provide about 100 mA quiescent drain current, subsequently adjusted for best performance.

Some adjustment of the input network was required on the prototype suggesting that the input impedance, S_{11}, of the particular VMP-4 was lower than indicated on the data sheet. ETI

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BUGGED BY INTERFERENCE?

You can banish the demon hum from your sounds if you know what you're looking for.

The most common irritant in hi-fi systems of any performance or cost standard is almost certainly hum, that horrible, low pitched noise which strikes almost every system at least once in its life. In fact, the only good thing that can be said about hum is that it is not selective; it will strike both amateur and professional equally.

And the most aggravating thing about hum is the trouble that it may cause — not that it will normally damage components unless extremely bad, but because it may sometimes take hours of concentrated searching to track it down. Until the cause is located and the problem corrected, satisfying listening is impossible.

What is Hum?

Once hum has been heard it is unmistakable. It is also difficult to describe. Typical textbook descriptions run pretty much as follows: 'HUM — an unwanted low-pitched sound produced in reproduction by an interference from the AC mains. It usually occurs at the mains frequency of 50 Hz, or at its second harmonic, 100 Hz. Can be caused by . . .", and then follows a list of about a dozen typical causes.

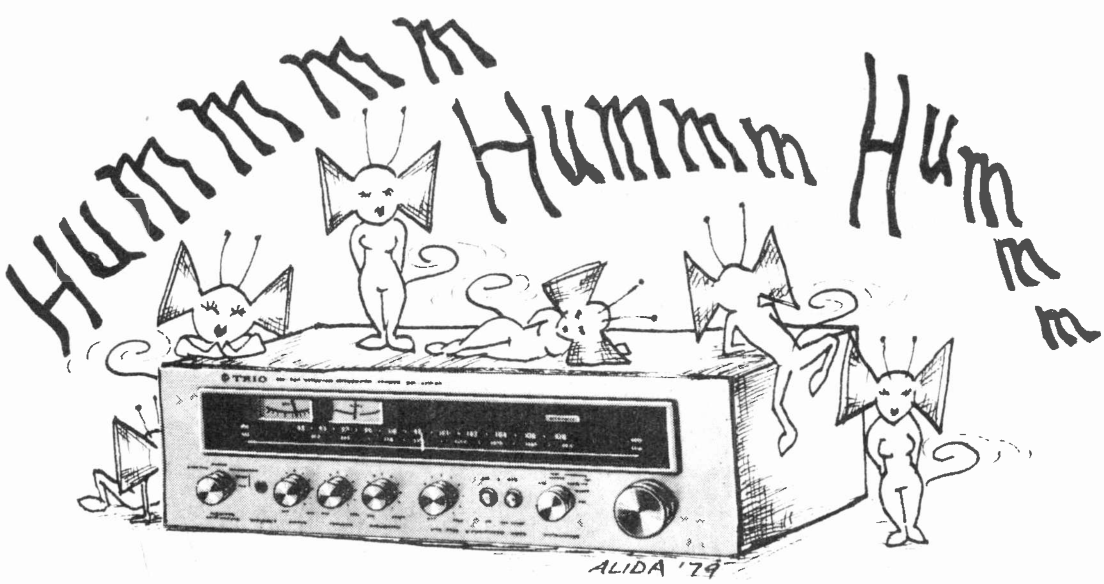
In spite of the rather open-ended descriptions, hum is immediately recognisable.

Its causes are not so easily pinpointed, although the sources of hum found in hi-fi systems can usually be traced back to any one of three chief sources — loops, screening and induction.

Hum generally affects low level signals with high circuit impedances — so the pickup cartridge and its associated signal connections are the prime offenders. The high gain of this circuit, and the large amount of bass boost applied in the RIAA equalisation, make it exceptionally prone to hum from any of the various causes.

In Britain, the AC mains power supply is a nominal 240 volts, alternating with a frequency of 50 Hz. Wherever these voltages occur, the mains conductors are surrounded by electrostatic and magnetic fields which fluctuate at the same frequency. With a voltage as high as 240 volts, these fields are fairly intense and can produce hum by inducing tiny AC currents in surrounding wiring and components.

Occasionally hum may arise from a faulty component in some piece of equipment, but most problems come from the linking and positioning of the hi-fi components.



Hum-bugs can strike ANY system, with no regard to make or quality!

Loops

Earth loops are possibly the most common cause of hum, and are the most annoying in that they are frequently caused by taking too much care! They are formed by duplicating earth links between components — a real trap for beginners attempting to set up a foolproof system.

The problem arises when the earthed screen of a signal carrying lead is correctly earthed, but an additional earth link is formed between the two components. The separate earth link may be redundant, in which case it forms an electrical loop.

If there are slight potential differences at the earth points, or if the loop falls within a stray magnetic field, a tiny circulating AC current will start to flow within the loop. This current affects the audio signal carried in the central core of the conductor by adding unwanted components to it, and hum results.

Hum loops can be particularly annoying!

Sometimes the loop may be formed through no fault of the person assembling the system. When the earthy sides of the signal connectors on the amplifier (or other component) are linked internally to form a common ground, a loop is very easily completed.

Troublesome loops are known as 'earth' or 'hum' loops, and although they are the common cause of a great many problems, their source may well be different in each case, and their cure may take considerable time and careful thought.

The ideal interconnecting system between any two components conveys the signal and the earthy (signal return) conductors for each channel by only one path — via a live and an earthed conductor. Separate earth connections should be used only to earthed metalwork which is not connected to the signal carrying circuits. Because of this pickup arm on a turntable is earthed separately without causing hum loop problems.

In these cases earthing may be essential to draw off any leaked voltages or static build-up directly to the mains earthing point. If these spurious voltages were carried via the signal earth leads, they too could cause interference with the audio signal.

Curing Earth Loops

As hum loops are set up when there is a redundant earth connection, they can be cured by breaking the loop — that is, by removing the redundant earth.

The process of tracking down a hum loop problem is rather long and laborious. If the majority of connections are made by RCA-phono plugs and sockets, it is rather more simple than when DIN connectors are used.

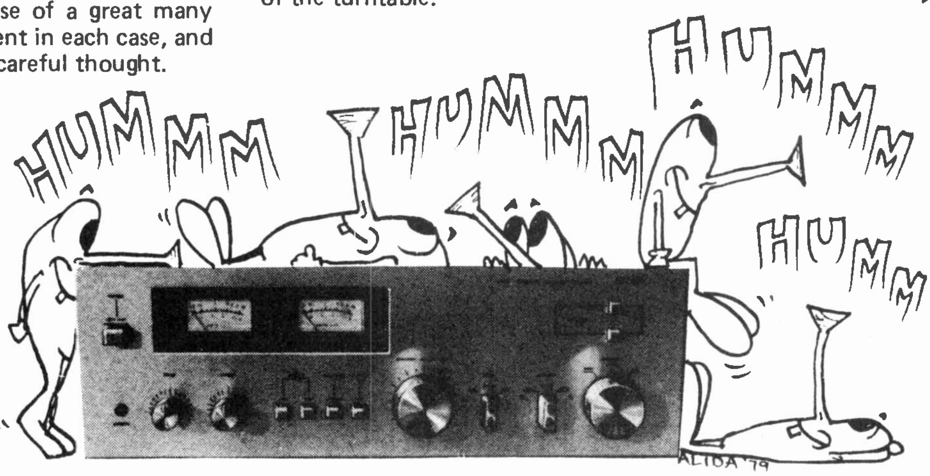
Start by disconnecting all inputs to the amplifier except for the separate earth link between the turntable frame and the amplifier's chassis. Connect one channel of the turntable and note the hum level. Try pulling the plug slightly out of the socket so that the outer rim doesn't still make contact. If the hum is now worse, push the plug fully home — excessive hum indicates that the rim contact is not redundant but is needed for shielding. If, however, the hum is reduced with partial connection, leave the plug as it is — this earth is redundant.

Now check the second channel from the turntable in the same way. If the hum is still present in spite of these checks, try removing the separate earth link from the frame of the turntable to the amp. It is unlikely that this will be redundant, as ideally it should be isolated from the signal carrying components. In rare cases, however, its removal may help.

Continue this checking process in the same way for all inputs, until you are sure which earth links are redundant and may be disconnected permanently.

DIN connectors pose more of a problem, and unless you are sure of your ability with a soldering iron it will be better to check only the auxilliary earth connections, and then investigate to see if the problem lies elsewhere.

When working through the checking procedure, make sure that the amplifier's volume control is turned down whenever making or breaking contacts. High level transients are easily generated, especially when checking for loops in the vicinity of the turntable. ▶



As the amplifier is the control centre of a system, central earthing is best carried out at this point to avoid loops. Only use single earth wherever possible

Electrostatic Hum...

Because of the fairly intense electrostatic fields surrounding mains supply cables, any signal-carrying leads within such a field may be affected, because of the capacitance across the space between the cables. The higher the circuit impedance, and the lower the audio signal level, the more likely the occurrence of hum breakthrough.

This problem is generally overcome by the use of an earthed shield around the signal carrying conductors — hence the almost universal use of shielded leads for connections between components.

The screen must be arranged so that the live conductors are shielded by some earthed metal at all times — it will be seen when looking at RCA or DIN plugs and their appropriate sockets, that this requirement is fulfilled. It is to prevent this type of hum that almost all signal carrying leads between components in a hi-fi system use a shielded cable.

The shield, or braid, should itself be insulated so that it doesn't inadvertantly contact any other earthed metalwork. If this happens, the earth bypass created will form an earth loop to bring even more hum.

The only components which do not require shielded connecting leads for the audio signals are loudspeakers, which are fed by high level signals via a low impedance circuit.

...And The Cure

The most obvious cure for hum of this sort is prevention. Any signal-carrying lead should be kept well clear of all mains supply cables, and should also be kept as short as practicable. However, as electric fields are coupled by capacitance, and the effects diminish as distance increases, length should not be sacrificed unnecessarily. Never lengthen the connecting cables supplied with a turntable, however, as this will degrade the unit's performance.

Mains cables should consist of twisted conductors or, when using two core mains leads, parallelled conductors so that the fields are reduced by cancellation.

If it can be established that hum is caused by some form of electrostatic breakthrough, but it is not practicable to move the offending cables, a form of shielding may be required between the mains cables and the signal leads. Any earthed metal should service the purpose — provided any signal leads and thus set up an earth loop.

When turntable hum is the problem, a trick of the trade which works in a surprising number of cases (with turntables fitted with two pin mains plugs) is simply to reverse the two pin mains plug in the power outlet — whether at the mains or at the amplifier's mains outlet. By transposing the active and neutral conductors in this way, it is sometimes possible to reduce the field that may occur around a switch, or some other internal device which is sufficiently close to the pickup, or to signal leads, to cause problems.

It is also worth experimenting with different routes for the signal cables — keeping them well clear of any cables carrying mains voltages. Make sure that any mains conductors are kept well away from the pickup cartridge.

Turntables and associated equipment are partciularly prone to hum in all its infuriating forms. This is due to the high impedances in this part of the circuitry and the bass boost applied by RIAA correction. Make sure for starters that the turntable is not earthed twice through the signal leads and its own leads. Some cartridge manufacturers earth the metal of the body to one channel of the system and if you get mono hum in one speaker have a look at the back of your head! (cartridge wires therein)

While it may be an advantage to use earthed metal equipment cabinets as a shield against induced electrical hum, this is not possible when the cabinet is electrically connected to the equipment's chassis. In this situation, any separate earthing of the cabinet will form a hum loop — the cure may be worse than the original sympton.

Hum fields exist around mains transformers and AC mains wiring in general. If sensitive equipment — unscreened — is placed near enough humbugs will immediately surround it making life unbearable

Magnetic Induction

Transformers and electric motors operate within powerful magnetic fields which are generated by passing the mains current through the windings of a coil. It is very difficult to contain that magnetic fields that occur around transformers or turntable motors, and they tend to spread out beyond the immediate vicinity of the device. Any coils (including earth loops) or windings used in signal carrying components which do fall within the stray magnetic field, are very prone to hum pickup of this type;

The earthed shield used to prevent hum from electrostatic fields is unfortunately no barrier to a magnetic field, and special metallic shielding — such as mu metal — must be used.

The components which are most susceptible to magnetic hum induction are the pickup cartridge and the magnetic heads on a tape recorder — low level devices which rely on magnetic coupling for their operation.

Generally tape heads are shielded by the internal design and layout of the recorder's electronics. However, the pickup cartridge by its very design and performance requirements must be close to the turntable's motor. While most good turntable motors do not give trouble, cartridges do vary in their sensitivity to magnetic fields, and troubles may occur when least expected.

In spite of any design features or in-built shielding included to prevent the breakthrough of magnetically induced hum in turntables and tape decks, these units should be kept as far as possible from the power transformers of amplifiers, tuners and other components.

Curing Magnetic Hum

The most common problem with magnetically induced hum is found around the pickup cartridge. To cure this hum it is necessary first to establish the cause.

If you suspect that the turntable motor is the cause of the problem, try switching the motor on when the arm is at different points across the turntable. If the hum appears and disappears as the motor is turned on and off, then the motor is the culprit.

It will be possible to tell where the problem is worst, and the only cure in some cases will be to relocate the arm. If this is impossible, as it would generally be with automatic and semi-automatic arms, it is necessary to look to some form of magnetic shielding.

If hum levels change with the position of the arm across the platter — even with the motor switched off — it is probable that some nearby component is the cause — possibly a power transformer in the amplifier or some other component nearby. Try changing the position of the turntable relative to the other components — sometimes a slight change in orientation is all that is needed.

Similar experiments will be required if the hum occurs in a tape deck, although this is only likely to occur when the equipment is mounted in a confined space such as an equipment cabinet.

Halting Hum

The search for the source of a hum may take a great deal of your time and when hum problems do arise, you must be prepared to devote several hours to the hunt. It is certainly worthwhile — you will not get any easy listening until it is found.

Remember that hum rarely comes from a faulty component so it is unlikely that you will banish it simply by buying replacement components.

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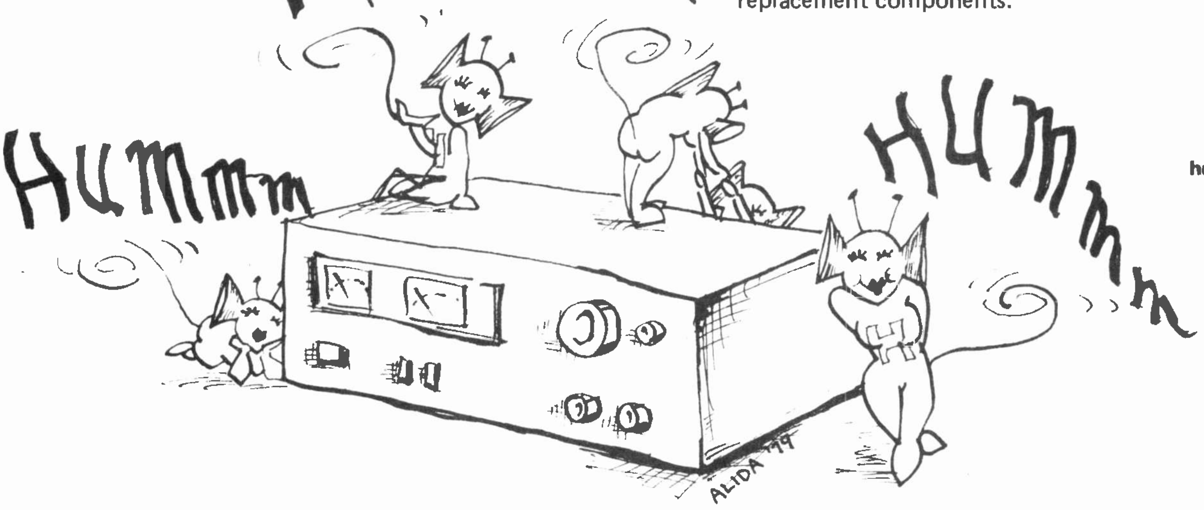

Don't let the hum-bugs get the last laugh! Follow the rules given here and MAYBE you'll get away hum-free!

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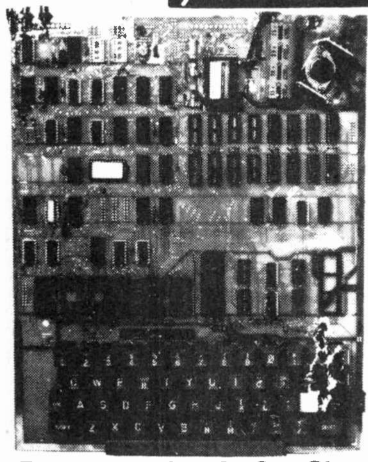

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74LS245	2.50
74LS247	1.09
74LS248	1.09
74LS249	1.09
74LS251	0.96
74LS253	0.92
74LS257	0.92
74LS258	0.92
74LS259	1.39
74LS261	4.50
74LS266	0.37
74LS273	1.70
74LS279	0.57
74LS283	1.09
74LS289	4.50
74LS290	0.91
74LS293	0.91
74LS295	1.30
74LS298	1.16
74LS348	1.39
74LS352	1.04
74LS353	0.92
74LS362	4.21
74LS365	0.47
74LS366	0.47
74LS367	0.47
74LS368	0.47

74LS373	0.78
74LS386	0.36
74LS393	0.84
74LS668	1.17
74LS670	1.71
74500	0.56
745262	15.85
745374	12.84
745387	2.33
745472	14.35
745474	11.24
75107AJ	1.52
75107BJ	1.52
75108AN	1.30
75182	1.52
75452A	0.43
75L90J	2.25
TTL	
7400	0.10
7401	0.10
7402	0.10
7403	0.11
7404	0.12
7405	0.13
7406	0.21
7407	0.21
7408	0.12
7409	0.13
7410	0.11
7411	0.17
7412	0.13
7413	0.19
7414	0.40
7416	0.19
7417	0.25
7420	0.10
7423	0.18
7425	0.18
7426	0.18
7427	0.25
7428	0.29
7430	0.10
7432	0.18
7437	0.19
7438	0.19
7440	0.16
7441	0.46
7442	0.35
7445	0.56
7446A	0.56
7447A	0.40
7448	0.49
7450	0.10
7451	0.10
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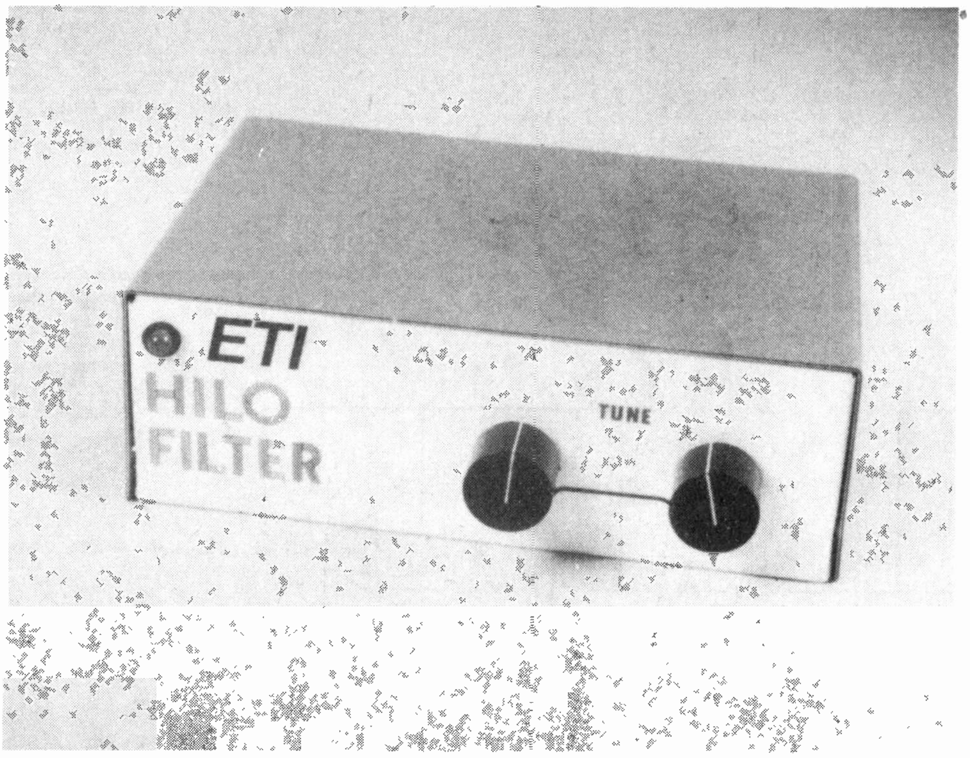
HI-LO PASS FILTER

Are you in the depths of despair because your highs are hissy, or because your laws are rumbly? Then you need the ETI Hilo Filter to remove your extremities - without anaesthetic.



We can hear you all now, saying to yourselves in unison simultaneously and all together — GOSH, is there no end to the ETI Project Team's ingenuity? Whatever will they come up with next? Well this really is the ultimate in audio gadgetry — a rumble and scratch filter that one can tune to suit an individual rumble or a personal scratch. Speaking for ourselves, we only scratch when there is no-one around anyway, it's bad manners to do otherwise.

The ETI HILO FILTER essentially consists of two separate filtera, a variable high pass and a variable low pass filter in series, which together form a tunable bandpass filter, whose cutoff frequencies at each end of the audio spectrum can be adjusted by varying the cutoff frequencies of the individual filters.

The cutoff point of the high pass filter is variable between about 235 Hz and 2.8 kHz depending on the setting of RV1. At all frequencies above this the filter operates as a unity gain buffer. The effect of this part of the whole circuit is to quite adequately filter out all low frequency oscillations and tremors which go under the heading "rumbles".

The low pass filter functions in just the opposite mode, in that it filters out all frequencies above its cutoff point (variable between about 2.2 kHz and 24 kHz dependent on RV2).

Unwanted tape hiss and record scratches can be filtered out with this part of the circuit. Frequencies below the cutoff point are buffered with unity gain.

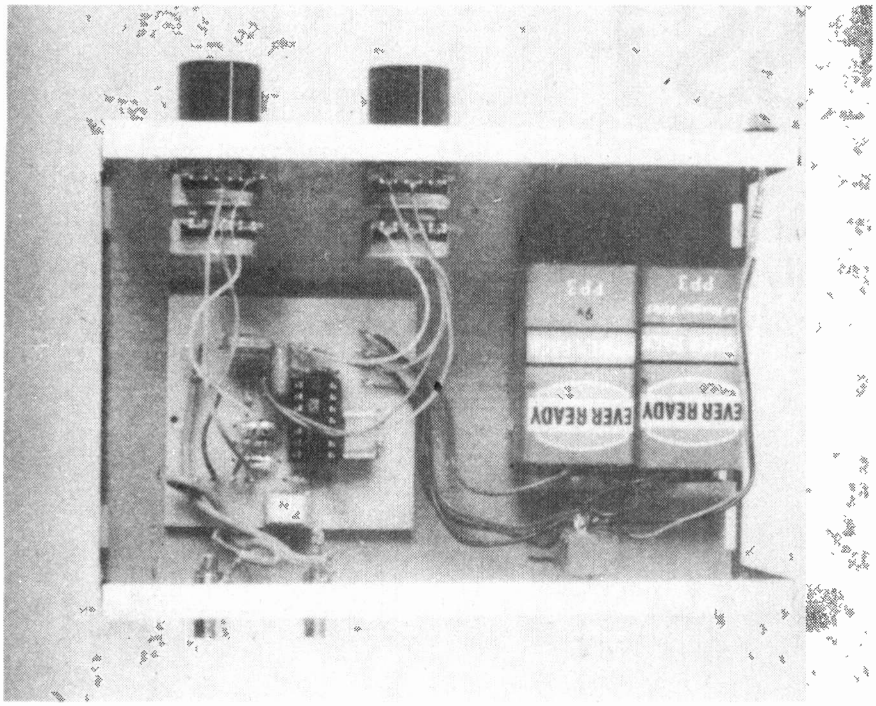
For the technically minded we can say that both filters are second order filters giving a cutoff rate of 12 dB/octave below or above the consecutive filter points.

Construction

The circuit really is so simple that very little need be said on construction techniques. The only area of possible difficulty might be encountered in the wiring up of the two potentiometers RV1 and RV2. Both are dual ganged types and obviously require to be wired correctly for proper function. Work from the circuit diagram and follow the wiring carefully. If the circuit does not work first time, it is more than likely that this is the area of fault.

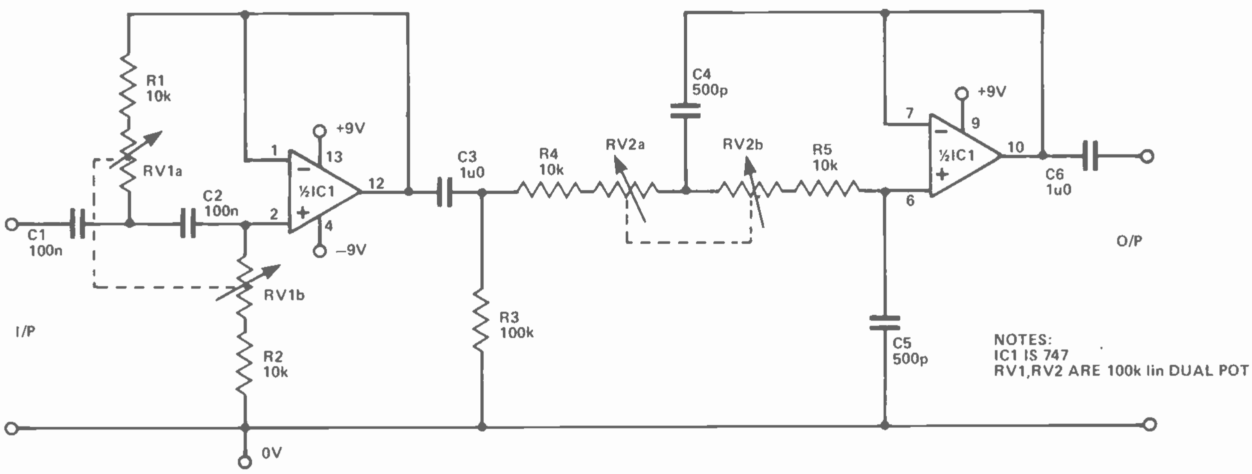
We build our filter into a box but this is not strictly necessary. You can build the board into your own system and run the filter from a mains/DC power supply (up to ± 15 V), which will save the expense of batteries, if you wish.

▶



The internal photograph (left) shows the completed PCB installed in its case and the connectors to the batteries and front panel controls. Two PP3s will give sufficient power for satisfactory operation. We have taken the outputs to two phono sockets on the back panel.

Fig. 1 (below) shows the circuit diagram. RV1 and RV2 are both ganged potentiometers.

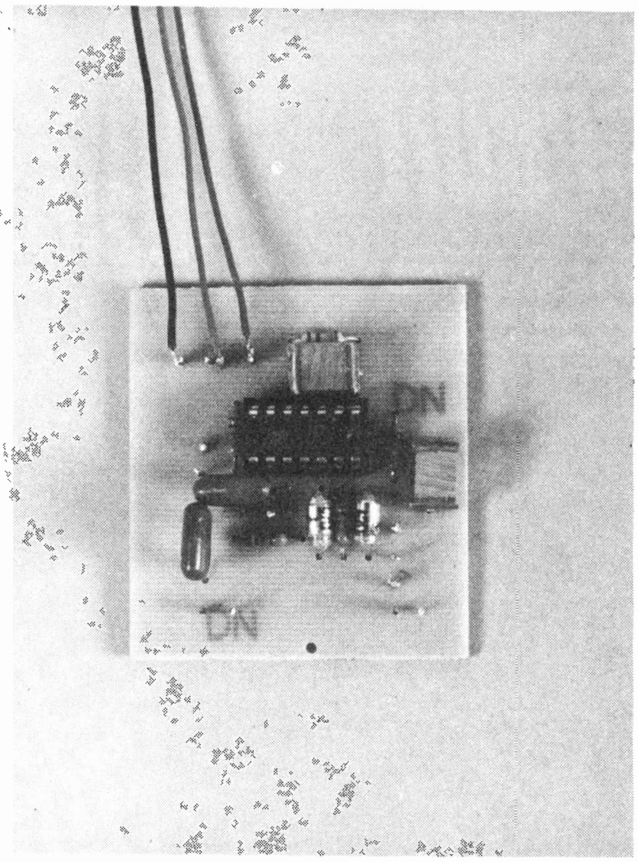


HOW IT WORKS

The high pass filter gives a frequency response as in the graph of Fig. 1. The response of the circuit can be seen to fall off below about 235 Hz. Adjustment of RV1 can alter the response to that of the broken line or any position in between.

Similarly, the low pass filter shows a frequency response as in the graph of Fig. 2. Adjustment of RV2 alters the cutoff frequncy 2.2 kHz and 24 kHz as shown by the broken and full lines of the graph.

When the two filters follow each other as in our circuit the overall response curve is simply a combination of the two diagrams of Figs. 1 and 2.



You shouldn't find this PCB (above) very taxing to construct. It may be small, but the mighty mica morsel banishes hiss and rumble a treat.

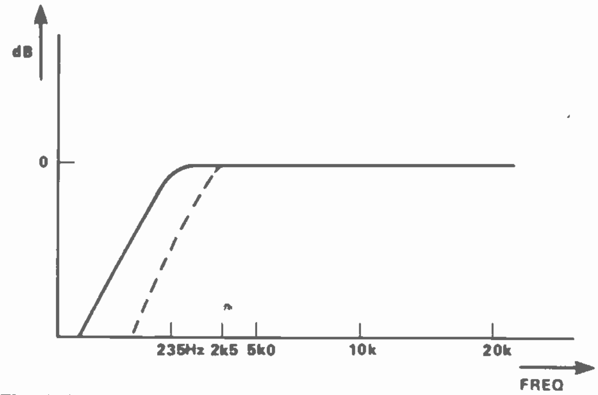


Fig. 1. The frequency response of the high pass filter. The response falls off below about 235 Hz.

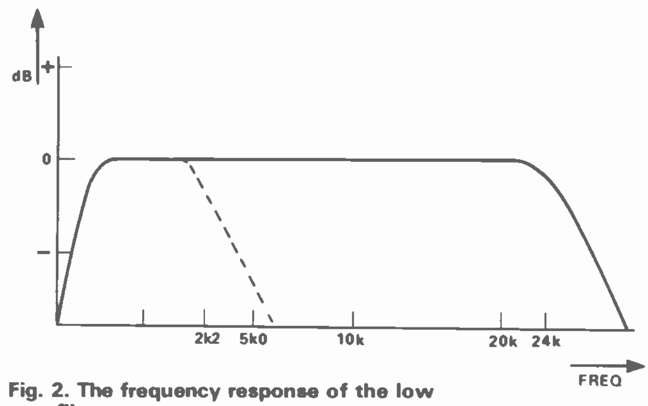
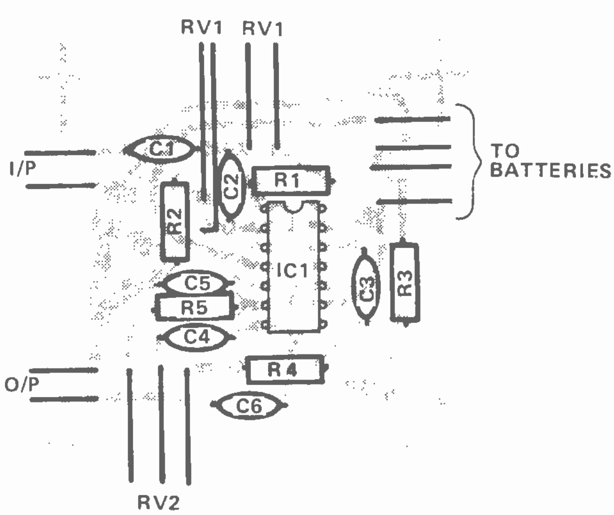


Fig. 2. The frequency response of the low pass filter.

Fig. 2 (below) shows the Hi-Lo Filter component overlay. The capacitors go in two by two — two polyester, two polycarbonate and two polystyrene.

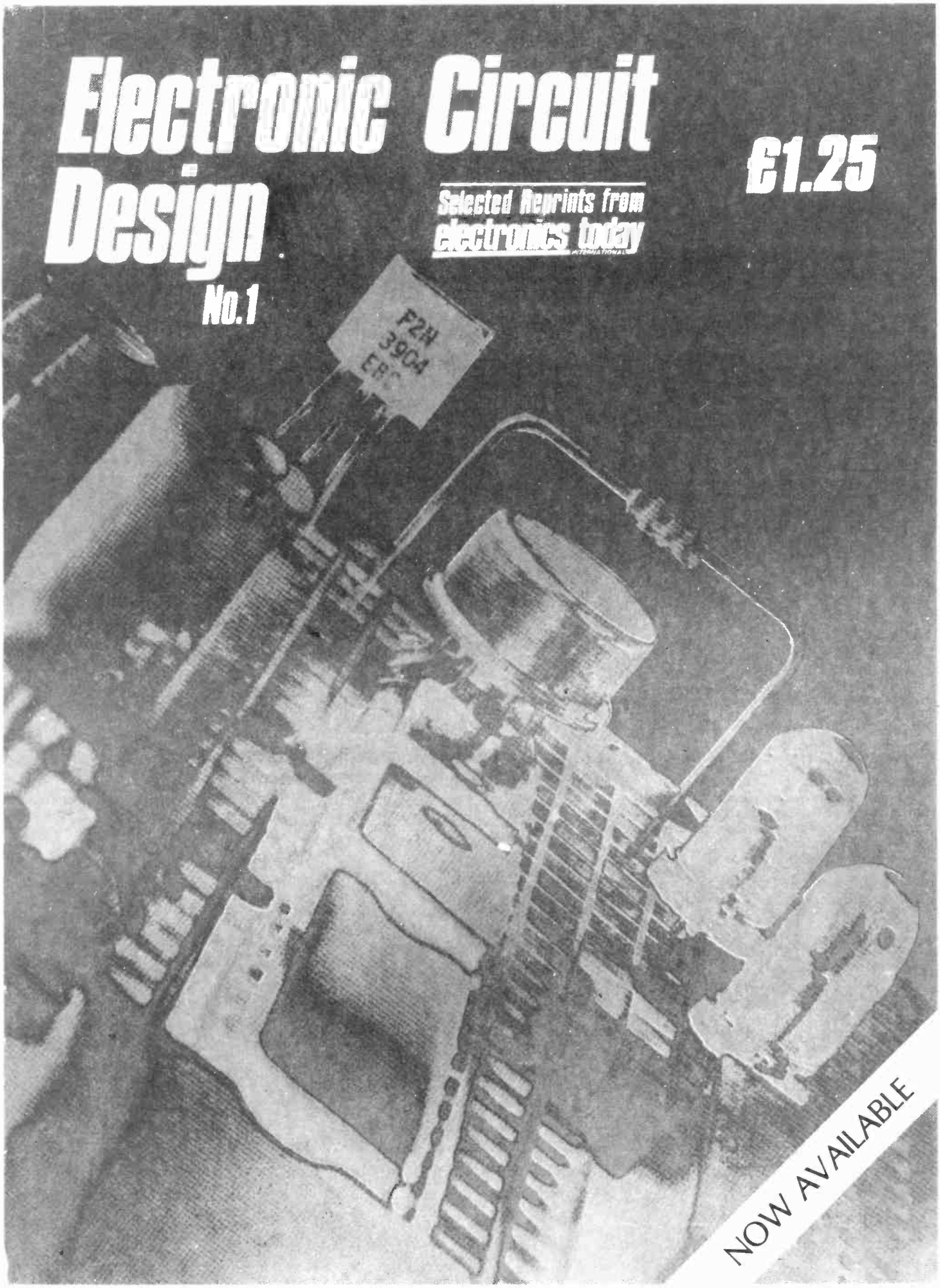


BUYLINES

There should be no difficulty at all in obtaining any of these components as the ETI HiLo Filter is made from standard components.

PARTS LIST

RESISTORS (All ¼W, 5%)	
R1,2,4,5	10k
R3	100k
POTENTIOMETERS	
RV1,2	100k lin dual ganged
CAPACITORS	
C1,2	100n polyester
C3,6	1u0 polycarbonate
C4,5	500p polystyrene
SEMICONDUCTORS	
IC1	747 (Dual 741 op amp)
MISCELLANEOUS	
2 x Battery clips type PP3 I/P and O/P connectors	
Case to suit (if required)	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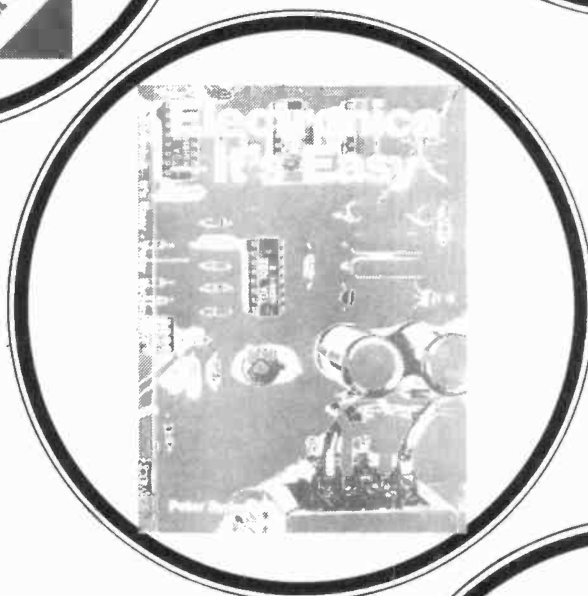

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Book 5: £1.00 + 25p P&P
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Book 6: £1.00 + 25p P&P.
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FROM ETI

CMOS 555 APPLICATIONS

Tim Orr brings you the result of bipolar versus CMOS in the 555 league

The bipolar 555 timer chip has been around for many years, but there is now a CMOS version that has some very significant design improvements. The two devices are functionally very similar, being interchangeable in most applications. The operation of the 555 is very simple, (Fig. 1). It consists of a pair of comparators that operate at ⅓ and ⅔ of the supply voltage, this being set up by a resistor chain. These comparators set and reset a flip flop which in turn drives the output stage. A second output is available which is an electronic switch, (Discharge) to ground. Other features include access to the resistor chain via the control voltage pin and an extra reset input to the flip flop. This simple network readily lends itself to all sorts of oscillators and timer circuits.

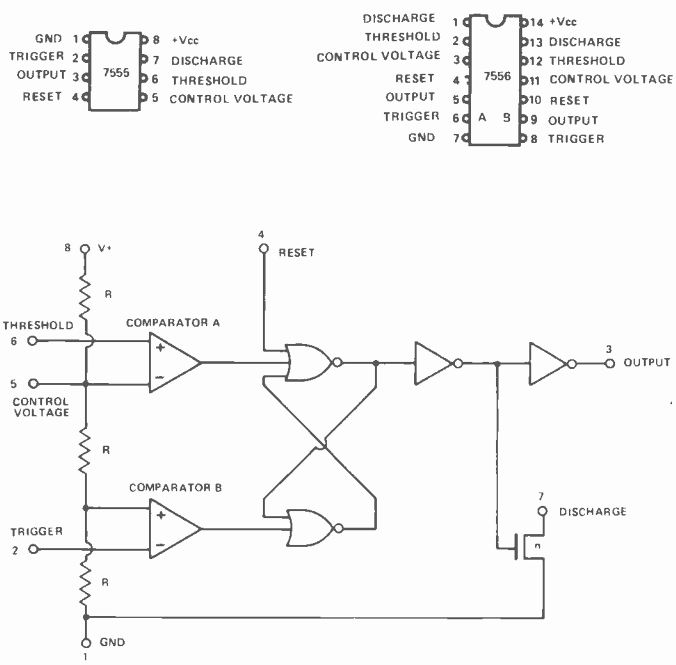


Fig. 1. The pin-out and internal configuration of the CMOS 555.

The bipolar 555 has a few parameters that can make it difficult to use, but which have been improved in the CMOS version, (Fig.2.). The bipolar quiescent supply current is generally about 10 mA which negates their use in small battery units. The CMOS version consumes a mere 120 uA.

PARAMETER	ICM 7555	BIPOLAR 555C
QUIESCENT CURRENT Vcc +15V	TYPICAL 120uA	TYPICAL 10mA
INPUT CURRENT TRIGGER	50pA	0u5A
THRESHOLD	50pA	0u1A
RESET	100pA	0m1A
MAX. OPERATING FREQUENCY	500kHz	500kHz
POWER SUPPLY RANGE	2 → 18V	4VS → 16V
PEAK SUPPLY CURRENT TRANSIENT	10mA	370mA
RISE AND FALL TIME AT OUTPUT	40nS	100nS

Fig. 2. A comparison between the Bipolar and CMOS version of the 555.

Also the CMOS inputs are very high impedance having input currents down in the pico amp region. Another major improvement is the reduction in the power supply current transient during an output transmission. The bipolar is very noisy in this respect and can often be the cause of lots of 'funnies' in nearby circuits.

The CMOS 555 is a low power high input impedance device that should be used where low current consumption is at a premium. The following circuits illustrate some possible uses of the device.

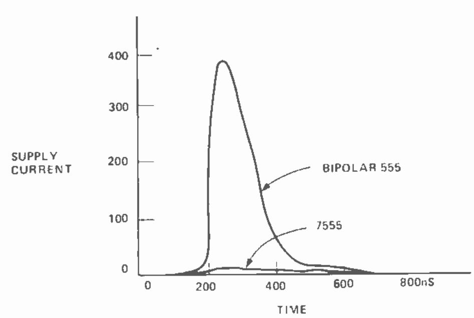


Fig. 3. The CMOS 555 displays an impressive reduction in supply current transient during an output transmission.

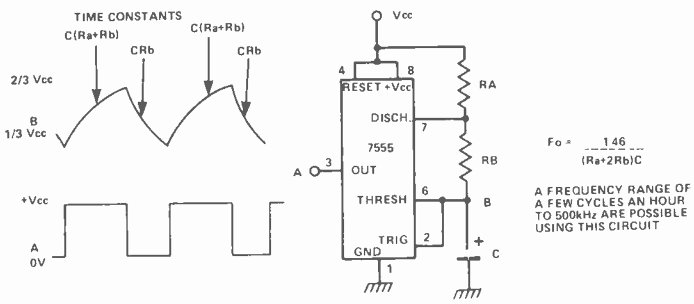


Fig. 4 (above) A simple oscillator can be constructed using two resistors and a capacitor. Due to the high input impedance of the CMOS device, resistor values up to 100M may be used. The operation is as follows. Capacitor C is charged up via Ra and Rb and so rises with a time constant of C(Ra+Rb). When the voltage B reaches ⅔ Vcc, the threshold hold comparator goes high causing the output (pin 3) to be set low. Also the discharge FET (pin 7) is turned on. This discharges the capacitor via Rb with a time constant of CRb, until the voltage B reaches ⅓ Vcc.

This causes the trigger comparator to go low which sets the output high and turns off the discharge FET. Thus, the voltage B oscillates between ⅓ and ⅔Vcc. The waveform is asymmetric but due to the nature of its generation its frequency is virtually invarient with regards to supply voltage changes. It is possible to generate a sawtooth waveform by reducing Rb to a short circuit. This causes the reset time to be very fast, of the order of a few microseconds. However, there is a propagation delay through the device from the trigger comparator to the output which causes the discharging waveform to overshoot the ⅓Vcc limit, thus making the waveform at B larger. This will cause the oscillation frequency to be lower than calculated. To maintain the calculated frequency, the discharge period should be 5 uS seconds or longer.

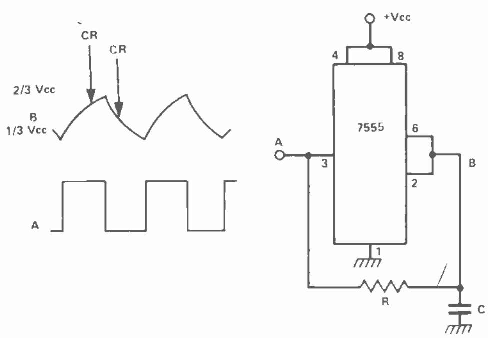


Fig. 5 (above) This oscillator has a symmetrical output because the charge and discharge paths are the same and the portion of the exponential cruve that is used is symmetrical. Note that in this circuit, the discharge pin (7) is available to do other jobs, such as drive a LED or some other device. The timing resistor R should be kept relatively high (above 10k) to prevent loading of the output.

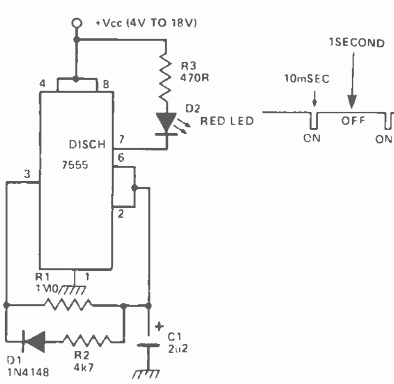


Fig. 6 (above) This circuit is an oscillator that has a wide mark to space ratio. It is OFF for approximately 1 second and then turns ON for about 10 mS. During this latter period the LED is turned on by the discharge FET. The long OFF period is generated by the R1, C1 time constant, whereas the short ON period is produced by D1 (which is forward biased) and R2, C1. The average current consumption is relatively low. If the unit were powered from a 9 V battery, then the current would be 120 uA for the ICM 7555 and an average of 140 uA for the LED, making 260 uA total. This would give a lifetime of a few months for a PP3 which would be extended by lengthening the OFF period (increase R1) and reducing the LED current (increase R3).

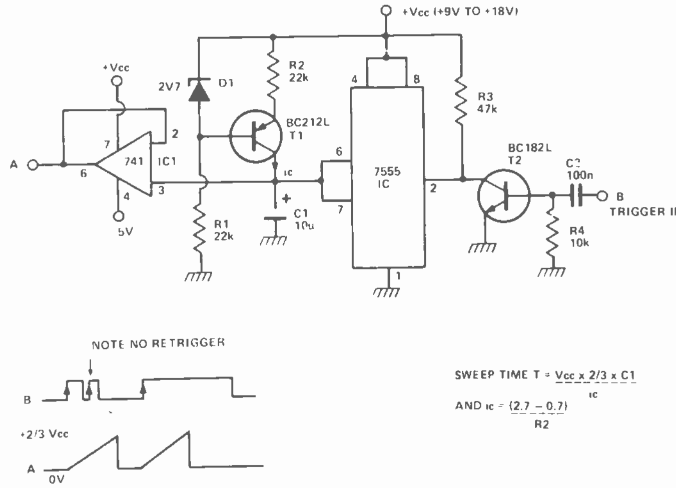


Fig. 7 (above) The 7555 is used to initiate and terminiate a triggered sweep. Normally the discharge FET (pin 7) is ON and so C1 is shorted to ground. When a trigger is applied to the input, the collector of Q2 momentarily goes low which sets pin 7 of the 7555 in its OFF condition. Q1, R1, R2 and D1 form a current generator that drives C1. Once the discharge FET has been turned OFF, the voltage on C1 rises linearly. When this voltage reaches + ⅔ Vcc, the threshold comparator sets the discharge FET into its ON state and so C1 is shorted to ground. IC1 is used to buffer the voltage on C1. The sweep generator is not retriggerable and is only initiated on fast positive going inputs. To vary the sweep rate, alter C1 and or R2.

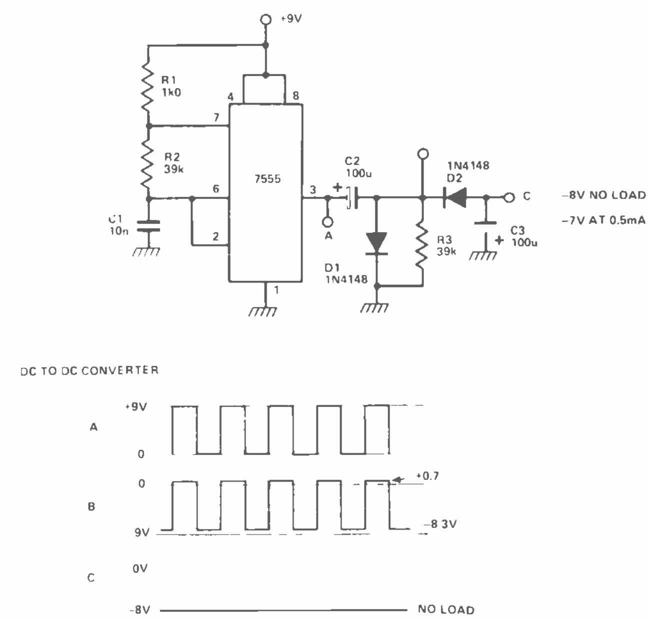


Fig. 8 (above) A DC to DC converter can be constructed from an oscillator and a diode charge pump. The 7555 forms a high frequency square wave oscillator. The squarewave from pin 3 is AC coupled via C2 to the charge pump. The voltage on the negative side of C2 is prevented from going more than 0V7 positive by D1 and so the square wave on this side of the capacitor biases itself so that it moves from +0V7 to —8V3. D2 charges up C3 on the negative excursion of this waveform and so a negative rail of about —8 V is generated. The current that can be taken from this rail is rahter low, being determined by the oscillation frequency and C2. Generally DC to DC converters have a poor transfer efficiency.

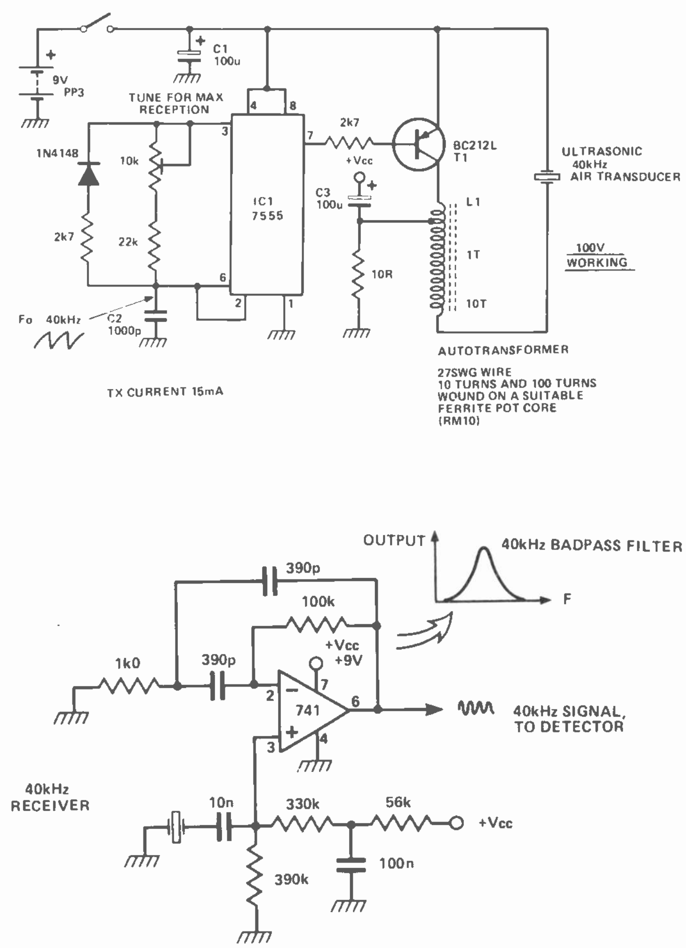


Fig. 9 (above) The 7555 can be used as the driving oscillator in an ultrasonic remote control system. The oscillator generates a thin pulse about 2.5 uS long at the natural resonant frequency of the transducer. This short pulse is used to turn on a transistor (Q1) which drives an auto transformer with a 10 to 1 step up ratio. The output of the transformer is connected to the transducer and when the oscillation frequency is correct a 100 V peak to peak sine wave will be produced at this point. The transducer is usually a crystal with a high impedance and so a high operating voltage is required to produce any power output. The receiver is a 40 kHz bandpass filter. This will amplify any audio signals at this frequency, which can then be sent to a detector circuit.

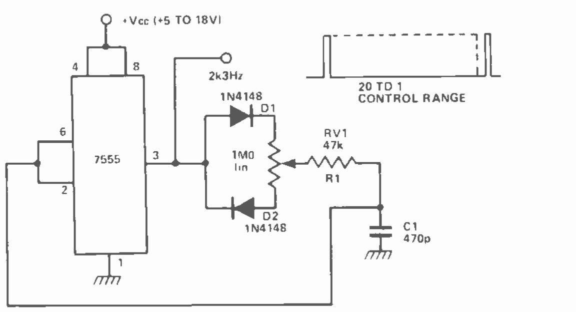


Fig. 10 (above) This oscillator allows the mark space ratio at pin 3 to be varied from 1 to 20, to 20 to 1, by using two feedback routes. When pin 3 is high, C1 is charged via D1, part of RV1 and R1. When it is low, C1 is charged via D2, the other part of RV1 and R1. Thus the position of the RV1 wiper determines the ratio of the charge and discharge periods. The oscillation frequency is slightly dependent on this ratio.

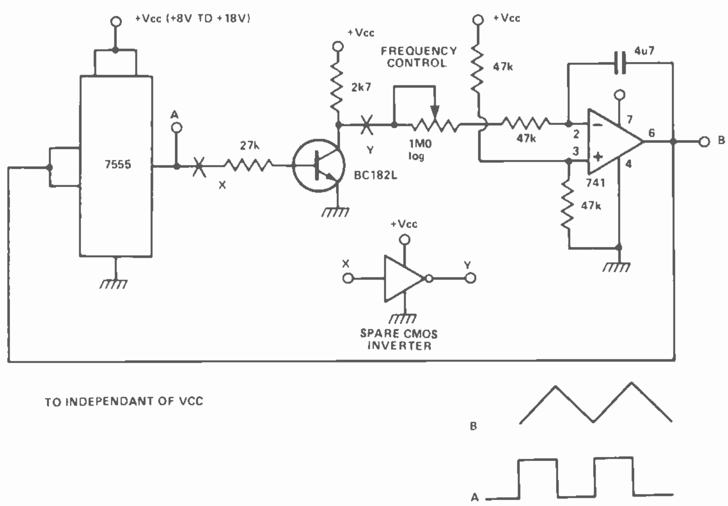


Fig. 11 (above) By making a loop out of a 7555, an inverter and an integrator, a triangle/square wave oscillator is produced. To operate well at high frequencies (up to 40 kHz) a CMOS inverter should be used to replace the transistor inverter. The op amp provides a low impedance triangle output, the frequency of which may be controlled with the 1M log pot.

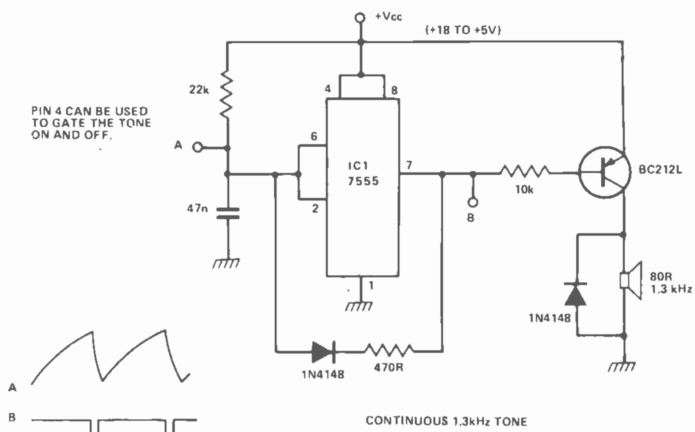


Fig. 12 (above) The 7555 can be used to generate an acoustic tone. The oscillator is set to run at 1k3Hz which has a low period of about 15 nS and a high period of about 755 nS. During the low period the transistor is turned ON and so the loudspeaker is connected across the power supply and sinks at about 100 mA (for a 9 V supply). This gives it a 'kick' on every cycle of the oscillation. As the transistor is only on for 15 out of every 770 nS the average current through the speaker is quite small, being about 1.95 mA. Therefore, the total current consumed by the whole system is only about 2.5 mA (at 9 V), and yet the 20 mW output signal is quite audible.

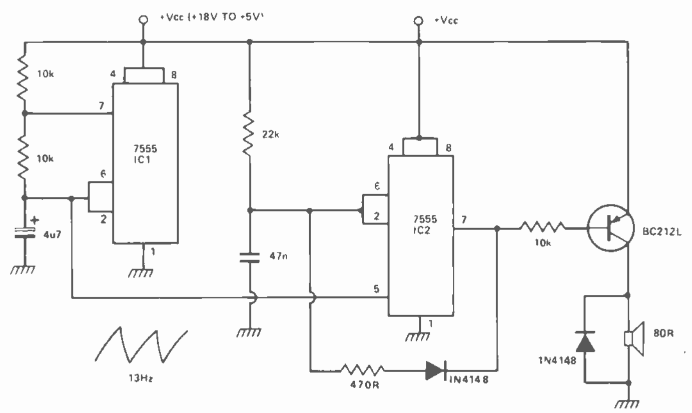


Fig. 13. A warbling tone can be generated by using two oscillators. The warble is produced by IC1 which generates a 13 Hz wave form that is used to frequency modulate the tone generator as described in the previous example. Pin 5 of a 7555 is connected to the + ⅔ Vcc tap on the resistor ladder. By tying it to a 'warble' waveform, frequency modulation of the final output tone is produced. A 7556 could be used instead of two 7555's.

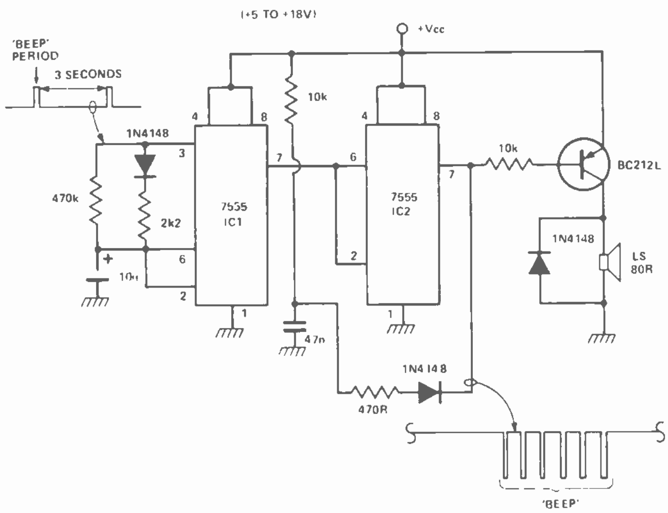


Fig. 14 (above) The police and other emergency services use a repeating high frequency 'beep' on their radio networks. This doesn't interfere with the normal radio traffic and allows the listener to be certain that he is still tuned in correctly to that channel. The circuit generates a similar 'beep' and yet consumes only a couple of milliamps. IC1 is a slow oscillator (3 second period) with a large mark/space ratio. The discharge FET is on for most of the time and only goes OFF for about 15 milliseconds in every 3 seconds. This FET is connected to the tone generator in such a manner that when the FET is ON the tone generator is inhibited. When the FET goes OFF the generator produces a burst of 3 kHz oscillations which are heard as a 'beep'.

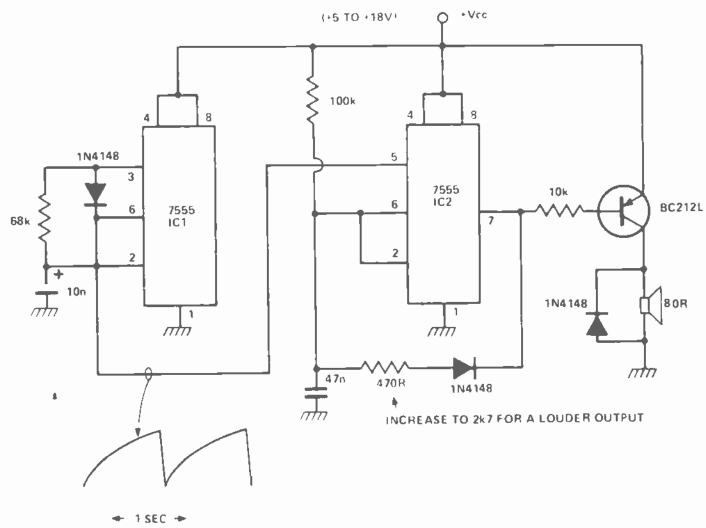


Fig. 15 (above) The last type of sound generator to be described is a simple siren. IC1 generates a sawtooth waveform which is used to frequency modulate, via pin 5, the tone generator (IC2). As the sawtooth voltage rises (with a period of 1 S) so does the tone generator frequency.

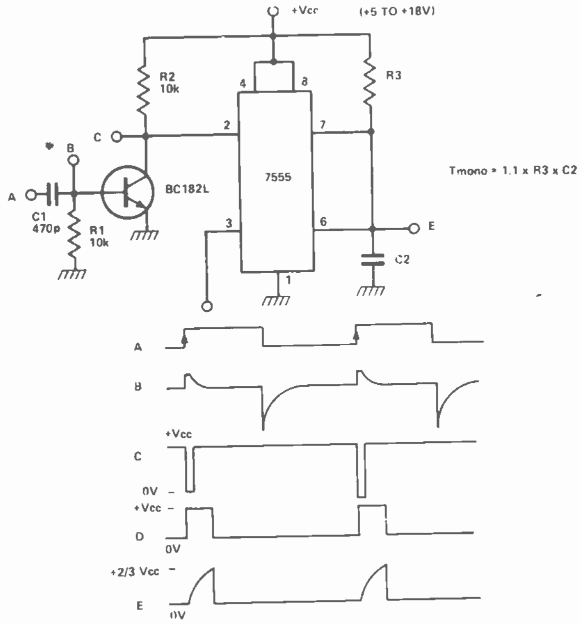


Fig. 16 (above) The 7555 can be made into a monostable, although some problems may occur in its use. A negative going pulse on the trigger input (pin 2) can be used to start the monostable period. It is important that this pulse goes high again before the end of the monostable period, or else it may prolong the period. To this end an AC coupled transistor inverter has been used so that a rising positive signal will initiate the event. Initially C2 is discharged to ground. When pin 2 is taken low, the discharge FET is set to be OFF and so the voltage at E rises with a time constant of C2, R3. When this voltage reaches + ⅔ Vcc, the discharge FET is turned ON, C2 is discharged to ground and the monostable period is finished. During this period the 7555 produces a high output at pin 3.

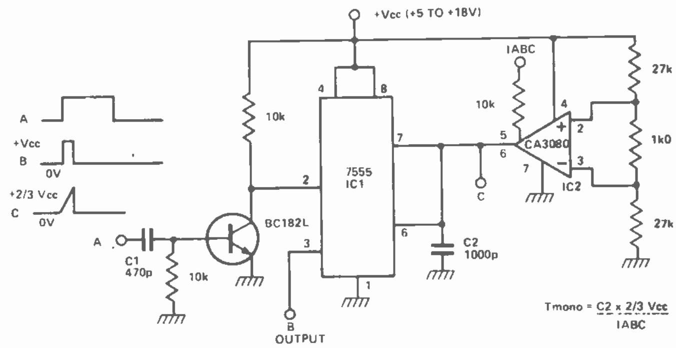
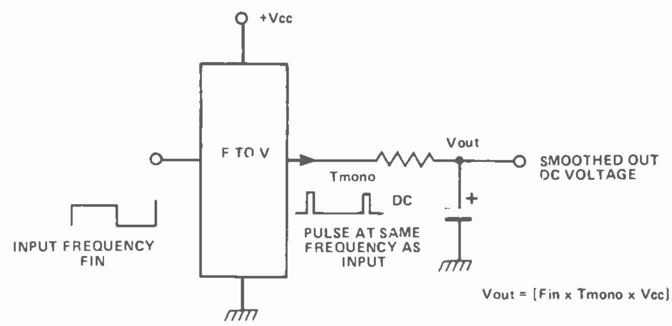


Fig. 17 (above) The previous circuit has been modified. The timing resistor has been replaced with a programmed current source, IC2. Whatever current is put into pin 5 of the CA 3080 (the I_{ABC} current) will appear at its output. This will linearly charge up C2 when the FET switch is turned OFF. The monostable action will be the same as in the previous example. The monostable period is linearly proportional to the I_{ABC} current so by programming this current the period is controlled.



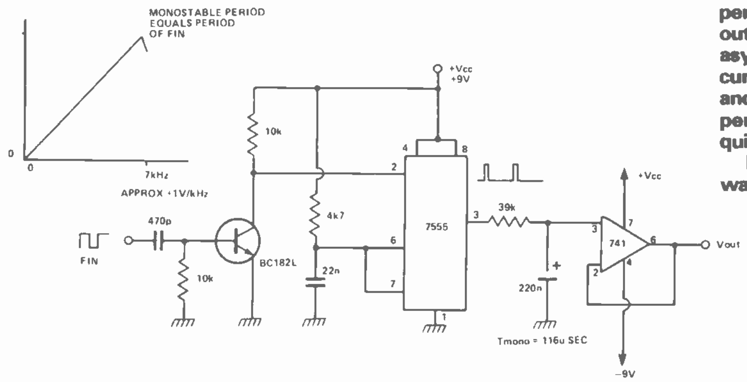
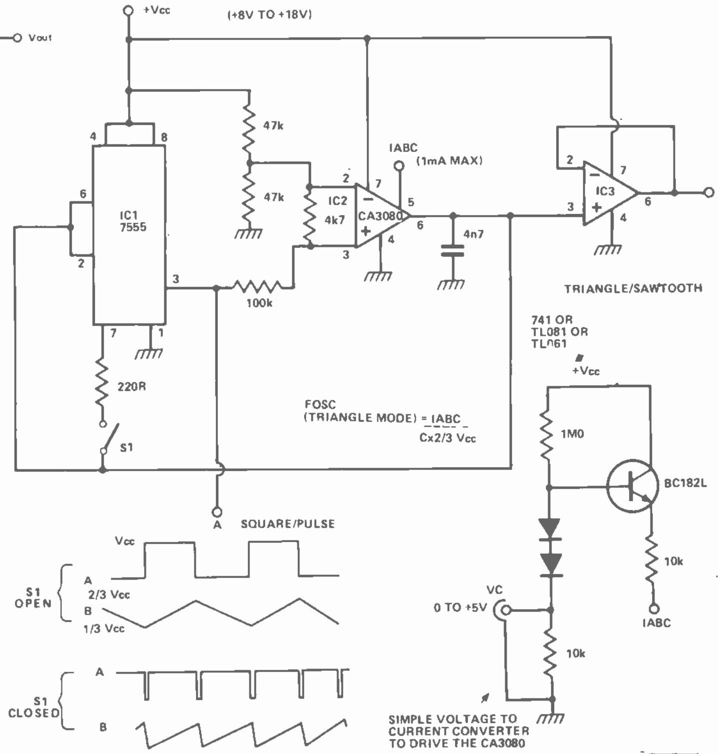


Fig. 18 (above) The monostable can be used to linearly convert a frequency into a voltage. The pulses at the output pin of the 7555 in this circuit are fixed in length but occur at the fundamental frequency of the input signal. Thus the average equivalent DC voltage of these pulses will be linearly proportional to their frequency. This averaging can be performed very simply with a CR low pass filter. This filter determines the response time of the circuit and the ripple. A long time constant will have little ripple and respond slowly and vice versa. Care must be taken to not exceed the range of the monostable. When the period of monostable exceeds that of the input signal, the circuit will miss every other period and will drop its apparent output by an octave.

Fig. 19 (right) IC1 and 2 form a triangle/squarewave oscillator. IC2 is a non-inverting, programmable rate integrator and its output ramps up and down between the 1/3 and 2/3 Vcc limits set by IC1. The rate at which the integrator ramps up and down and hence the oscillation frequency, is determined by the I_{ABC} current. Because the input impedance of IC1 is so high, it is possible to directly connect the timing capacitor to it, without any unwanted loading effects. This circuit has excellent high frequency performance producing good quality triangle wave forms at 40 kHz. The circuit can also produce very low frequency signals by making C a 100n tantalum and I_{ABC} a current of say, 1 nA. This oscillator would then have a period of 800 seconds. IC3 is used to buffer the triangle to the outside world. If a 741 is used, then the waveform will become asymmetrical at low I_{ABC} currents (below 1 uA) due to the input bias current needed to run a 741. A TL081 has very little input current and so could be used for both low I_{ABC} currents and high frequency performance. If low power is needed, then a TL061 (200 uA quiescent) could be used.

By closing switch S1, the oscillator will produce a sawtooth waveform and a pulse.



ETI

The Logic Probes

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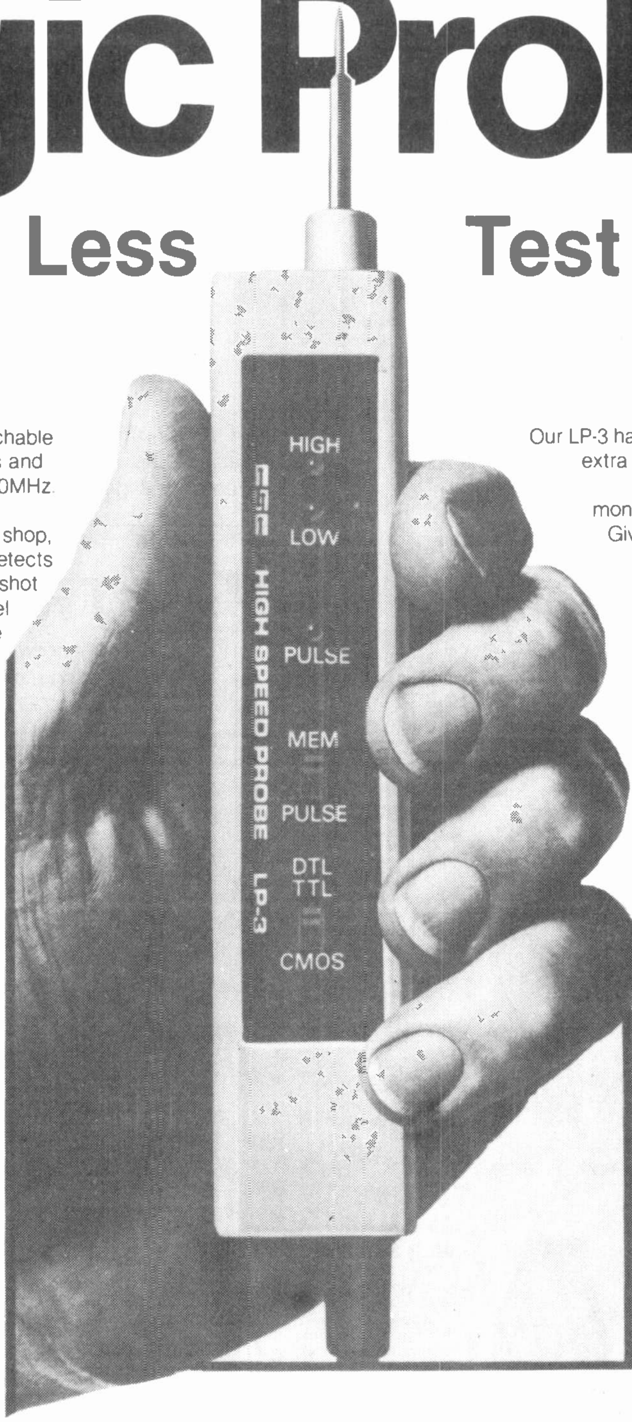

LP-1 Logic Probe

The LP-1 has a minimum detachable pulse width of 50 nanoseconds and maximum input frequency of 10MHz. This 100 K ohm probe is an inexpensive workhorse for any shop, lab or field service tool kit. It detects high-speed pulse trains or one-shot events and stores pulse or level transistions, replacing separate level detectors, pulse detectors, pulse stretchers and pulse memory devices. All for less than the price of a DVM

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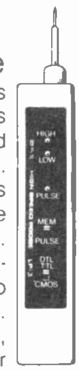

LP-3 Logic Probe

Our LP-3 has all the features of the LP-1 plus extra high speed. It captures pulses as narrow as 10 nanoseconds, and monitors pulse trains to over 50 MHz. Giving you the essential capabilities of a high-quality memory scope at 1/1000th the cost. LP-3 captures one shot or low-rep-events all-but-impossible to detect any other way. All without the weight, bulk, inconvenience and power consumption of conventional methods.

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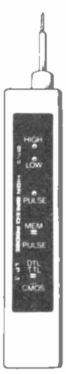

LP-2 Logic Probe

The LP-2 performs the same basic functions as the LP-1, but, for slower-speed circuits and without pulse memory capability. Handling a minimum pulse width of 300 nanoseconds, this 300 K ohm probe is the economical way to test circuits up to 1.5 MHz. It detects pulse trains or single-shot events in TTL, DTL HTL and CMOS circuits, replacing separate pulse detectors, pulse stretchers and mode state analysers.
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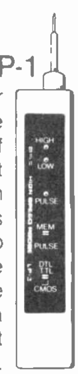

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Try your luck with the ETI Coin Toss game. Heads or tails with LED indicators, full sound effects and fingertip control.

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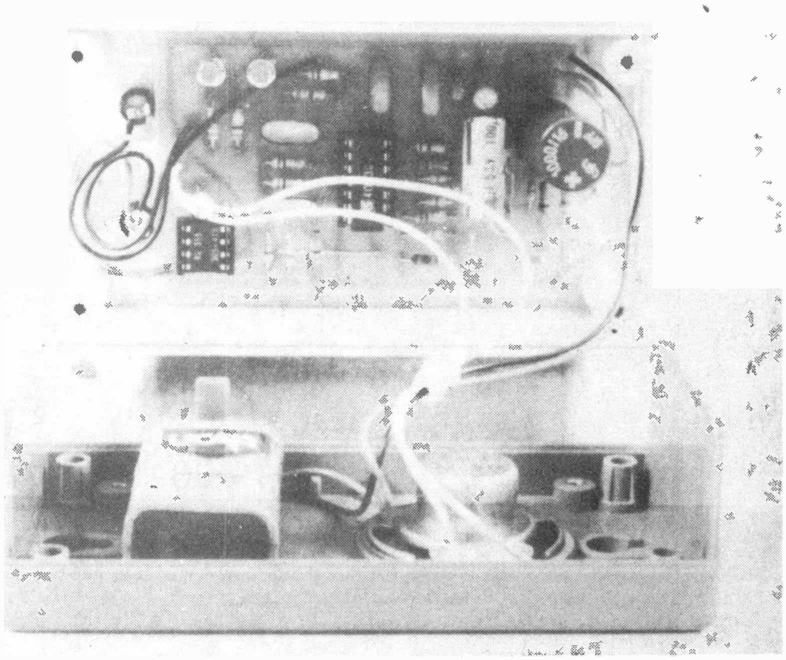
Only a couple of cheap chips are used along with three transistors and a scattering of discrete passive components. Depressing the push-button causes the unit to emit a 'whooping' siren sound. Also the LEDs flash alternately, gradually slowing down until one remains illuminated. A further depression of the push-button starts the process again. If the unit is left undisturbed it will turn itself off, emitting a couple of quiet squeaks. Once the flashing display has settled and one LED is illuminated continuously, the display will remain stable until both LEDs are extinguished. This avoids any troublesome arguments!

Construction

The unit is assembled on a single PCB with the battery, push-button switch, LEDs and loudspeaker connected via flying leads. There are two links to make on the board; from IC1 (pin 4) to IC2 (pin 4) and from IC1 (pin 3) to the junction of diodes D6, 7. Note that this is a straight wire link which ▶



The finished coin machine (right) installed in a standard Verobox.

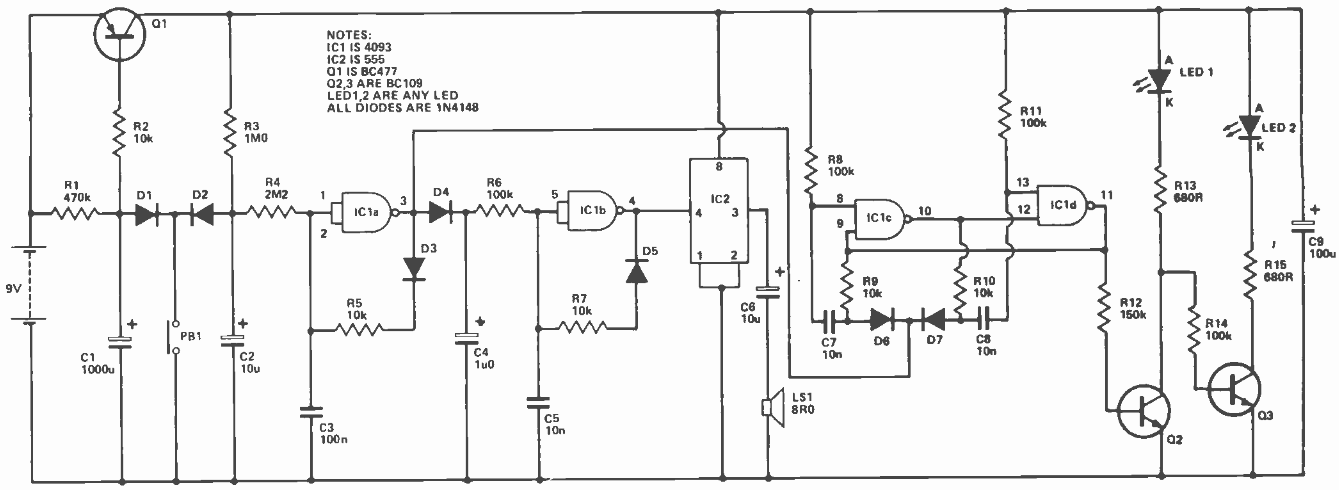


Fig. 1 Circuit diagram. We found that the circuit operated more reliably if D1 was made a 1N4001.

PARTS LIST

Resistors

R1	470k
R2,5,7,9, 10	10k
R3	1M0
R4	2M2
R6,8,11, 14	100k
R12	150k
R13,15	680R

Capacitors

C1	1000u electrolytic
C2,6	10u tantalum
C3	100n polyester
C4	1u0 tantalum
C5,7,8	10n polyester
C9	100u electrolytic

Semiconductors

IC1	4093
IC2	555
Q1	BC477
Q2,3	BC109
LED 1,2	ANY LED
D2 to D7	1N4148
D1	1N4001

Miscellaneous

PB1 SPST, LS1 8 ohm loudspeaker, PCB, PP3 9V battery.

BUYLINES

The Coin Toss project uses standard components. You should have no difficulty in obtaining them from your favourite mail order supplier.

passes under R11 and D6. The flying lead link is most easily made on the underside of the board after construction is complete.

Assembly is quite simple. As usual, pay attention to the orientation of the diodes, transistors, ICs and capacitors. C9 may have to be bent to one side to accommodate C1. However, there is plenty of space for the other components. As IC1 is a CMOS chip, use a socket if you are worried about damage from static electricity. There are no problems with IC2 or the other components.

Layout of the unit is uncritical and any construction technique may be employed. You need two different coloured LEDs. Any size or colour of LED will do. The unit should work as soon as power is applied and again upon depressing PB1. Build one now and try your luck! ETI

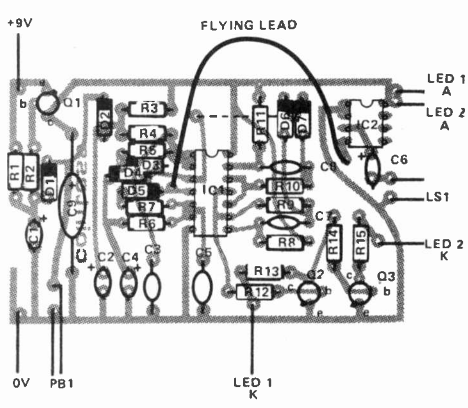


Fig. 2. Component overlay.

HOW IT WORKS

The circuit has a single push-button control, PB1. When PB1 is closed, C1 is shorted to ground via D1. Current then flows through R1,2 and the base-emitter junction of Q1, turning the transistor on and providing power to the rest of the circuit. Upon releasing PB1, the charging current in C1 maintains power for about twenty seconds, after which the circuit will shut down.

A voltage-controlled-oscillator is formed around IC1a, which generates the clock pulses for the sound-effects oscillator IC1b and bistable flip-flop IC1c, d. Depressing and releasing PB1 causes the voltage across C2 to rise exponentially from near zero volts as it recharges via R3. IC1a then produces a train of pulses which decay from about 10 Hz until the oscillator stops when the voltage across C2 rises above the lower threshold voltage of the IC's input. Note that IC1 is a Schmitt trigger device. Use of the specified chip is essential ensure proper circuit operation.

Oscillation occurs as C3 is discharged below the lower threshold voltage of IC1a, causing the output (pin 3) to go 'high'. C3 then charges via D3, R5 until the voltage across it reaches the positive threshold, flipping the output of IC1a 'low'. C3 then discharges via R4 and the cycle continues until the voltage across C2 rises above the lower threshold voltage of IC1a. A falling siren tone is generated by IC1b. Operation of this VCO is identical to IC1a except that it is configured to operate with a positive control voltage. The ouput of IC1b drives IC2, a 555 timer which simply acts as an amplifier driving LS1.

The slow oscillator pulses from IC1a drive the bistable flip-flop formed around IC1c, d. R9,10, C7,8 and D6,7 provide a 'steering' network for the trigger pulse. The indicator LEDs are driven by Q2,3. Overall supply decoupling is provided by C9.

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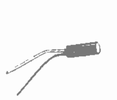

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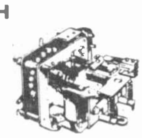

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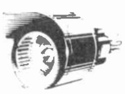

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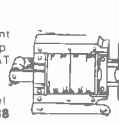

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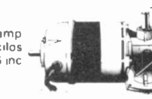

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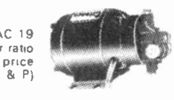

CROUZET — 230/240V AC **2 rpm** synchronous geared motor **£2.90** P&P 30p (Total **£3.68** inc VAT) N M S
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REDUCTION DRIVE GEARBOX
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'VENNER TYPE' ERD TIME SWITCH
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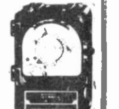
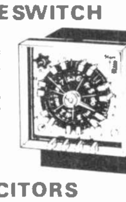


SANGAMO WESTON TIME SWITCH
Type S251 200/250 AC 2 on 2 off every 24 hours 20amps contacts with override switch Diameter 4" x 3" price **£8.00** P&P 50p (**£9.78** inc VAT & P) Also available with solar dia R&T

AEG TIMESWITCH
200/250V AC 1 on/1 off every 24 hours 80 amps contact (ideal storage heaters) Spring reserve **£10.00** P&P 50p (Total **£12.08** inc VAT)

MINIATURE PROGRAMMER
Crouzet 1 rpm 115V AC Motor operating 2 roller microswitches (4 amp) Can be used on 240V AC with either 0 25 mfd 250V Condenser or 5 6K wirewound resistor, 7 watts (supplied) Price **£2.50** + 50p P&P (**£3.45** inc VAT & P)

MINIATURE 24-HOUR TIMESWITCH
(German mfr) 240V AC operation Spring reserve 10 amp contacts one on-off every 24 hours Calibrated in two hour steps Minimum on off period 6 hours **Day Omission.** Unusual feature with these switches is that trips may be removed at will enabling individual days to be programmed as required Size only 3" x 4" Depth 2¼" Price **£6.50.** 50p P&P (**£8.05** inc VAT & P)



A.C. WKG TUBULAR CAPACITORS
Fraction of makers price Motor start etc

1 5 mfd 440V AC	**60p**	6 5 mfd 280V AC	**£1.00**
2 mfd 250V AC	**60p**	7 5 mfd 200V AC	**£1.00**
2 mfd 450V AC	**75p**	10 mfd 250V AC	**£1.00**
2 2 mfd 440V AC	**75p**	10 mfd 400V AC	**£1.75**
3 mfd 440V AC	**£1.00**	14 mfd 400V AC	**£3.00**
4 1 mfd 440V AC	**£1.00**	15 mfd 2 500V (Block)	**£1.50**
5 mfd 400V AC	**£1.25**	19 mfd 280V AC	**£2.00**
5 3 mfd 160V AC	**60p**	20 mfd 250V AC	**£2.25**
5 4 mfd 280V AC	**75p**	50 mfd 370V (Block)	**£5.00**

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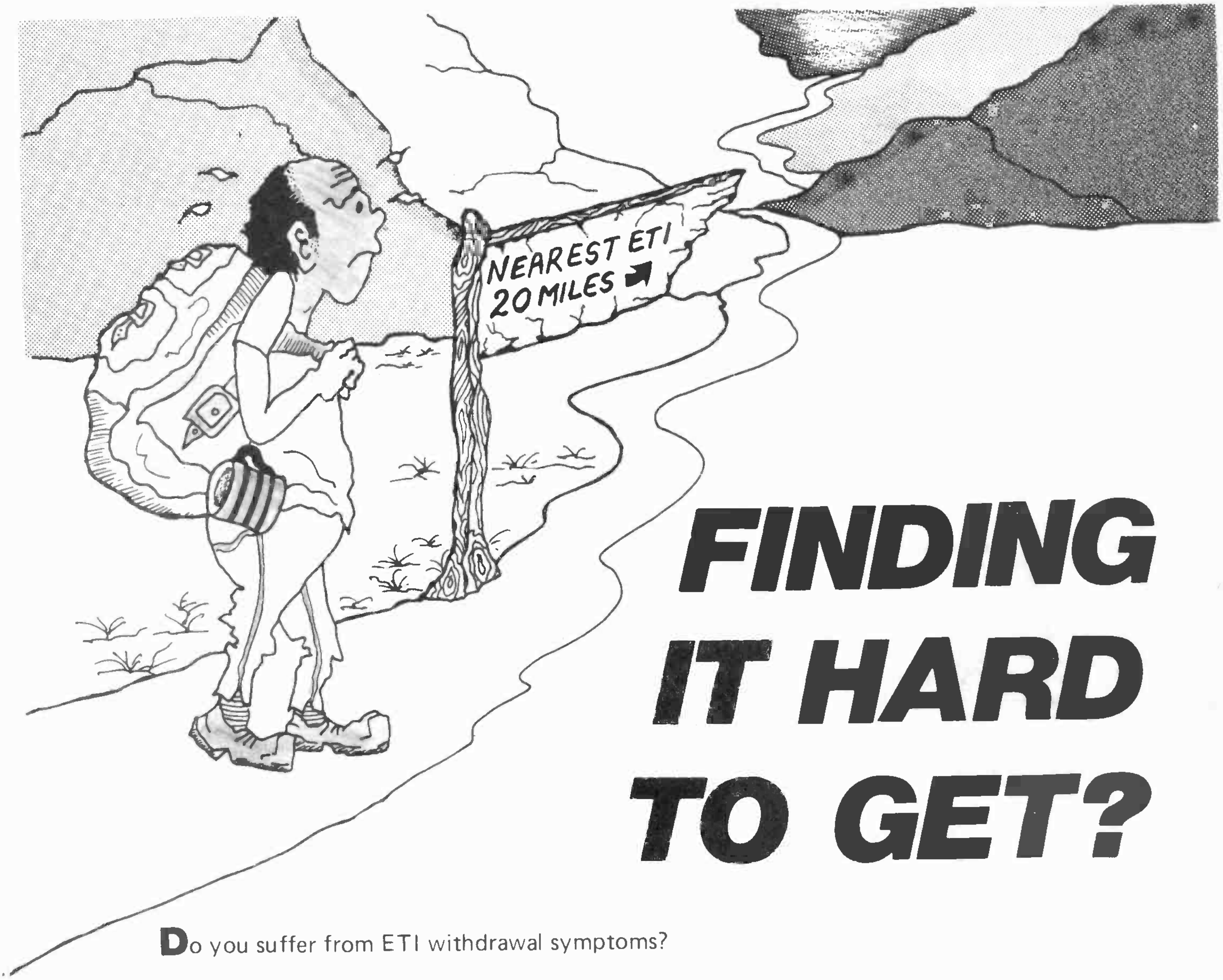

FINDING IT HARD TO GET?

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RAVEN ON...

This month Dave Raven of Metac Electronics goes computer shopping and casts doubts on lie detectors.

Starting a new year is not only necessary but can be quite enjoyable since it now possible to reflect on the previous year as history. Errors of judgment, success and missed opportunities are all behind us and cannot be brought back. The only positive thing you can do is cast all thoughts and aspirations forward. In the words of G. B. Shaw "Man can climb to the highest summits but he cannot dwell there long".

If electronics is your chosen career then 1980 is to be another exciting year of challenge and new opportunities. Behind clouds of doom and gloom painted for us by the Press and politicians, not forgetting those great British patriots, the government and business spokesmen, who roam the world speaking out, never failing to tell the world how bad things are in Britain or how bad they are going to be, there are still signs of the continuing revolution in the electronics industry. Difficult decisions have to be taken, since, to remain in the industry, it will be necessary to spot the trends. An interest in small computing systems must be formed since organisations that wish to remain competitive and efficient have to make the change from mechanical to computerised systems. Fewer jobs, even for school-leavers, will be available to those who have not had sight of a computer keyboard. These new tools for industry and commerce are being pushed out onto the market at an alarming pace. It is already possible to buy a small system with 4K of memory for half the price of a modern shop cash register. My own company is introducing a mixture of small systems for general purpose operations backed by larger units for the mail order centre. This philosophy of decentralising computers away from one large system gives maximum flexibility and enables a company to match the computer system to the job.

In America it is not uncommon for solicitors to sit at their word processor and prepare complex company merger documents in a fraction of the time previously required. So watch out ladies, this is just as important for you too. Secretaries and office juniors will all need the ability to change from typing pool mentalities to the new "smart" methods.

Computers In The High Street

Major efforts have been made in the UK during 1979 to bring small computers onto the High Street. However, my own impression is that most of the retailers have ended up selling mainly to established businesses. The consumer will not be rushed into these things and it does appear that home computers have still to take off. I would also hazard a guess that video recorder specialists are finding a similar pattern of sales. Currys, the electrical retail chain, is to establish a subsidiary company to market small computers and provide computer programs. Operations are expected to start next year with outlets being opened at Currys established premises. They are aiming for the small to medium size business market, also industrial and commercial outlets. Figures quoted in the Press suggested that they aim to take a whole 10% of the domestic market in their first year which doesn't leave a lot for the rest of us. Coincidently, news that the president of the electronics giant Fairchild Camera and Instrument Corporation had resigned reminded me of an announcement he made several years ago predicting that their range of Time Band LED watches were going to take some huge percentage of the world's market, I think it was about 40%. Not all that long after this they announced getting out of watches completely and promptly moved their entire UK service facility to somewhere in West Germany.

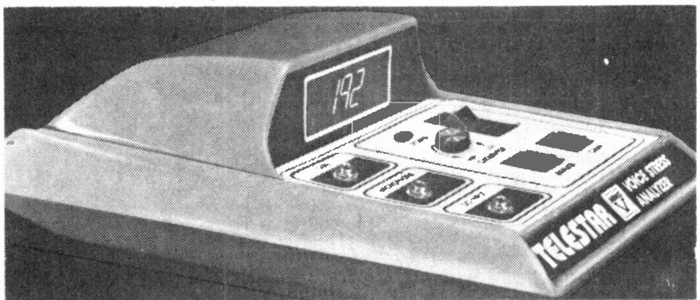
Confusion In The Shops

An interesting article on Computing Today describes the experiences of the author when shopping in London's Tottenham Court Road for a small computer. I mention this since it provides a classic story of the current state of immaturity and confusion that exists in the High Street. His experience when buying a computer may not be dissimilar to those buying electronic watches, video recorders, etc, mainly a bewildering choice of different systems, functions and, of course, prices. It is quite possible to spend £3,000 on a computer and find that the system is totally unsuitable for your requirements. Shortage of software for particular systems is a common complaint and the price of the add-ons.

Honest Truth Machines

A sinister new electronic product is being sold in America, called the Truth Machine. I have not seen these advertised in the UK yet, but when they come I can imagine a similar reaction to the one created in the States. Doubts have been cast on their accuracy. However, this has not prevented these solid state, voice stress analysers being used in personnel offices and other areas where people may stray from the truth. One leading professor of psychiatry and psychology at the University of Minnesota claimed that ▶

lie detectors are about as accurate as flipping a coin. Professor Lykken goes on to say that you cannot discriminate with a stress analyser between a stress and a non-stress situation. Even if tests could detect stress, one could not assume that stress indicates lying. Speaking the truth under stressful circumstances would typically show up as stress in these machines. A more traditional machine used for lie detection, the polygraph, was compared for accuracy with one of the new stress analysers. Results showed that the stress analyser detected lies 38% and 20% of the time compared to the polygraph machines record of 92% and 76% assuming of course that stress indicates lying. The companies marketing the products will not disclose the identity of the integrated circuits used, saying that patent rights are still being sorted out. To use one particular model of stress analyser the operator first adjusts the circuitry to recognise the fundamental frequency range of the voice of the person under test. While talking to that person under non-stress conditions, the user tunes the analyser with a one-knob control, until the number 20 registers on the LED display. That number



The Truth Machine — currently being sold in America for about £75 each. Doubts are cast on the accuracy of its results.

signifies that the machine is locked into the fundamental voice frequency range. The claim then made by the manufacturers is that when a person experiences stress, normal harmonics disappear from the voice and they shift so that they are no longer integral multiples of the fundamental. A sensor which also doubles as a filter and may be a tuned circuit, is programmed to anticipate harmonic changes, and measure their duration and intensity. The LED display indicates stress by a rise in the numerical value at displays. The model described has a built in microphone, or it can be connected to an external mike or to a telephone. On the drawing board is another model which I hope my company will be cautious about handling. It incorporates a stress analyser in a digital watch. Just think of the reaction when you're told "The time is 9.30 and you're already lying through your teeth."

New SAW Devices

One old saying which regularly comes to mind is that "there ain't nothing new" especially in science. Acoustic surface wave devices are becoming more familiar and I was interested to see an article recently describing a new high speed SAW device on gallium arsenide material. The material used is the same as that required for producing Field Effect Transistors and, by making use of the properties of gallium arsenide, strain-sensitive FET heterodyne mixers can be fabricated in the epitaxial layer grown on the surface of the bulk gallium arsenide compound, producing a useful programmable tapped delay line.

Well, my news for the researchers is that a research programme I worked on ten years ago at Birmingham University developed working devices as described above. Ah well, back to the drawing board. ETI

Next Month

Hobby Electronics

PASSIONMETER

Months of fearless research (mainly on calibration) have led to the design we hope to be publishing next month. It is primarily intended to visually display (via a column of LEDs) the degree of passion being experienced by the subject.

Measurement of passion is made by inserting the subject's finger into an orifice in the case to contact with a sensor array. Use of CMOS circuitry enables the unit to function for many months without being switched off. This project, whilst a little tongue-in-cheek should prove a great success at parties and may just provide a few surprises!

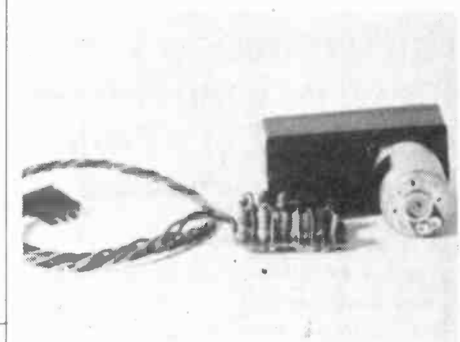
KEZY DOES IT

Unless you've heard it you will find it almost impossible to believe, American radio that is. Rick Maybury hot foot from Los Angeles brings back a report of one particular AM/FM station, KEZY. In a city that has over 80 other stations catering for just about every taste KEZY manages to capture a very large audience. Find out about this and the American radio scene in general in next month's issue.

INTO CONSTRUCTIONAL ELECTRONICS

Are you thinking about taking that first step into the wonderful world of electronics? Ian Sinclair begins a major new series just for you.

Many newcomers are often daunted by the thought of building that first project. This series is designed to take you gently by the hand, through the jungle of jargon and coloured bits and pieces and hopefully leave you with the confidence and expertise to tackle just about anything. Much of the series is centred around the Eurobreadboard so why not drop a few hints to Father Christmas so you can be ready.



KIT REVIEW SPECIAL

Two kits this month. Even though we've delayed the Radio Control system for a few months we will still be presenting the review of the Servo Kit we hope to be using with the system.

Our second kit comes from THE kitmakers — Heathkit. They may be a bit pricey but they are the best. The one we're reviewing is probably one of the finest pieces of test equipment we've ever seen. It's the Digital Multimeter with an LCD readout. If you think a price tag of around £80 is a bit steep then see what we think next month.

INFRA RED CONTROL

Look out for a new remote control system using Infra Red techniques. Coming next month.

The February issue will be on sale January 11th

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

MODULAR SYNTHESISER

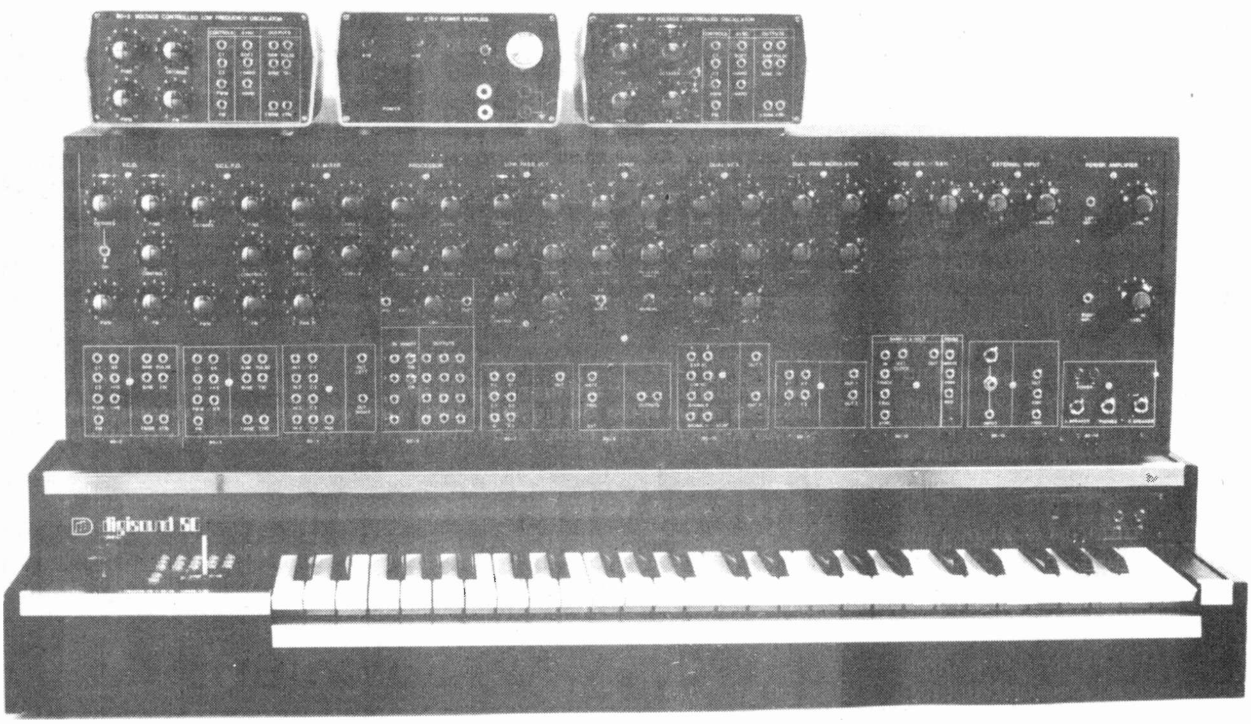
The synthesiser you've been waiting for. Presented as either a full spec., rack mounting, stage instrument or as a set of stand-alone modules, ETI's Project 80 gives you the options.
Circuit designs by R. C. Blakey.

One of the fascinating, and sometimes irritating, aspects of electronics is its rate of technological growth. It is the recent development of customised integrated circuits for music applications which justifies another synthesiser project. The use of these devices greatly simplifies construction of stable, accurate and reliable modules, which will be of particular benefit to constructors. These new integrated circuits are equally useful to the musician since they allow greater control of many of the complex 'music-making' parameters.

Design Philosophy

The popular conception of a synthesiser is a musical instrument which can produce all manner of wondrous sounds. In fact a synthesiser is a multi-function machine having sound generators, modifiers and mixers which are electrically compatible with one another. It is the designer who connects the various modules together in a particular manner to produce an integrated musical instrument. He (she) has certain targets of portability, ease of playing and cost — and inevitably these result in compromises in terms of the capabilities of the instrument.

The basis of the current project is that for hobby application and greater exploration of musical expression there is no substitute for a truly modular system inter-connected by patchcords. Of course, patchboards or switches are alternatives to lots of drooping cords, but sooner or later the compromises begin as the cost, or the trouble, of adding more switches or boards arises. Furthermore a patchcord synthesiser is just as easy to play as a pre-set machine.

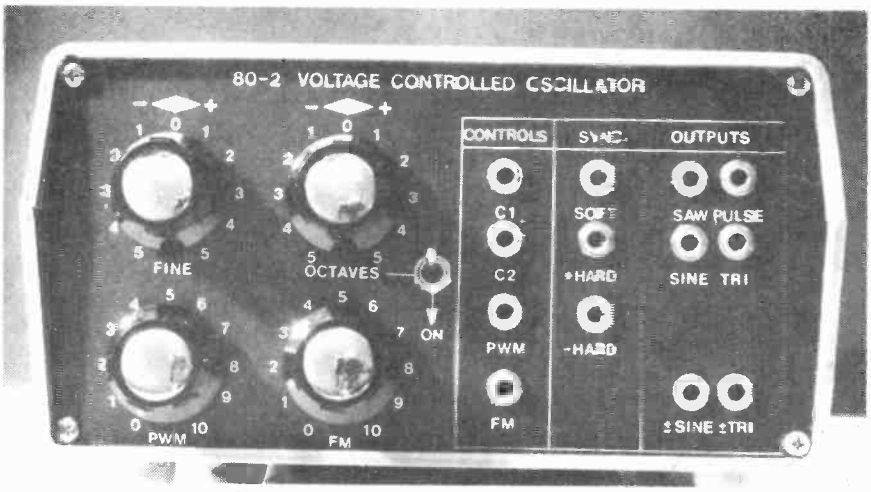


SPECIFICATION

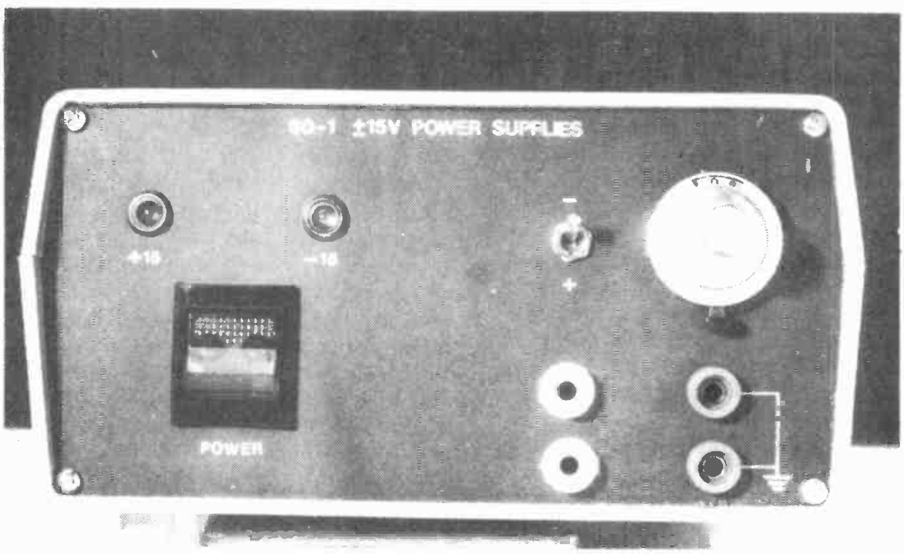
General Specification
The design features of the modules follow the principles adopted by many of the major manufacturers of synthesisers. These are:-

1. Exponential voltage control. For the basic signal and treatment units (oscillators and filters) this will be the widely used one volt per octave relationship. For some modules the response level may be variable, as with the voltage controlled amplifier.
2. 10 V minimum control range providing a span of 10 octaves without switching.
3. 10 V peak to peak signals.
4. Signal and control inputs via a summing op-amp stage. This allows multiple inputs. It is also a simple matter to alter the inputs to make the modules compatible with existing equipment.
5. Normally all inputs will have an input impedance of 100k or a minimum of 47k. This allows a single control signal to drive several modules without adverse loading effects.
6. Output impedance will be 1k wherever practical, that is, without adding significantly to cost. These outputs may be mixed by shorting them together which results in an average of the mixed signals.
7. DC coupling, except for a few instances where it is essential to avoid errors which may arise from any DC drift and when the use of AC coupling does not result in loss of flexibility.
8. ±15 V supplies, common to all modules. Single PSU required.
9. All major features to have voltage control capability, for example, Q control of filters, pulse width modulation, envelope generation and so on.

An important feature of the above is that it allows *anything* to be plugged *anywhere* without fear of causing damage. Where modules are interfaced with external equipment then ¼inch jack sockets are used to avoid problems which may arise from incompatibility. Another aspect that should be noted is that because one signal can control several modules any attenuation of the signal should be made at the input to the modules.



Above and below: the VCO and PSU modules as they appear in their free standing cases. Note the vernier drive on the PSU. This is for calibration of oscillators etc. This case will be standard throughout the series.



Modules To Come

The modules to be described in this series are as follows:-

1. **Power Supply**: ±15 V regulated and trimmed supplies which, as described, are sufficient to drive all of the proposed modules.

2. **Voltage Controlled Oscillator.** Good exponential response over a range from 10 Hz to over 16 kHz. Triangle, sawtooth, pulse and sine outputs of 0 to 10 V amplitude and triangle and sine outputs of ±5 V amplitude. Manual and voltage control of pulse width duty cycle from 0 to 100%. Linear frequency modulation input. Three techniques for synchronising oscillators.

3. **Voltage Controlled Low Frequency Oscillator.** Same features as the VCO but with a frequency range of 0.2 Hz to 205 Hz with a 10 V control input. The frequency range extends to over 5 kHz with higher control voltage or by manual adjustment of initial frequency. The lower frequency limit is easily altered to suit individual requirements.

4. **Processor.** The flexibility of the input-output structure described above has one main disadvantage, namely, that to take full advantage of it one should have several output jacks for each control source and an attenuating potentiometer on each control and signal input. This can be overcome by having a panel ▶

(or panels) which only contain attenuating potentiometers and/or sets of commoned jack sockets for distribution purposes. Such panels are not powered and do not require further description. On the 'processor' module facilities have been incorporated for inverting two of the inputs and also for slowing down control signals by means of a lag circuit. The latter circuit may also be used as a control source by using a foot pedal.

5. Voltage Controlled Mixer. Four input mixer with manual and external voltage control of mix together with a single control for manual and external voltage control of pan.

6. Voltage Controlled Filters. A state variable filter with low pass, high pass, band pass and notch outputs will be described. Also a 24dB/octave low pass filter which is the most widely used type for music applications. Voltage control of Q provided.

7. Voltage Controlled Envelope Shaper. Voltage control over the attack, initial decay and final decay responses of the envelope generator provides opportunity for more realistic envelopes, for example, a change in envelope with pitch. A third generation IC will be used which has many other features allowing control over the formant of the sound.

8. Dual Voltage Controlled Amplifier. Exponential and linear control for increased flexibility and variable gain of both. Ability to partially bury the envelope so as to reduce the exponential final decay of the envelope which in imitative synthesis can be a problem. Provision for stopping the VCA so that when used in conjunction with other instruments it does not continue playing when the rest of the group has finished.

9. Dual Ring Modulator. Based on a single IC and having a wide dynamic range and high signal to noise ratio.

10. Noise Generator and Sample & Hold Module. White, pink and red (random) noise sources. The sample and hold unit allows creation of sounds from a variety of sources.

11. External Input. Pre-amplifier to increase external signals to a level compatible with the other synthesiser modules. Includes an envelope follower with a variable threshold level to generate trigger pulses.

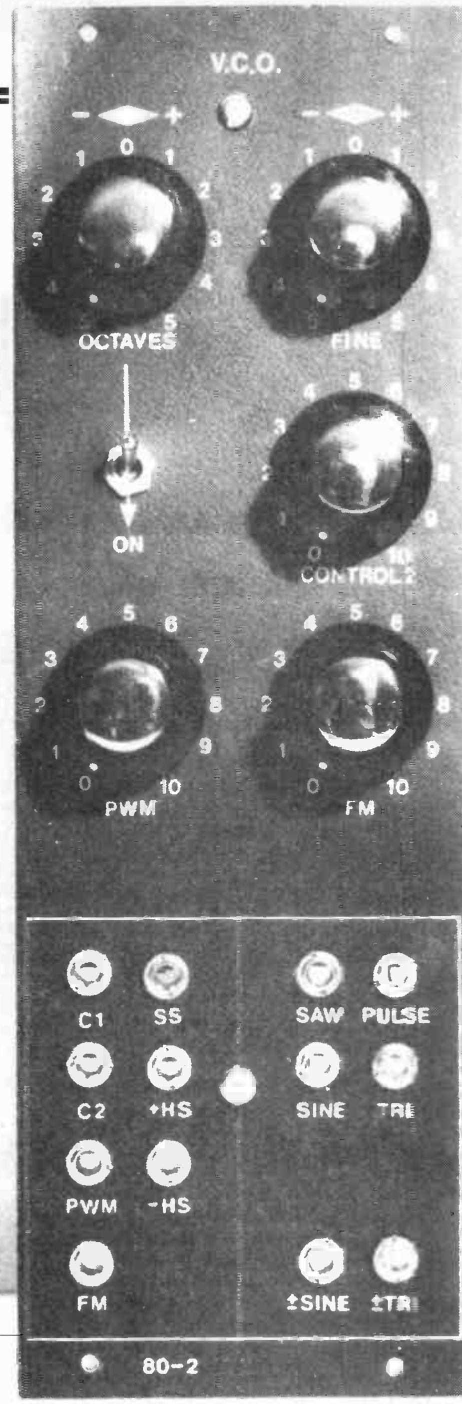
12. Power Amplifier. Two speaker channels and headphone output. It is not advisable to use the domestic Hi-Fi for synthesisers since the tweeters can be destroyed by continuous tones at an output above a few watts. A pair of good quality speakers is a worthwhile investment. A separate power supply is used for the power amplifier.

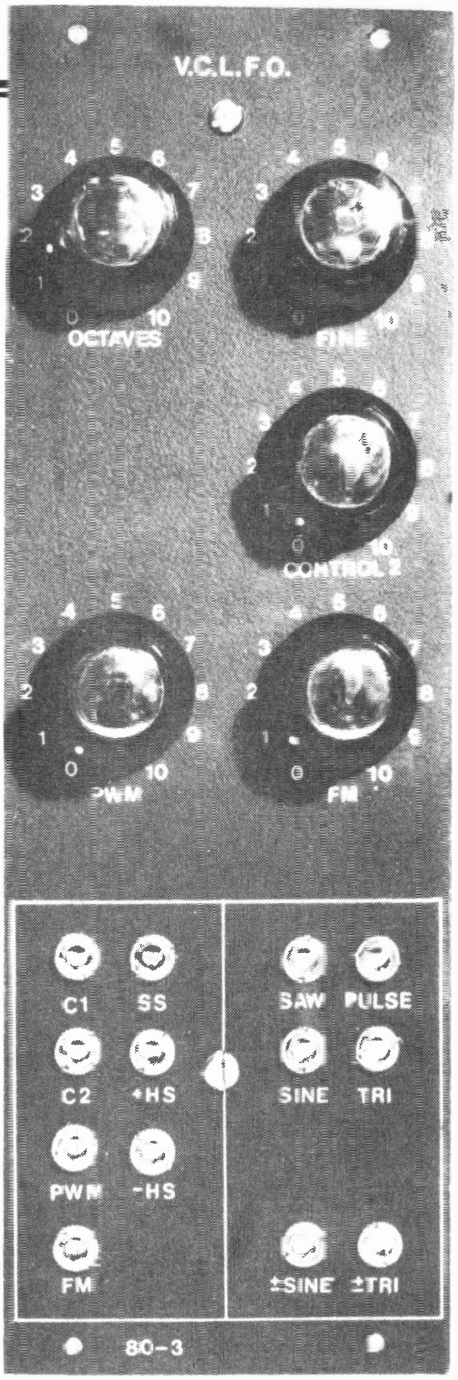
13. Keyboard Controller. Digitally scanned keyboard capable of controlling a five octave keyboard. Sample and hold with portamento. Precise octave shift over range of –2 to +3 octaves. Gate and trigger pulses. Pitch bend with variable bend level. Suitable for standard monophonic synthesiser and microprocessor compatible for polyphonic capability.

Construction

Each module is designed for both panel mounting or for housing within a standard low cost plastic case. The use of a case serves a number of purposes, one of these being a neat packaging of the modules for those who wish to construct them for other applications. The cased units are also appropriate for teaching and learning purposes, for example, the beginner should start by thoroughly exploring the functions and capabilities of each module. If electronic music is approached in this systematic way it becomes a relatively simple matter to create specific sounds at a later date. Furthermore one should not have any pre-conceived notions on the format of a synthesiser and a methodical study will enable the user to determine his approach to electronic music.

The panels are 228 x 76 mms. (9 x 3 inches). This size is widely used by commercial manufacturers of patchcord synthesisers. Such a panel will comfortably accommodate at least six control potentiometers or rotary switches with control knobs of an easily manipulated size. Standard quarter inch jack sockets are used on most of the professional equipment but their physical size limits the number of inputs and outputs per panel and it is back to compromises again. This project uses 3.5 mm jack sockets and up to twenty may be fitted onto the panel along with the six rotary controls. These miniature jack sockets should be of good quality. Screened patchcords are used to reduce the likelihood of crosstalk or noise. A major advantage of panels is their ease of construction which also applies to the case to house the panels. 1.2 mm aluminium sheet provides adequate strength and a professional appearance can be obtained by spraying and the use of transfers for the markings. The cabinet can be constructed from a proprietary laminated blockboard assembled with 'Lok-Joint' fasteners. With this type of shelving a maximum of twelve modules per row is advised unless intermediate supports are used. 9.5 mm hardwood beading along the edges of the shelves allows the panels to be mounted using small woodscrews and if only a small pilot hole is made then the panels can be repeatedly removed without refilling the holes. The panel approach provides flexibility in lay-out and virtually unlimited scope for expansion.





Above: both versions of the VCO, panel mounted for rack fixing. Note that all inputs/outputs are at the bottom of the panel to prevent wiring fouling the controls.

MODULE 1: POWER SUPPLY

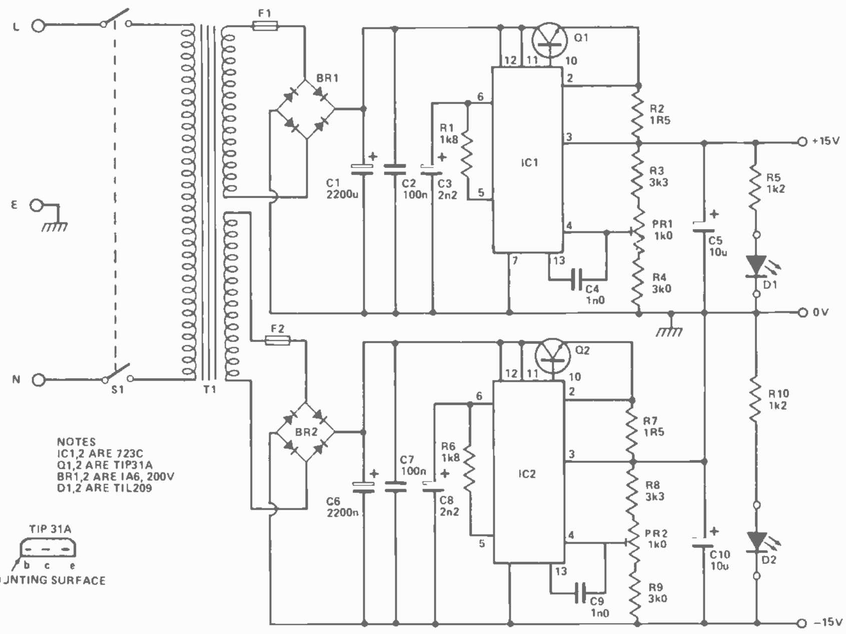
A ±15 V power supply is used for the modules except for the power amplifier which has its own supply. A design based on the 723 regulator is used and the circuit is shown in Figure 1. The circuit incorporates the recommended features for stability and both rails can be adjusted to a precise 15 V output.

Construction

The PCB has been designed to suit the mounting holes in the recommended case and these same holes can be used for vertical mounting of the power supply in the keyboard housing by means of L brackets. A 100 mm x 65 mm heatsink provides generous heat dissipation from the plastic box and this is secured to the outside of the rear panel. The transformer should be bolted onto a small piece of aluminium plate which is screwed down to mounting lugs moulded into the box. Addition of plastic feet to the box will ensure adequate ventilation through the grills.

Before connecting to the mains supply ensure that all mains connections ▶

Fig 1 (below). Circuit diagram for the Project 80 power supply.



HOW IT WORKS - PSU

Power Supply

A synthesiser requires very stable power supplies because in most designs the voltage is used to establish reference currents in the exponential generators. It is also desirable that the voltages are set at the precise 15 V levels. The ±15 V power supply for this project is based on the 723 voltage regulator. The circuit comprises two identical positive 15 V supplies with one of the outputs tied to the ground rail of the other to generate the ±15 V required.

The circuit will supply up to 300 mA per rail at full voltage and the current sensing resistor R2 (R7) limits output to about 450 mA under overload or short circuit conditions. R3, TP 1 and R4 allow precise adjustment of output voltages; R1 improves temperature stability; C3 increases ripple rejection; C4 is for compensation; and C5 reduces noise on the output which originates from the voltage reference diode in the IC.

The output is adequate for the basic project but if extension is envisaged then the same circuit board can be used for much greater outputs. The only changes required are: increased power rating of the transformer; appropriate increase in value of fuses; adjusting R2 (R7), i.e. halving this resistor will double the current limit and the PCB has provision for two resistors in parallel to facilitate obtaining the correct value. Wirewound 2W5 resistors are also used since low ohmic values are more easily obtained and the resistors are physically smaller than 1 W carbon types; increasing power rating of transistors and when more than 1 A per rail is required the latter should be mounted on separate heatsinks.

Setting up voltage controlled synthesiser modules requires a voltage source that can be quickly adjusted to a precise value. A ten turn potentiometer which can be switched to positive or negative voltage is an asset. This is shown on the boxed module. Two commoned outputs are provided, one for the output to the unit being calibrated while the other may be used for direct connection to a voltmeter. Installation of this variable voltage source is optional and components are not listed.

to plug, switch and transformer are properly insulated. The calibration consists of setting TP 1 and TP 2 to obtain, as accurately as possible, +15 V and −15 V respectively.

PARTS LIST - PSU

RESISTORS All ¼W, 5%

R1,6	1k8
R2,7	1R5, 2.5W wirewound
R3,8	3k3, metal film, 100ppm T.C.
R4,9	3k0, metal film, 100ppm T.C.
R5,10	1k2
TP 1,2	1k0 cermet trimmer

CAPACITORS

C1,6	2200uF, 35V electrolytic
C2,7	100nF, polyester
C3,8	2u2, 25V tantalum
C4,9	1nF, polyester
C5,10	10uF, 25V tantalum

SEMICONDUCTORS

BR1,2	1A6 200 V
IC1,2	LM 723CN
Q1,2	TIP 31A
D1,2	Red LED

MISCELLANEOUS

T1	0 – 17V5, 0 – 17V5 secondaries, 20 VA transformer.
F1,2	1A fuses with PCB holders.
S1	DPST rocker switch.

Heatsink (4°C/W); mains connector; output socket.
The above will fit into a Teko Alba A23 case.

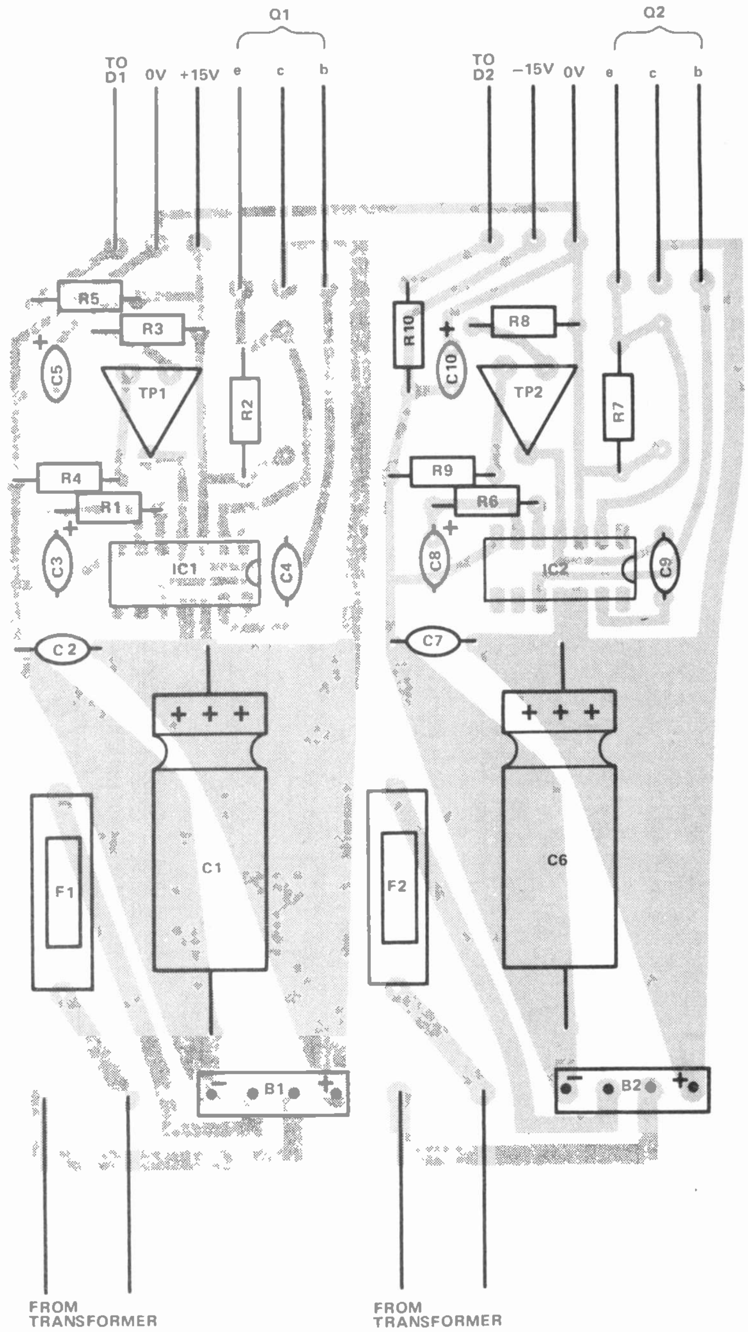
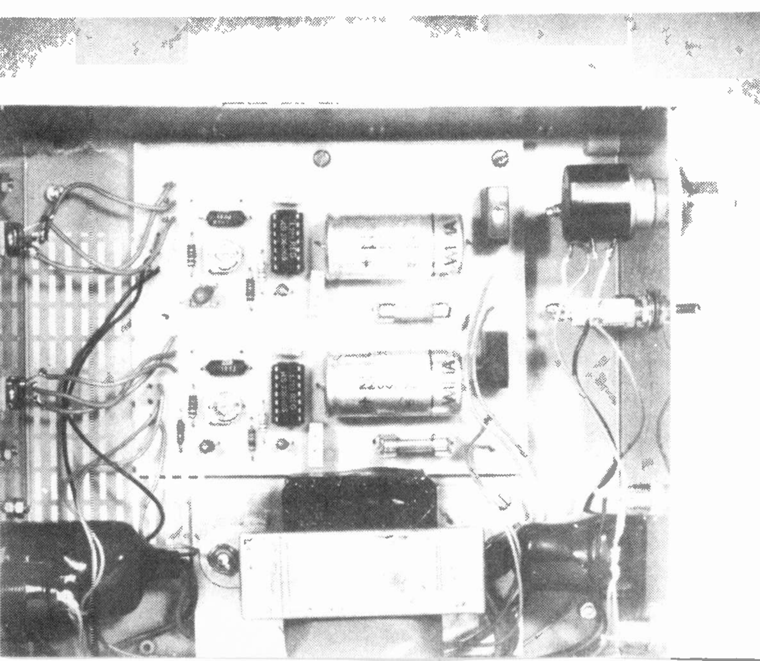


Fig. 2 (above). Component overlay for the PSU project.



Left: the inside story on the PSU project. The heatsink is mounted on the rear panel of the case.

MODULE 2: VCO

The VCO is based on the CEM 3340 IC produced by Curtis Electromusic Specialities and specifically designed for music applications. Figure 3 shows the block diagram of the device which is packaged in standard 16-pin DIL form. It provides the exponential law required for music, that is, a doubling of the frequency for a fixed increment of input control voltage, which for this project has been set at one volt per octave. The design provides excellent conformity to the exponential response from less than 10 Hz to over 16 kHz.

The CEM 3340 has triangle, sawtooth and pulse outputs. In the design presented a sine wave has been generated from the triangle output. The outputs are 0 to 10 V in amplitude which facilitates their use as control signals. Additionally, the triangle and sine waveforms are provided at ±5 V amplitude and are directly suitable for modulation applications. The duty cycle of the pulse output can be varied from 0 to 100%, either manually or by external voltage control. A linear frequency modulation input with a 10% change in frequency per volt is also included.

The IC allows three methods of synchronising the oscillator which provides an exceptional range of modulation and harmonic locking effects.

The circuit is shown in Figure 4.

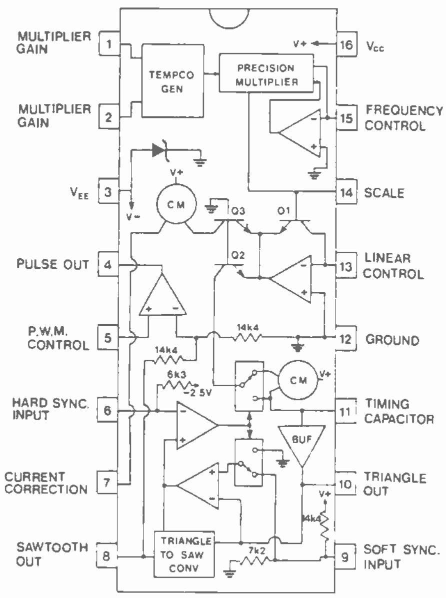


Fig. 3. Block diagram of CEM 3340 VCO chip.

Construction

Construction is straightforward and the component layout on the printed circuit board is shown in Figure . It is essential to use the components specified if the accuracy and stability of the design is to be realised. All jack sockets and potentiometers should be wired up except for the wiper of the fine control (RV2). Neat and short wiring reduces the likelihood of crosstalk and all inputs and outputs are provided at the front edge of the PCB to avoid excessive wire length. The PCB will fit the mounting lugs in a Teko Alba A23 case. It may also be mounted to the 228 x 76 mm panel with proprietary brackets or L-brackets. If the latter are used a 12.5 mm spacer between the panel and the bracket is recommended since this provides adequate space for the wires.

When all components have been installed carefully check their placement and orientation and also inspect the underside of the board to ensure that no solder bridges have been made. Before inserting the IC it is good practice to connect the board to the power supply and check that power is available at the correct points in the circuit and this is simplified by using IC sockets. If this step is satisfactory then disconnect power before inserting the IC.

A final check before calibration is to ensure that all outputs are functioning. Connect the 0 — 10 V triangle to an oscilloscope or amplifier (turn volume control nearly off) and then power up the circuit. If there is no response then switch off immediately and repeat the checking procedure. If functioning then check the other outputs although remember that the sine waveform has not been trimmed at this time.

Calibration

Set all trimmers to their mid positon. The first step is to adjust the sinewave output. With an oscilloscope, or by ear via an amplifier, adjust TP 4 then TP 5 for purest sine output. These adjustments may have to be repeated a few times to obtain the best results. Next adjust TP 6 to get the 10 V output referenced to ground. The simplest method is using an oscilloscope, but it can be trimmed using another VCO. If the latter technique is used, set the other VCO to about 1 kHz and the frequency of the VCO being calibrated at a low frequency (coarse control switch on and RV1 fully anti-clockwise). The sinewave output is then plugged into the other VCO and TP 6 adjusted until there is no discernible jump in frequency.

The last and most important step is to calibrate the oscillator to the 1V/octave relationship. The easiest method requires a variable voltage source (from a potentiometer or a calibrated keyboard), an accurate voltmeter and a digital frequency meter.

Alternatively, if a previously calibrated oscillator is available then the beat frequency technique may be employed. Another approach is to build two stable fixed frequency oscillators and use these in conjunction with an oscilloscope to calibrate the VCO by generating Lissajous figures. Whichever method is chosen the calibration proceeds as follows. With the coarse control switch, SW1 in the OFF position apply a positive voltage to Control Input 1 (R5) until the frequency is about 200 Hz. ▶

Increase voltage by one volt (as accurately as the measuring equipment allows) and adjust TP 1 until the frequency is doubled. This step is repeated until a doubling of frequency for a one volt change in input is achieved. Next increase the frequency to about 5 kHz, increase voltage by one volt and adjust TP 3 to obtain doubling of frequency. Finally, re-check the first step and if a DFM is available check the VCO over its full range.

Note that the oscillator has been (accurately) calibrated for Control Input 1. This input should be used for the keyboard, if fitted, since there may be a slight difference between Control Inputs 1 and 2 even though 1% resistors are used.

The oscillator may now be adjusted so that with no input voltages it will be tuned to the lowest frequency of a four octave C – C keyboard. Adjust TP 2 to 65.4 Hz, or if connected to a keyboard press note A and adjust to 440 Hz. This step is not essential until the VCO is connected to a keyboard. Also R4 and TP 2 may be changed to suit other keyboard requrements.

The wire to the wiper of the fine control potentiometer (RV2) may now be connected. ▶

HOW IT WORKS - VCO

Voltage Controlled Oscillator

The VCO utilises an integrated circuit which has been specifically designed for music applications. Understanding the IC and how it overcomes the many problems associated with building exponential converters from discrete components is best approached by considering the latter circuits. A transistor design makes use of the fact that in an ordinary transistor the collector current is an exponential function of the base-emitter voltage and the current can then be used for, say, charging a capacitor. The emitter saturation current, however, doubles for every 10 C change in temperature and so to employ a single transistor necessitates use of techniques such as 'ovening', that is, maintaining the transistor at an elevated temperature. A better approach is to use a well matched transistor pair, preferably on the same chip, and to arrange them so as to cancel out this particular temperature dependent term. A simplified oscillator input stage using two transistors is shown in Figure A below.

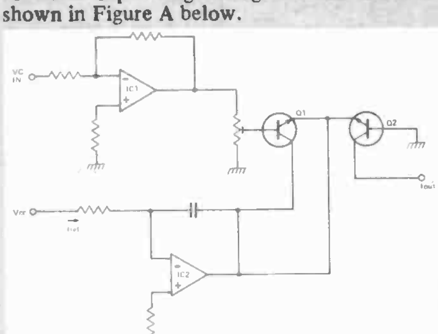


Fig. A. Input circuit.

IC1 and associated resistors and trimmer provide a means of scaling and ranging the input voltages and for the standard 1V/octave response the components are chosen to give approximately 18 mV increase at the base of Q 1 for an increase of 1 V at Vin. Next the control range is adjusted by applying a reference current to the collector of Q 1. Ideally this would be in the middle of the exponential range of the transistor, about 1uA, but considerations of bias current from IC2 usually dictate that Iref is 10uA, or more. IC2 also serves to sink the excess current from the emitters of Q 1 and Q 2. Thus the current from the output transistor Q 2 becomes:-

$$I_{out} = I_{ref} e^{V_b q/kT}$$

so that with Vin = 0, Iout = Iref. There remains, however, a temperature dependent term, 1/T, which changes the exponent by about 0.33% for every degree Centigrade change in temperature. To compensate for this the usual practice is to use a temperature compensating resistor, having a similar temperature coefficient, in the input stage so that Vin also changes by 0.33% per °C.

This project is based on the CEM 3340 Voltage Controlled Oscillator produced by Curtis Electromusic Specialities. Reference to the simplified block diagram (Figure 3) shows that the whole of the input stage described above has been incorporated within the IC. Pin 15 is the input summing stage while Pin 14 determines the scale. Since the current gain of the multiplier is set near unity a 100k input resistor (R5, R6) and a 1k8 scaling resistor (R3) provide the standard 1V/octave response and about 18mV/volt at the base of Q 1. Components R4 and TP2 set the initial frequency of the oscillator and have been chosen so that with no external voltage inputs the frequency can be adjusted to 65.406 Hz, i.e. the lowest note of a 4 octave C – C keyboard. R7 and RV1 allow manual adjustment of the oscillator by ±5 octaves. Switch S1 has been fitted between RV1 and R7 so that in normal use, i.e. keyboard; precise octave shift; and external voltage controls, slight variations in RV7 will not cause the oscillator to go out of tune. R8 and RV2 provide a fine adjustment of approximately ±0.5 octaves. The other components (R9, C5) on the summing input are for compensation and are always required. The sum of the input voltages should always remain positive for proper operation of the oscillator.

For greatest multiplier accuracy the current flowing out of Pin 2 (22VT/R2, where VT = 26 mV at 20°C) should be close to the current flowing out of Pin 1 (3.0/R1 + TP1). TP 1 is used to adjust the oscillator to a precise 1V/octave response.

The exponential generator is capable of delivering a current, Ieg, for charging and discharging the timing capacitor, from greater than 500 uA to less than the input bias current of the buffer which gives a typical frequency range of 500,000:1. For synthesiser applications one should use the most accurate portion of this range, which is from 50 nA to 100 uA. These current limits are used to determine the value of the timing capacitor, CT (C7). The oscillation frequency is given by fo = 3Ieg/2VccCT and therefore to keep within the above current limits and to maintain an accurate frequency range of 5 Hz to 10 kHz the capacitor will be 1000p with a Vcc of +15 V.

An Iref of 10 uA is produced by R11 connected to the +15 V supply. This input (Pin 13) is also used for linear frequency modulation of the oscillator. R12 adjusts the FM range to a 10% change in frequency per volt and an attenuating potentiometer (RV3) allows manual adjustment of this range. The FM input has been AC coupled so as to avoid errors from any DC drift although it may be DC coupled if required. A negative voltage at Pin 13 will gate the oscillator off.

Reference was made earlier of the need to provide temperature compensation. One of the many novel features of the CEM 3340 is the incorporation of temperature compensation within the device. This is achieved by multiplying the current sourced into the control pin (Pin 15) by a coefficient directly proportional to the absolute temperature. This coefficient is produced by the 'Tempco Generator' using the same mechanism as in the exponential generator and thus cancellation is nearly perfect.

A further problem that occurs with transistor exponential converters is their bulk emitter resistance which becomes a significant factor as current is increased and will cause the oscillator to go flat. With the CEM 3340 this situation applies when current from Q 2 is greater than 50 uA. Means of correcting for this effect have been included since Pin 7 outputs a current which is a quarter of the exponential generator current. The current is converted to a voltage across TP 3 and a proportion can be fed back into the control input via R10.

Waveform Outputs: All waveform outputs from the IC are short circuit protected and may be shorted continuously to any supply without damaging the device. A 0 – 10 V sawtooth waveform is available at Pin 8 which can sink at least 0.6 mA and source over several milliamps without any effect on oscillator performance and only a negligible effect on waveshape. The pulse output from Pin 4 is an open NPN emitter and therefore requires a pull down resistor to ground or a negative voltage. This output has been clamped with a 10 V zener diode (ZD 1) to give a 0 – 10 V pulse output. Pin 5 allows pulse width modulation and 0 to 5 V applied to this pin will vary the pulse width from 0 to 100%. Attenuating resistors R19, R20 increase the control range to our standard 0 to 10 V. P4 connected to +15 V provides manual control of pulse width and this control voltage is further attenuated by R18. RV4 input is connected via a jack socket so that it is disabled when an external voltage control source is used. Pin 10 outputs a 0 – 5 V triangle waveform. Although the sink and source capabilities approach those of the sawtooth this output has a finite impedance and also drives the comparator with the result that loading of this output into 100k impedance may lower frequency by 0.15%, in the worst case. This

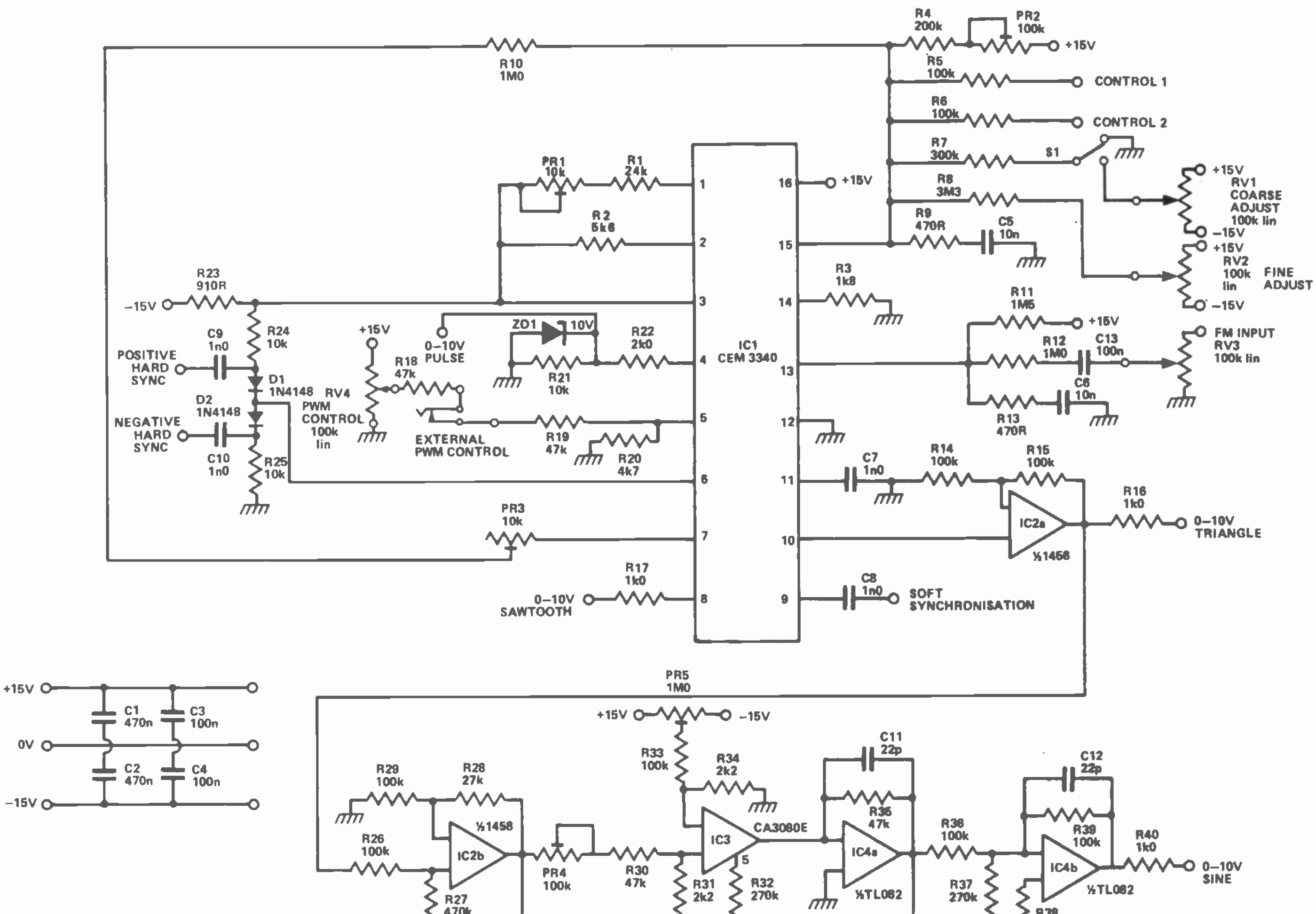


Fig. 4. The circuit diagram for the Voltage Controlled Oscillator block used in the project 80. Note that with some component value changes, this is the same configuration as used in the low frequency VCO (module 3).

output has therefore been buffered by IC2a and addition of R14, R15 increases gain by two to give a 0 – 10 V triangle output.

The triangle output is converted to ±5 V at IC2b (this output is made available from the VCO) and attenuated to about ±100 mV by TP 4, R30 and R31 prior to IC3 which is a CA 3080E. Use is made of the non linear characteristics of the OTA at high input levels to convert the triangle into a sine wave. TP 4 adjusts the 3rd harmonic content and TP 5 and associated components at the inverting input of IC3 trim the 2nd harmonic. IC4a converts the current from IC3 to a voltage and provides a ±5 V sinewave. This output is 180° out of phase compared to all other outputs but this is not detrimental in most applications of this output. Finally the sine wave is shifted to a 0 – 10 V input by IC4b with R37 and TP 6 as the level shifter.

Power supply to IC: The CEM 3340 will operate directly from positive supplies of between 10 and 18 V (although the amplitude of the waveforms as given above will decrease and increase respectively) and negative supplies from –4V5 to –6V0. Nevertheless the IC has a 6V5 zener diode within the chip which allows it to operate from virtually any negative supply voltage if R23 is selected according to (VEE – 7.2)/0.008. In this design R23 allows use of the ±15 V supplies described earlier.

Synchronisation of waveforms: Synchronisation of oscillators is often used to prevent unpleasant beating effects when two oscillators are set to ratios to produce a complex waveform. Synchronisation can, however, also be used to produce some pleasing timbral effects. The CEM 3340 has a wider range of synchronising effects than found on conventionally synchronised oscillators. Soft synchronisation by negative pulses to Pin 9 causes the triangle upper peak to reverse direction prematurely with the result that the oscillation period is an integral multiple of the pulse period. If this input will not be used it should be by-passed to ground with a 100n capacitor (provision for this has been made on the PCB). Alternatively, the 100n capacitor (C8A) may be connected to ground via a jack socket input. By-passing is to prevent unwanted synchronisation or waveform instability from noise pulses on the Vcc supply line. Pin 6 is used for hard synchronisation and R24, D1 and C9 allow synchronisation from rising edges while R25, D2 and C10 allow synchronisation from falling edges. A positive sync. pulse will cause the triangle wave to reverse direction only during the rising portion of the triangle, whereas a negative sync. pulse will cause direction reversal only during the falling portion. Figure B illustrates the hard synchronisation capabilities of the CEM 3340.

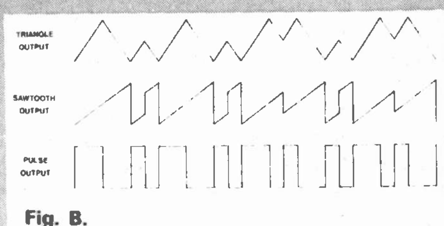


Fig. B.

PARTS LIST - VCO

RESISTORS All ¼W, 5%.

R8	3M3
R9,13	470R
R12	1M0
R14,15,26, 29,33,36,39	100k
R16,17,40, 41,42	1k0
R18,19,20, 30,35	47k
R21,24,25	10k
R22	2k0
R23	910R
R27	470k
R28	27k
R31,34	2k2
R32,37	270k
R38	24k

RESISTORS All ¼W, 1%, 100ppm T.C.

R1	24k
R2	5k6
R3	1k8
R4	200k
R5,6	100k
R7	300k
R10	1M0
R11	1M5

CAPACITORS

C1,2	470n polyester
C3,4,13	100n polyester
C5,6	10n polyester
C7	1n0 polystyrene
C8,9,10	1n0 polyester
C8A (see text)	100n polyester
C11,12	22p polystyrene

TRIMMERS

TP 1	10k cermet multiturn
TP 2	100k cermet
TP 3	10k cermet multiturn
TP 4,6	100k carbon
TP 5	1M carbon

POTENTIOMETERS

RV1,2,3,4	100k lin.

SEMICONDUCTORS

IC1	CEM 3340
IC2	LM 1458
IC3	CA 3080E
IC4	TL 082
D1,2	1N4148
ZD1	BZY 8810V

MISCELLANEOUS

S1	SPDT miniature switch;
	3.5mm jack sockets (13)

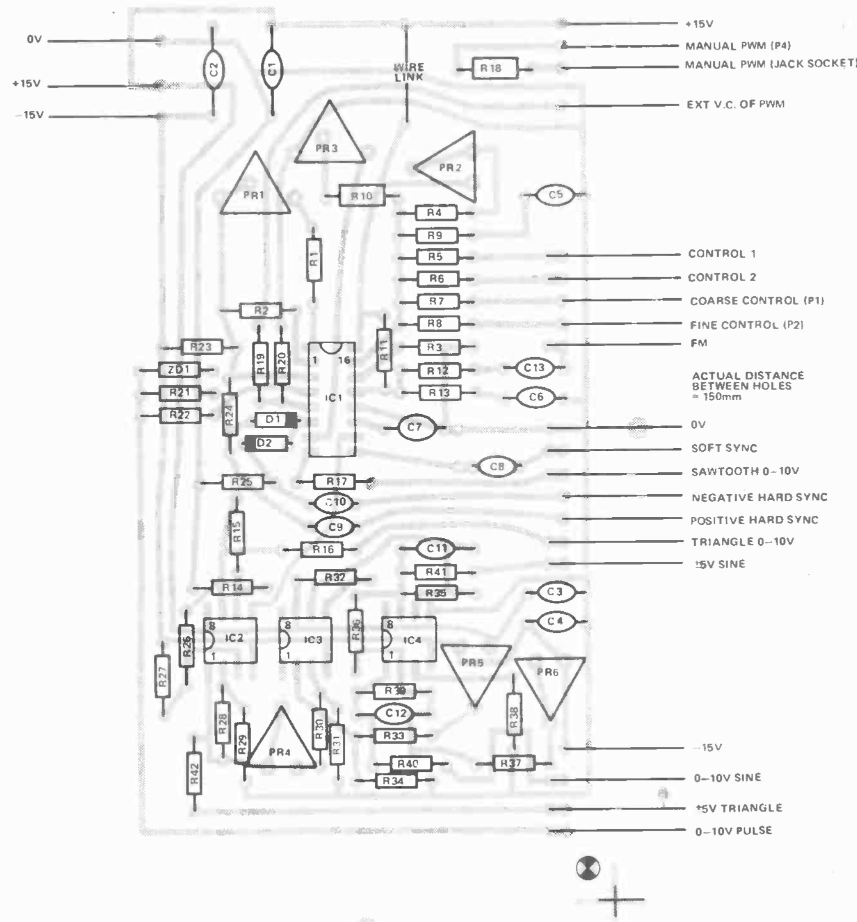
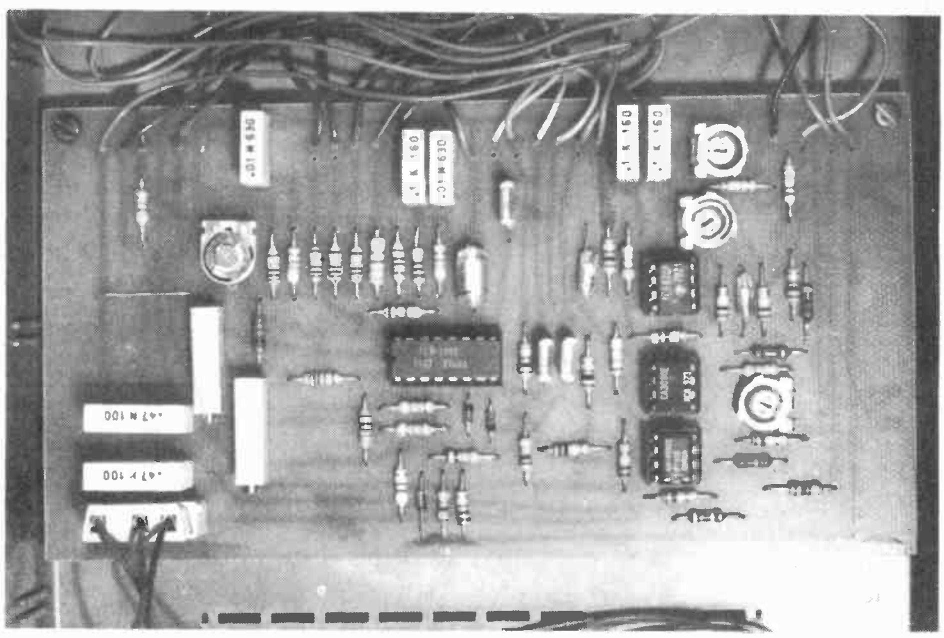


Fig. 5 (above). Component overlay for the VCO/VCLFO modules. The parts list to the left is for a standard VCO circuit. Use the changes given to the far right of page facing to convert to a low frequency oscillator.
Below: A made up PCB sat sitting in its box.



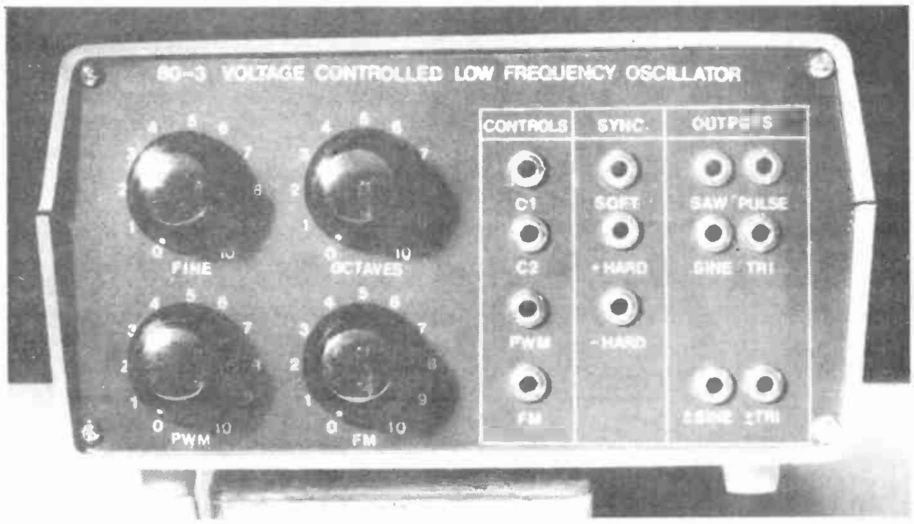
MODULE 3: VCLFO

The VCLFO is identical in design to the VCO described above. It is designed to operate in the range of 0.2 to 205 Hz with a 10 V control input. It is, however, capable of about 5 kHz. Alternatively a lower minimum frequency may be obtained by using a higher value timing capacitor, C7, provided that the capacitor is a very low leakage type.

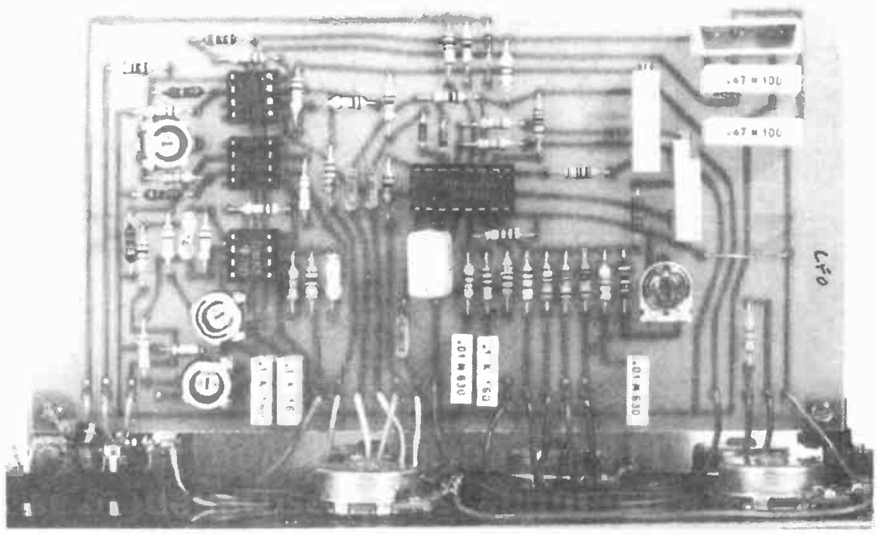
Note the component changes listed. Construction and initial setting up follows the same procedure as the VCO except that the fine control potentiometer can be wired up prior to calibration.

Calibration

Set all trimmers to their mid position.
Adjust sinewave output as described for VCO.
Turn both coarse and fine controls fully anti-clockwise (zero input) and apply a voltage to Control Input 1 to obtain doubling 100 Hz. Increase voltage by one volt and adjust TP 1 to obtain doubling of initial frequency. Repeat step until the one volt per octave response is achieved. Next increase frequency to about 1500 Hz, increase voltage by one volt and adjust TP 3 to obtain doubling of frequency. After adjusting TP 3 re-check setting of TP 1. Finally with 10 V applied to Control Input 1 adjust TP 2 to give a frequency of 205 Hz which will result in a frequency of 0.2 Hz with no external input voltages applied. ETI



Above and below: the inside and outsides of a low frequency VCO. The PCB is panel mounted just to show we did both ways! This method of construction is best suited to professional (or *very* serious amateur) use.



BUYLINES

The power supply PCB and components, including the heatsink and illuminated rocker switch but not the connectors, are available from Digisound for £19.55 incl. postage and VAT.
The PCB and components (including pots) for each voltage controlled oscillator are available from Digisound for £18.86 incl. postage and VAT.
Digisound Ltd
13 The Brooklands
Wrea Green
Preston
Lancashire PR4 2NQ
The modules are cased in Teko Alba A23G cases, available from
West Hyde Developments Ltd
Unit 9
Park Street Industrial Estate
Aylesbury
Bucks HP20 1ET
They cost £4.43 each incl. postage and VAT. Please use order code TEK A23G.

HOW IT WORKS - VCLFO

Voltage Controlled Low Frequency Oscillator
The LFO is identical in design to the VCO described above. A larger timing capacitor (C7) is used to give a frequency range of between 0.2 and 200 Hz with a 0 to 10 V control voltage. R4 and TP 4 are used to set the lower limit; RV2 provides an adjustment of one octave; and RV1 a range of 10 octaves. A switch is not required between RV1 and R7 in this instance. One reason is that both RV1 and RV2 are connected between +15 V and ground and so when the controls are fully anti-clockwise the oscillator is at the pre-set frequency (0.2 Hz). Secondly minor variations in frequency arising from RV1 and RV2 are of little importance for low frequency applications.

PARTS LIST - VCLFO

Component changes from VCO parts list.

R7	150k, 1%
R4	470k, 1%
C7	10n polycarbonate
R8	1M5, 5%
TP2	1M0 cermet

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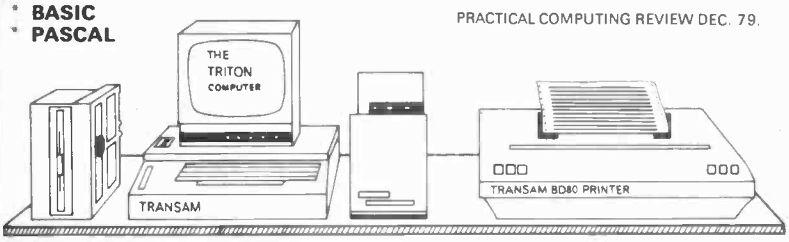

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- L9.1 CP/M disk based system **p.o.a.**
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SN74LS02N	.22	SN74LS63N	1.50	SN74LS145N	1.20	SN74LS197N	1.20	SN74LS327N	2.95
SN74LS03N	.26	SN74LS73N	.35	SN74LS148N	1.75	SN74LS221N	1.25	SN74LS352N	1.35
SN74LS04N	.26	SN74LS74N	.40	SN74LS151N	.85	SN74LS240N	2.20	SN74LS353N	1.50
SN74LS05N	.26	SN74LS75N	.46	SN74LS153N	.60	SN74LS241N	1.99	SN74LS365N	.65
SN74LS08N	.20	SN74LS76N	.35	SN74LS154N	1.60	SN74LS242N	1.90	SN74LS365N	.65
SN74SL09N	.22	SN74LS78N	.35	SN74LS155N	1.25	SN74LS243N	1.95	SN74LS367N	.65
SN74LS10N	.18	SN74LS83AN	1.15	SN74LS158N	1.25	SN74LS244N	2.10	SN74LS368N	.65
SN74LS11N	.26	SN74LS85N	1.10	SN74LS157N	.60	SN74LS245N	3.60	SN74LS373N	1.75
SN74LS12N	.25	SN74LS86N	.40	SN74LS158N	.90	SN74LS247N	1.25	SN74LS374N	1.70
SN74LS13N	.55	SN74LS90N	.65	SN74LS160N	1.15	SN74LS248N	1.99	SN74LS375N	.72
SN74LS14N	.89	SN74LS91N	.90	SN74LS161N	1.15	SN74LS249N	1.30	SN74LS377N	1.75
SN74LS15N	.25	SN74LS92N	.90	SN74LS162N	1.15	SN74LS251N	1.45	SN74LS379N	1.32
SN74LS20N	.20	SN74LS938N	.85	SN74LS163N	.90	SN74LS253N	1.25	SN74LS379N	1.40
SN74LS21N	.26	SN74LS95AN	1.20	SN74LS164N	1.50	SN74LS257N	1.40	SN74LS361N	3.65
SN74LS22N	.26	SN74LS96N	1.75	SN74LS165N	1.70	SN74LS258N	.95	SN74LS388N	.57
SN74LS26N	.29	SN74LS107N	.30	SN74LS166N	1.75	SN74LS259N	1.45	SN74LS390N	1.90
SN74LS27N	.35	SN74LS109N	.39	SN74LS168N	1.95	SN74LS260N	.39	SN74LS393N	1.50
SN74LS28N	.35	SN74LS112N	.30	SN74LS169N	1.95	SN74LS261N	3.50	SN74LS395N	1.80
SN74LS30N	.25	SN74LS113N	.44	SN74LS170N	2.50	SN74LS266N	.30	SN74LS396N	1.70
SN74LS32N	.27	SN74LS114N	.44	SN74LS173N	2.20	SN74LS273N	1.65	SN74LS398N	2.75
SN74LS33N	.39	SN74LS122N	.79	SN74LS174N	1.15	SN74LS279N	.79	SN74LS399N	1.60
SN74LS37N	.29	SN74LS123N	.90	SN74LS175N	1.05	SN74LS280N	1.75	SN74LS424N	4.50
SN74LS38N	.29	SN74LS124N	1.90	SN74LS181N	2.75	SN74LS283N	1.80	SN74LS445N	1.25
SN74LS40N	.25	SN74LS125N	.65	SN74LS190N	1.75	SN74LS290N	1.80	SN74LS447N	1.25
SN74LS42N	.79	SN74LS126N	.65	SN74LS191N	1.75	SN74LS293N	1.80	SN74LS490N	1.95
SN74LS47N	.95	SN74LS132N	.75	SN74LS192N	1.45	SN74LS295AN	2.20	SN74LS668N	.95
SN74LS48N	.95	SN74LS133N	.39	SN74LS193N	1.75	SN74LS298N	2.20	SN74LS669N	.95
SN74LS49N	1.00	SN74LS136N	.40	SN74LS194AN	1.89	SN74LS324N	1.80	SN74LS670N	2.70

SUPPORT	
8212	2.20
8216	2.80
8224	2.80
3853 (F8)	10.00
8228	4.20
8T26A	1.75
8T28	1.90
6522	8.75
8251	5.00
8253	11.00
8255	5.00
8257	11.00
8259	12.50
8155	12.50
6402	5.00
6821P	4.50
6850P	4.60
6852P	5.50
AY-5-2376	11.50
MC14411	12.00
M57109	12.43
M57160	10.00
M57161	10.00
TMS6011	5.00
81LS95	1.80
81LS96	1.80
81LS97	1.80
81LS98	1.80

RAMS	
2101	2.32
2102L-4	1.20
2111	2.32
2112	2.46
6810	4.00
8154	11.50
2114L-450	5.50
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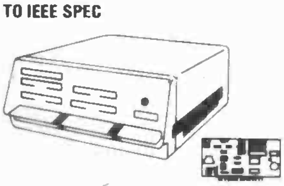

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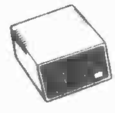

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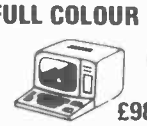

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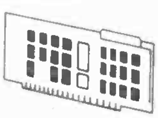

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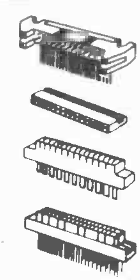

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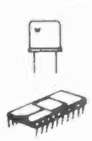

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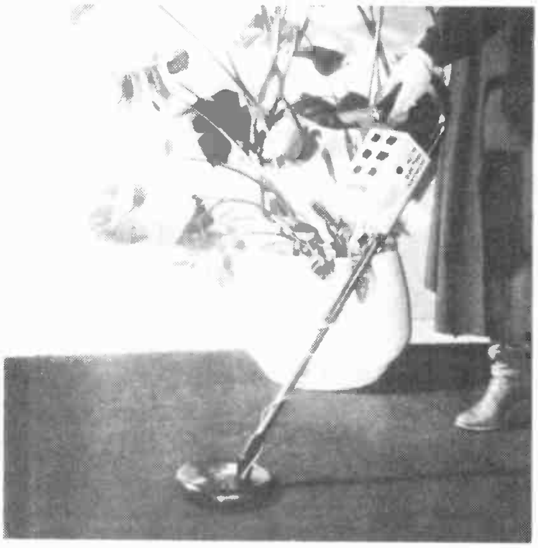

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Next month Ian Graham has a bash at explaining that most enigmatic of astronomical propositions — the black hole.

TV SOUNDS GOOD?

Tired of tinny tunes from your telly? The melodic meanderings start out from the transmitter in super-duper hi-fi, but the cost cutting sounds section of your set takes care of that, lowering the fi at the speed of light. Next month Richard Maybury explores the world of TV sound and comes up with a few ideas on improving it.

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DESIGNER'S NOTEBOOK

Project editor Ray Marston makes an in-depth review of the revolutionary mini-robot, HEBOT.

The basic electronic concept of the Hobby Electronics HEBOT is brilliantly innovative and uses the priority encoding principle illustrated in Fig 1. Each drive motor is energised fron an analogue driver circuit. Each driver has a high input impedance and can drive its motor forward or backward at a speed proportional to the input voltage. The motor drive 'instructions' (analogue voltages) can be selected from any one of (up to) eight independent sources (or circuit boards) via a motor instruction selector or 'multi-way electronic switch', which has its position controlled by an (up to) eight-level priority encoder. This encoder causes the motor to take its instructions from the source or circuit board with the highest active priority coding at any given moment of time and is analogous to a human central nervous system.

Suppose that we connect just four independent circuit boards to the HEBOT's central nervous system and assign each board a priority number as shown in Fig 1. Board 1, with the lowest coding, simply instructs the motors to drive HEBOT in a 'search' pattern. Board 2 is a light-sensing circuit that gives a 'high' output to the priority encoder only in the presence of bright light and then produces motor instructions that steer the HEBOT towards the light source.

Board 3 is designed to detect the presence of, and guide the motors along, an inductively-coded wire loop. This board produces a 'high' priority output only in the presence of the loop. Finally, board 4 (with the highest priority coding) handles the tactile sensor logic and produces a 'high' priority output in the event of a collision and then instructs the motors to execute a suitable avoidance manoeuvre.

A Sequence Of Actions

A possible sequence of HEBOT actions may in this case be as follows.

At switch-on, all priority outputs except '1' may be low, so HEBOT accepts instructions from board 1 and goes into a 'search' or rotary-movement mode. During this move-

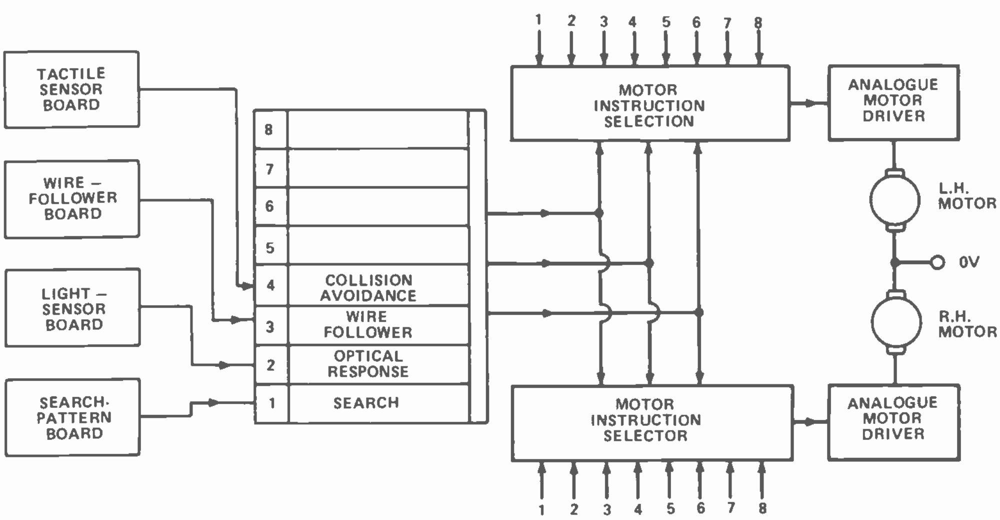


Fig 1. The priority encoding principle used in HEBOT has revolutionary implications in Robotics.

ment the light-sensing board may detect a powerful light source some distance away and so set its priority output high and start generating the motor instructions necessary to steer the HEBOT towards the light source. Since '2' is a higher priority number than '1', the priority encoder will automatically turn the motor instruction selectors to board 2 and HEBOT will start moving towards the light source. Note that under this condition the 'search mode' instructions may still be generated but will be ignored by HEBOT.

Suppose now that, as HEBOT moves towards the light source, board 3 detects the presence of an inductively coded wire loop. In this case the priority-3 output of the board will go high and HEBOT will lock on to the motor drive instructions of board 3, ignoring the instructions of boards 1 and 2. While following the inductive wire, HEBOT may collide with an object. The collision will be detected by board 4 (the highest priority board) and the mini-robot will then execute an avoidance manoeuvre based on instructions from board 4, ignoring all instructions from boards with lower priority numbers.

On completion of the avoidance manoeuvre, HEBOT may have lost contact with both the inductive wire (priority 3) and the light source (priority 2), in which it will revert to the priority-1 'search' mode until a higher priority number is generated.

A Revolutionary Concept

This 'priority coding' system has enormously important and revolutionary implications in robotics. First, it means that robots no longer have to be designed as single complex entities, but can be built as highly versatile devices containing a number of quite independent control/sensing modules, all feeding ino a simple central nervous system or priority encoder.

The simple (?) version of HEBOT published in the recent editions of Hobby Electronics uses only the four priority levels already described. The experimenter can, however, design additional control boards and add them to the HEBOT at will. Figure 2 shows a possible way of connecting a number of independent circuits into the HEBOT central nervous system to give eight levels of priority encoding.

Individual boards can even incorporate their own priority-coded response conditioners, in which case they can be regarded as NERVOUS SUB-SYSTEMS

8	RADIO CONTROL
7	COLLISION AVOIDANCE, (TACTILE)
6	COLLISION AVOIDANCE, (ULTRA–SONIC)
5	HUNGER AVOIDANCE
4	WIRE FOLLOWER MODE [SEARCH AND LOCK]
3	OPTICAL RESPONSE
2	ACOUSTIC RESPONSE
1	'SLEEP' MODE

Fig 2. A possible sequence of priority coding for an advanced version of HEBOT.

Human Behaviour

The second important implication of the HEBOT priority coding system is that it can give a very close analogy of animal/human behaviour. Figure 3 is a provisional table of human behavioural priority levels. The table shows six main priority levels, with COMFORT/PLEASURE (into which work ethic is entwined) having the lowest priority level and CONFORMANCE (conditioned resposes) having the highest priority level (even higher than survival). If a ▶

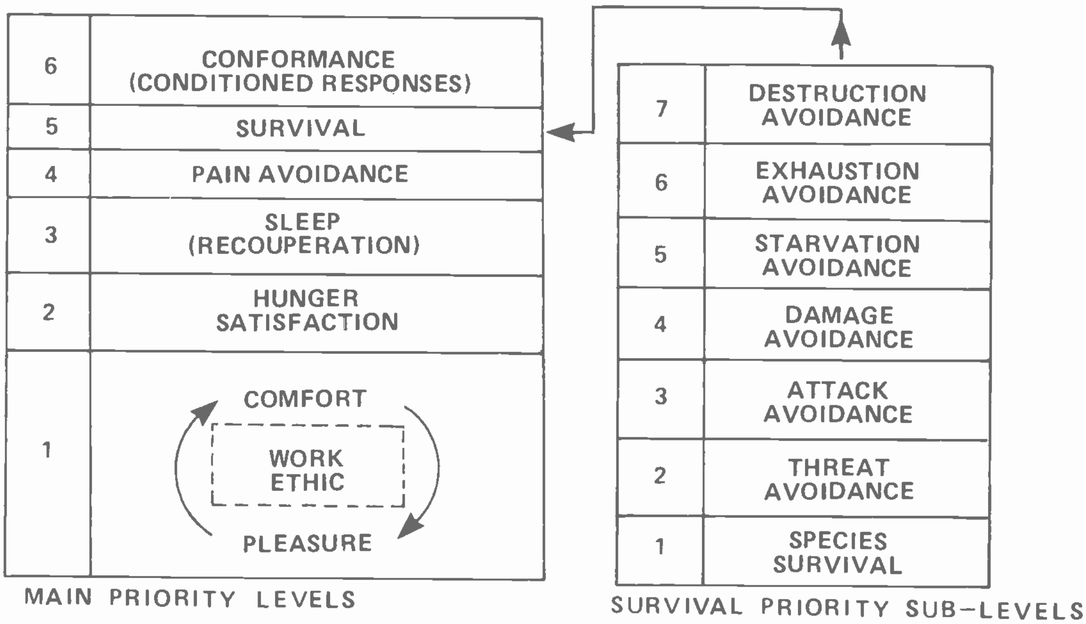
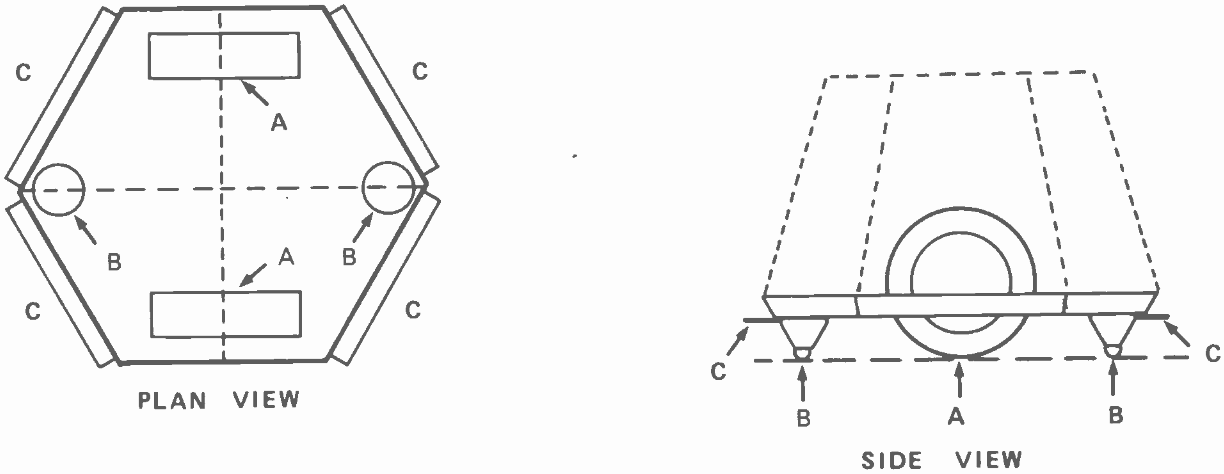


Fig 3. Provisional chart of human behavioural priority levels and survival sub-levels. Behavioural patterns are predictable and can be simulated by a HEBOT-type robot.



A = MOTOR DRIVE UNIT
B = BALL CASTOR
C = TACTILE SENSOR

Fig. 4. (Above) The HEBOT chassis. Although outwardly very simple, a great deal of thought and effort went into the final design of this. Anyone who saw HEBOT trotting around at Breadboard exhibition recently will realise that this configuration is in no way a limiting factor on HEBOTS performance.

The shape of the chassis helped us to determine several important factors for HEBOT and helped in finalising the tactile sensor arrangements.

number of these priority levels are stimulated simultaneously, the highest priority will override the lower ones.

The really fascinating feature of human/animal behaviour is that each of the main priority levels consists of a number of sub-levels. In Fig 3 seven main sub-levels of the survival priority are shown. Each of these sub-levels can in turn contain priority sub-levels. Each level and sub-level is fed with sensor information which itself has a number of basic levels: peckishness, hunger and starvation are, for example, three levels of the same basic sense which, when connected to the appropriate levels and sub-levels, produce highly complex but predictable behavioural patterns.

Similarly, work ethic normally has a low rating in the main priority levels but may, under certain circumstances, attain very high priority ratings as discrete sub-levels of a survival (level 5) or conformance (level 6) main priority level.

These complex behavioural patterns can easily be electronically simulated,or modified and improved upon, by using HEBOT's basic and revolutionary 'priority encoding' concept.

Indestructible

The final important implication of the HEBOT 'priority encoding' system is that, since most priority levels and sub-levels are normally low or inactive,, it follows that total obliteration of an individual priority level will result in a mere degradation of the total performance of, rather than the total disabling of, a priority encoded robot system. Compare this concept with that of a television or computer, where every individual component is vital to the functioning of the total system! An alternative way of stating the same point is to say that the performance sophistication of a priority-encoded robot can be enhanced at any time by merely adding extra priority levels or sub-levels to its existing 'nervous system'.

Thus, at one end of the complexity scale, our simple little HEBOT project can (in principle) easily be expanded into a highly sophisticated super-robot. At the other end of the scale, it is feasible that a highly sophisticated HEBOT-type robot could (like a living animal) have 90% of its circuitry blasted to shreds by machine-gun fire yet still be able to perform useful function (stay alive). In this latter case, the 'vital organs' of the HEBOT are the central nervous system, the motor drive system and the power supply unit.

You can see, then, why we are so proud of HEBOT. Superficially, it does not look very impressive, but it in fact incorporates the most far reaching design concept yet devised in the field of robotics. It represents a major breakthrough in robot technology and places the off-the-shelf commercial/domestic robot of 'science fiction' within the reach of all of us. And, by jove, it's British! ETI

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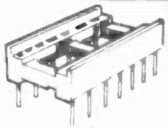

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	100					8p
		220				10p
				470		15p
	1000					23p

CONNECTORS

JACK PLUGS AND SOCKETS

	unscreened	screened	socket
2.5mm	9p	13p	7p
3.5mm	9p	14p	8p
Standard	16p	30p	15p
Stereo	23p	36p	18p

DIN PLUGS AND SOCKETS

	plug	chassis socket	line socket
2pin	7p	7p	7p
3pin	11p	9p	14p
5pin 180°	11p	10p	14p
5pin 240°	13p	10p	16p

1mm PLUGS AND SOCKETS

Suitable for low voltage circuits, Red & black.
Plugs: 6p each. Sockets: 7p each.

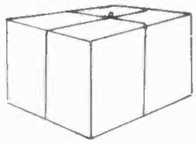
4mm PLUGS AND SOCKETS

Available in blue, black, green, brown, red, white and yellow. Plugs: 11p each. Sockets: 12p each

PHONO PLUGS AND SOCKETS

Insulated plug in red or black	9p
Screened plug	13p
Single socket 7p Double socket	10p

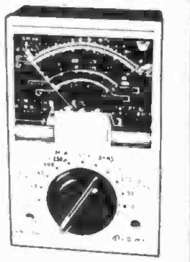
JANUARY SPECIALS



A range of special offer items valid during January. All orders placed for these items must be received during January.

	was	now
Pack of 3 x LM380	~~225p~~	200p
Pack of 30 x 1N4001	~~120p~~	100p
Pack of 4 x FND500	~~400p~~	350p
Pack of 15 x 2N3702	~~120p~~	100p
Pack of 15 x BC107	~~120p~~	100p
Special pack of nuts + bolts containing over 600 4BA + 6BA nuts, bolts and washers	~~330p~~	250p
Pack of 4 red + 4 black crocodile clips	~~64p~~	50p
Mixer control knobs, per 100 (mixed) colours to suit	~~1400p~~	1300p

MULTIMETERS

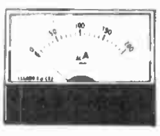


A really smart looking multimeter with an impressive specification for such a small size. The very clean scale in white and green on a black background makes this meter very easy to read. The D.C. Impedance of this meter is 4K ohms per volt which is exceptionally good compared with the vast majority of multimeters of a similar size. **£5.95 each.**

SPECIFICATION

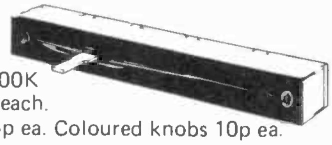
DC Volts	5V 25V 250V 500V (4K ohms/V)
AC Volts	10V 50V 500V 1000V (2K ohms/V)
DC Current	250uA 250mA
Resistance	0 – 600K (7K ohms centre)

PANEL METERS



High quality 2" wide view meters. Zero adjustment. Back illumination wiring.
Available in 50 uA, 100 uA, 500 uA, 1mA, 100mA, 500mA, 1A. £4.95 ea.
VU meter similar style. £1.50 ea.

SLIDE POTENTIOMETERS



Good quality 60mm travel slider with 80mm fixing centres. Available from 5k – 500K in log and linear. 55p each.
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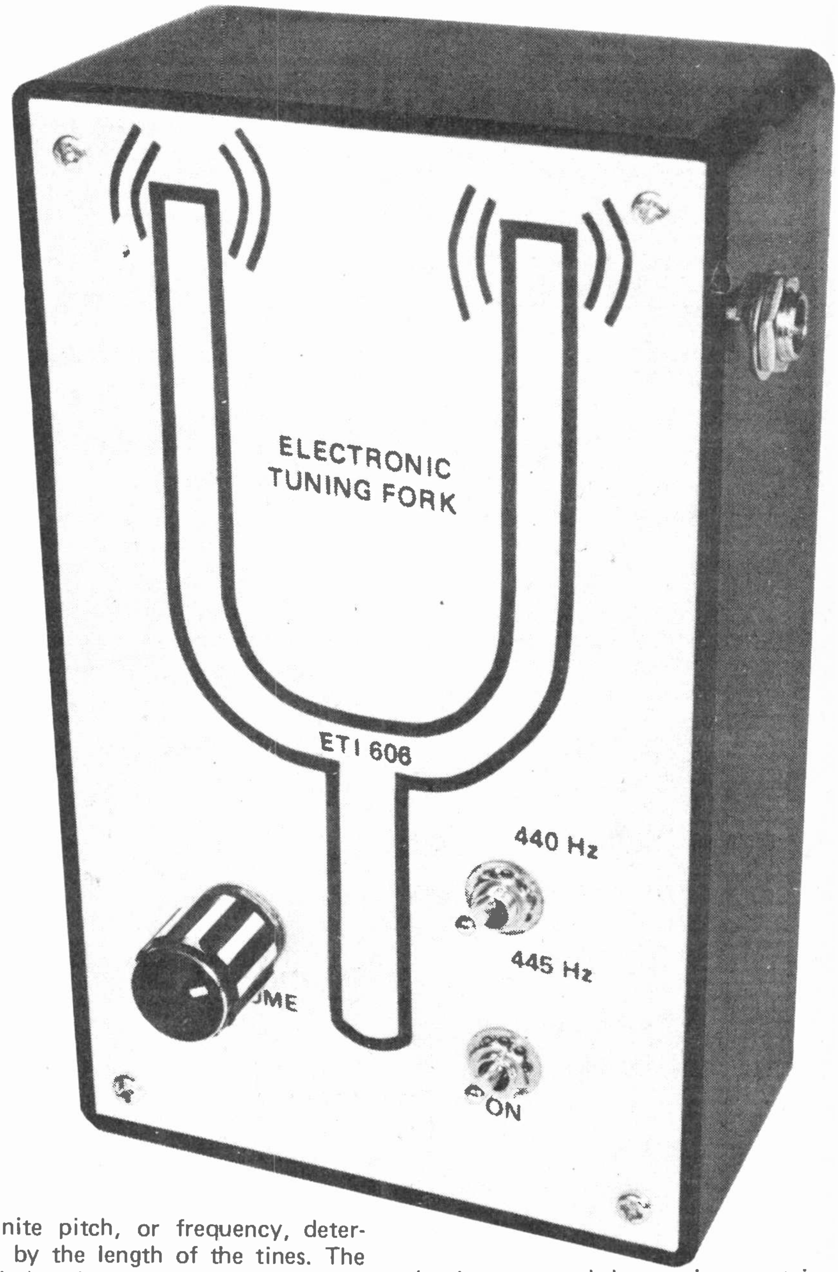
TUNING FORK

You don't have to bash this tuning fork on its head and sit it on the sideboard to get a note. Just flick a switch and get a constant frequency tuning tone.



Musical instruments are generally a clever and harmonious blend of physics and aesthetics (both aural and visual). But, underlying all this wonderful harmony and human cleverness is the law of 'the cussedness of nature'. This law, simply explained, says that through all the consistency and harmony we find in nature runs a streak of cussedness always causing *something* to be out of place. It is this very streak of cussedness that has thwarted attempts to date to develop a 'unified field' theory that would link gravity, electricity and magnetism.

It doesn't seem, at this stage, that gravity, electricity and magnetism have much to do with musical instruments and tuning forks, but we'll get around to it!

For one musical instrument to be played with another requires both to be tuned to the same fundamental pitch (or frequency). If not, the sound will be unpleasant — generally described as discordant.

Fork Lore

Over the centuries there were various ideas as to what basic 'standard' pitch would be adopted. After some considerable squabbling a 'standard concert pitch' was settled upon in 1929. This gave the note 'A' a pitch of 440 Hz. That standard remains to this day. Of course, it means that modern orchestras playing the music of Hadyn, Mozart and Bach, for example, will not be playing in the pitch in which the music was originally composed.

The traditional tuning fork consists of two cantilevered bars attached to a common base — it resembles that common eating utensil, hence the name. When the tines are struck (or one tine) they will vibrate, producing a sound of a definite pitch, or frequency, determined by the length of the tines. The pitch is largely unaffected by temperature, except by gross variations, and accuracy can be maintained within about 0.1%.

They are portable and relatively inexpensive but suffer from low sound level output and do not give a sustained note — it 'dies away'. What's more, as many modern groups use electrically amplified instruments and sound reinforcement, a failing of tuning forks is lack of a pick-up. ▶

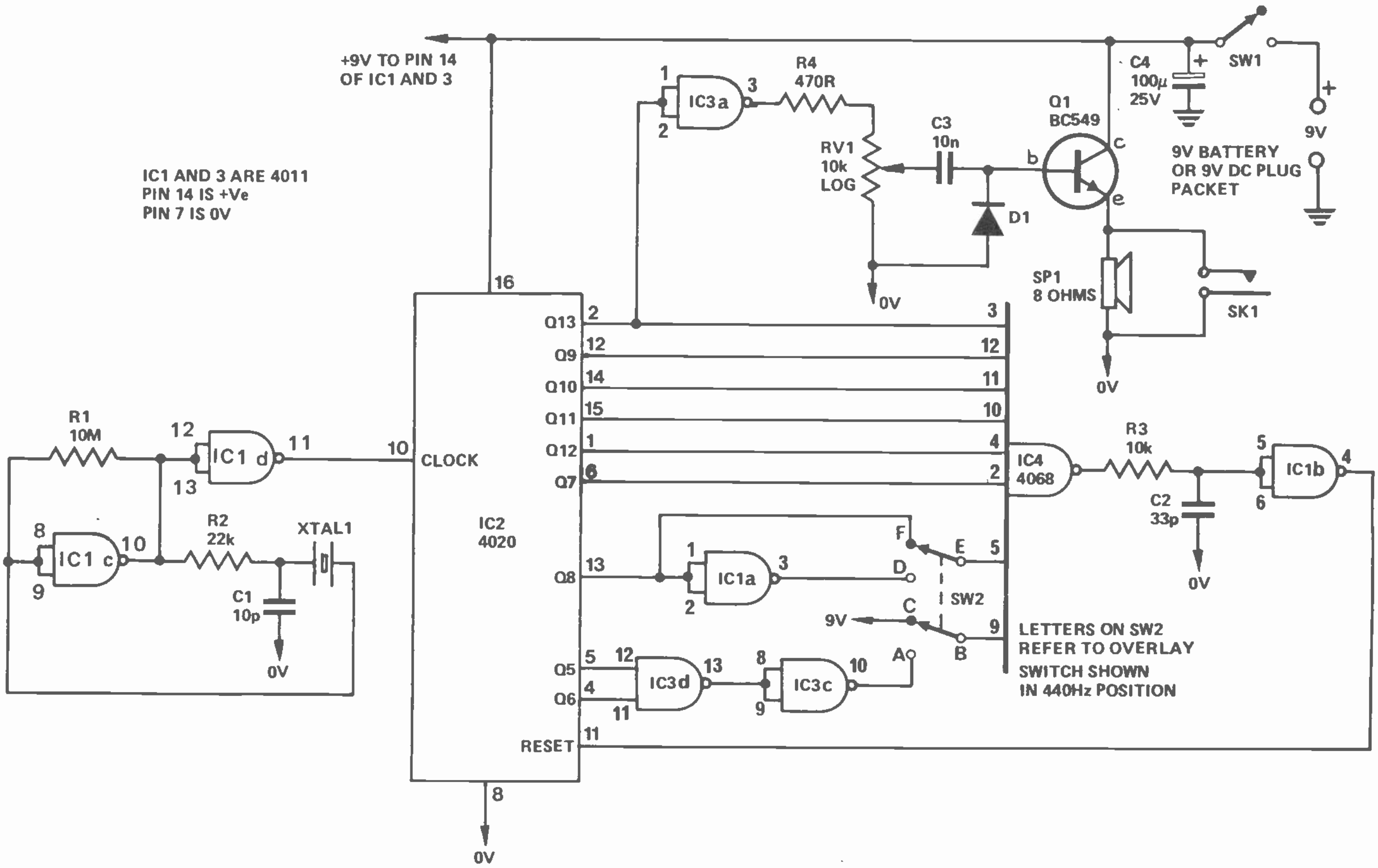
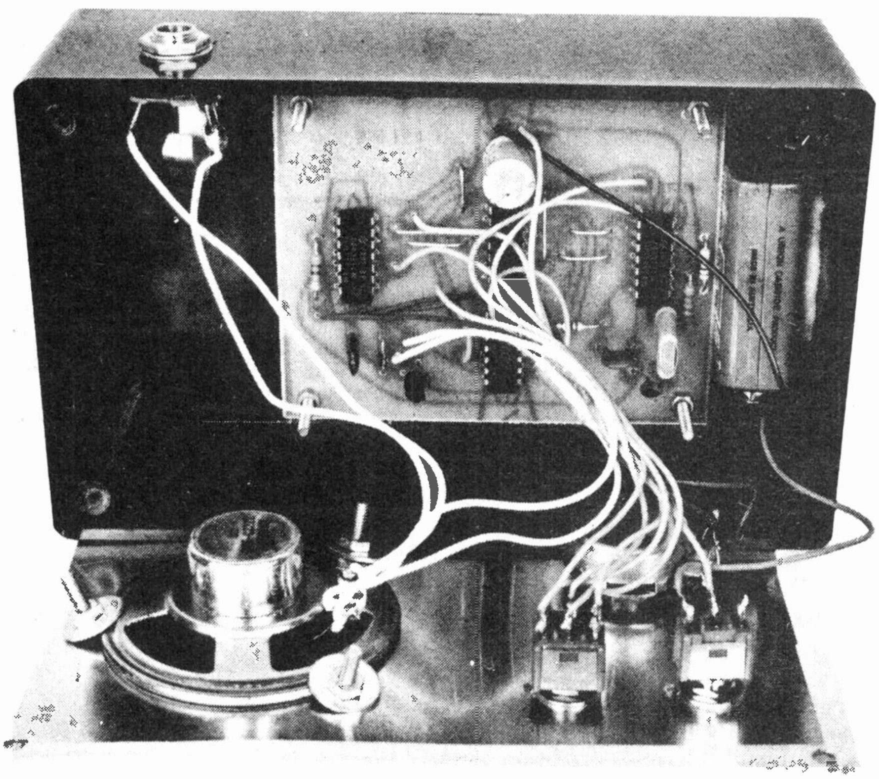


Fig. 1. Circuit diagram.



When you get all your bits bolted down into box, it should look like this.

HOW IT WORKS

The signal is generated at a high frequency (about 3.6 MHz) by a crystal oscillator and then divided down to the output frequency by a counting circuit. IC1c is the oscillator – gates biased into their linear region by R1 and R2. Capacitor C1 forms a phase-shift network with the bias components, providing a shift of 180 degrees at the crystal frequency. As the crystal is in series with the feedback path, the circuit will oscillate at the crystal frequency.

IC1d forms a buffer between the oscillator and the clock input of IC2, a 14-stage counter.

As the required division is not a power of two, decoding of the counter (IC2) outputs is necessary. This is provided in three gates – IC1a, IC3c and IC3d. These modify the ouputs of IC2 to obtain the required division by resetting IC2 after the appropriate count.

Switch SW2 changes the decoding for either a division by 8128 for a 440 Hz output or 8048 for a 445 Hz output.

When all the inputs of IC4, an eight input NOR gate, go high its output goes low and drives IC1b via a network to remove noise pulses (R3, C2). IC1d then provides a reset signal to the divider, ready for the next count.

The Q13 output from the divider provides a signal at the required frequency and, after buffering provided by IC3a is fed to the volume control. The pulses are then fed to an emitter follower (Q1) and thence to the speaker.

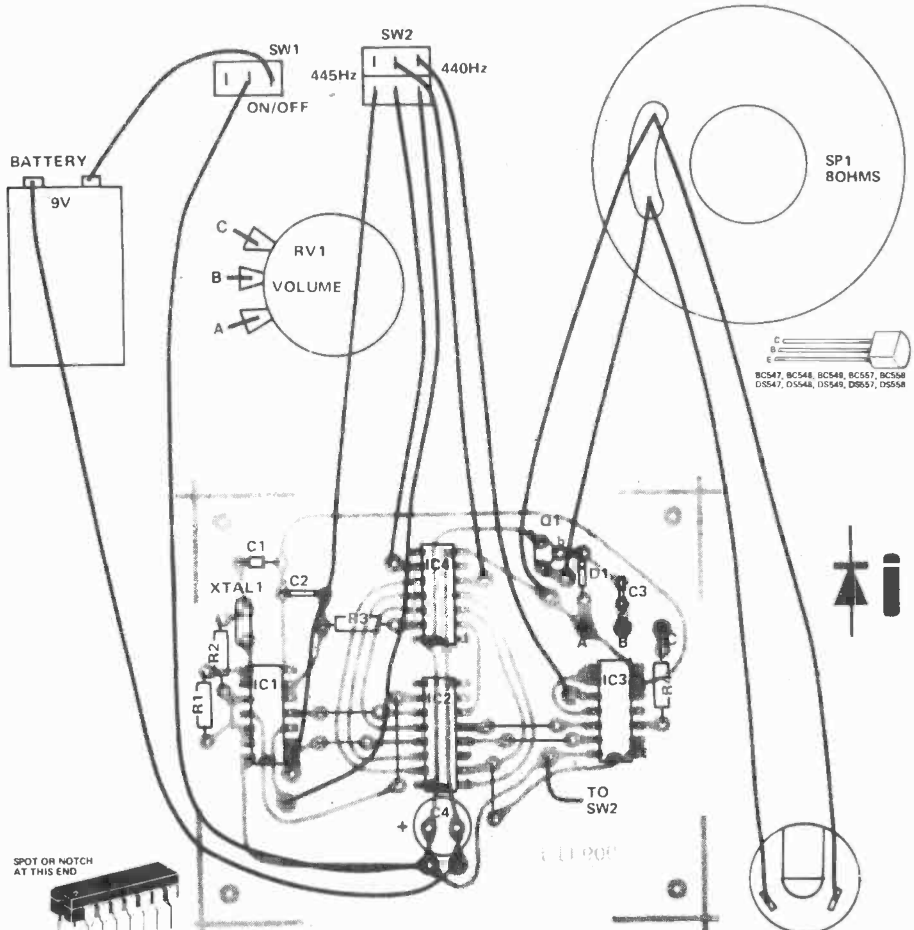


Fig. 2. Component overlay.

PARTS LIST

Resistors	**All ¼W, 5%**
R1	10M
R2	22k
R3	10k
R4	470R
Capacitors	
C1	10p ceramic
C2	33p ceramic
C3	10n polyester
C4	100u 25V electrolytic
Semiconductors	
IC1,IC3	4011B or C
IC2	4020
IC4	4068
Q1	BC548,BC108 or similar
D1	1N914, or similar
Miscellaneous	
RV1	10k log potentiometer
XTAL 1	3.579545 MHz Xtal
SP1	8 ohm speaker
SW1	SPST miniature toggle switch
SW2	DPDT miniature toggle switch
SK1	mono jack socket

9 V battery or Plug Pack (Ferguson type PPA9 – DC or similar), PCB, box to suit (155 mm x 105 mm x 50 mm), knob, plug for jack socket (if needed).

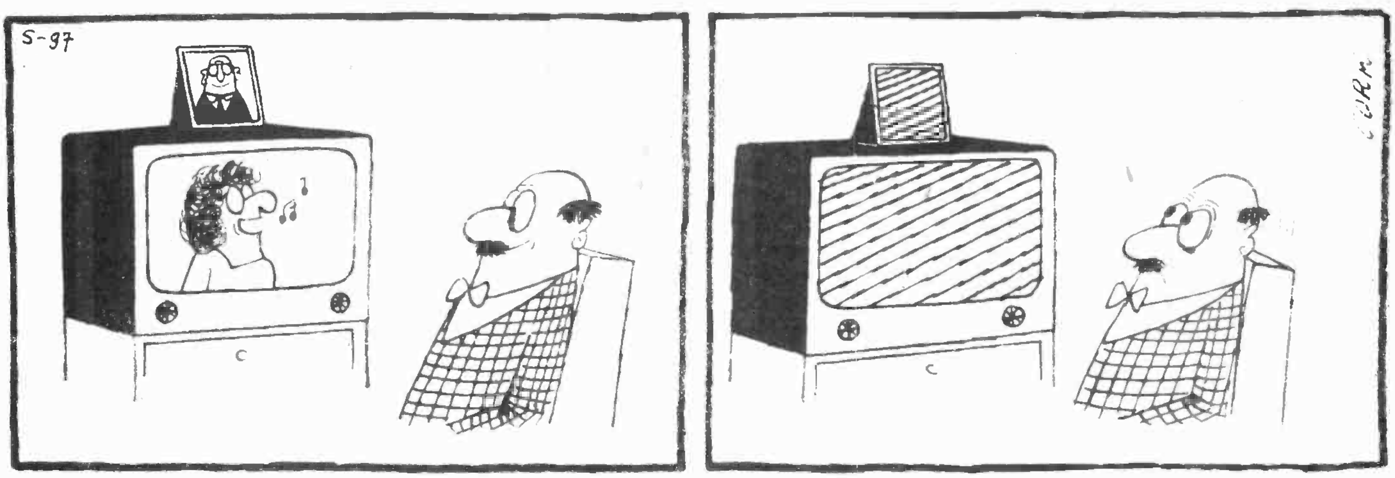
Again, the cussedness of nature raises its head. Remember too, the popularity of the electric guitar. They have magnetic pickups and require plugging into an amplifier. Now you see what electricity and magnetism have to do with musical instruments! Gravity? Oh, most instruments will go out of tune when dropped from a height!

Construction

We strongly recommend you use the pc board specified for this project. For a start, it simplifies construction, and secondly it reduces the possibility of wiring errors. With digital circuitry, bugs created by wiring errors can prove most frustrating to track down – particularly if you haven't had much experience with digital equipment. The project is not a difficult one; if you have had a small amount of experience constructing projects and finding your way around circuits and layout diagrams, then it should not prove too challenging.

It is best to commence construction by assembling the components on the printed board. Leave the ICs till last. Solder the crystal, the BC547 transistor, diode, resistors and capacitors in first. Watch the orientation of the diode, D1. Then do all the links using, say 22 gauge, tinned copper wire. There are six in all. Take care here, and refer to the overlay.

The last thing to do is check that you have the switches wired correctly. Make sure that when you switch from 440 Hz to 445 Hz the output goes a little sharp in pitch. ETI



computing today

WHAT TO LOOK FOR IN THE FEBRUARY ISSUE ON SALE JANUARY 11TH.

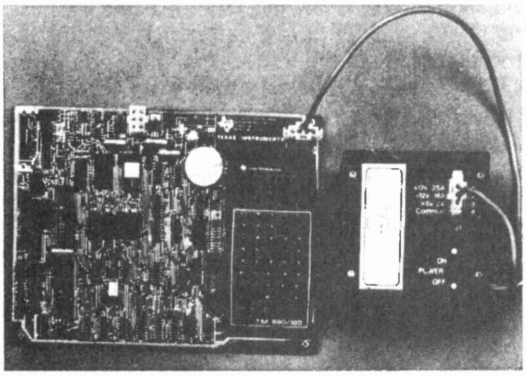
LOGIC EMULATOR

Does your logic lie to you? Do you doubt the truth of your tables? Next month we present a solution to your logic design problems with a software logic emulator for the Nascom. The design caters for the usual range of logic gates and will allow you to try out various input combinations. A must for all who are not up to Mr. Spock's logical capabilities!

MICROLINK

We start a new occasional series on connections you can make with your micro. In the first part we show you how to get your Mk14 or Acorn to flash lights on and off, a vital step for micro-mankind.

TEXAS UNIVERSITY MODULE



There have been evaluation kits and there have been teaching aids. Now there are teaching aids which can double as an evaluation kit! What Texas have produced, however, is a one board education system (TM990/189) which is also an excellent evaluation and to the TMS 9980 16-bit MPU!

A 300 page course comes with the board — along with a hell of a lot else. But is it good value? Can it teach machine code programming as promised? Could it really educate cavement and Spurs supporters? Can it make good tea?

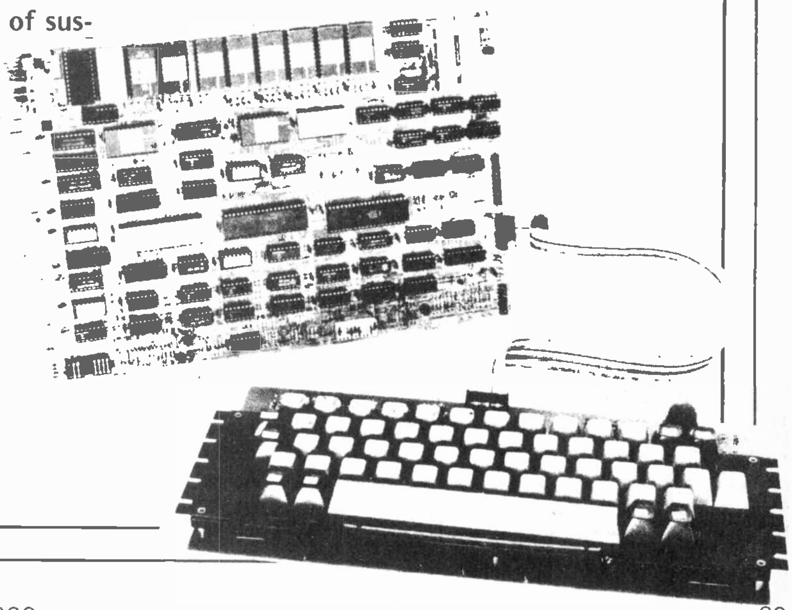
Don't miss next month's stunning inside information when CT reveals all on the TM990/189. The Wews of the Norld will envy us.

NASCOM 2

It has been the most (and longest) awaited home computing system for a considerable time. Everyone we spoke to had heard of it — and knew a great deal about it — but no-one had actually seen it!!!

Well we can put you out of the state of suspense because CT has been examining a Nascom 2 in great detail and will report all that there is to be reported in our next issue.

Whatever you were expecting we can guarantee you that the Nascom is a surprise!



AUDIOPHILE

Ron Harris takes time off returning noisy records for a chat with the record industry and a word about mini headphones with a mighty performance.

I am appalled. Totally and utterly appalled. Apart from that I'm not even happy. In the past month I have attempted in vain to buy myself some LPs with which to exercise all this hi-fi stuff our hobby is based upon.

I was particularly looking forward to 'Tusk'. After all, it cost a large fortune to produce — digital mixing and all — and the music promised to be worth all the effort. Six copies later I still cannot comment on how good the production finally turned out. Six copies and six doses of snap crackle and pop made me give up on the idea completely. Sorry Warner Bros but I *do* like some music with my surface noise. Silly, I know, but I'm old-fashioned that way.

The new Pink Floyd double LP led me a similar dance, wearing out the carpet in the record shop in the process. No-fi 2 me 0, and so it continued all month. Final score? LPs purchased — five; LPs kept — one; copies returned twelve.

Now admittedly this has been the worst ever month for duff records, but it is not unfortunately actually unique. Most records these days have to go back at least once — the record shop next to our office (Our Price Records — and very helpful they are too, thank God) is thinking of giving me a job. After all I spend more time at the exchange counter than the staff.

Other people I've talked to about this seem to suffer from a similar malaise, so I'm not gonna feel too paranoid just yet. Besides, you meet a nice class of person exchanging LPs. Beats discos anytime.

Trouble is — what *is* the point of all this ultra-fi that some of us are addicted to, if record companies go on churning out pure unadulterated garbage for us to play on it? Digital LPs may be on the way but in the meanwhile we have got to live with the surfaces upon which our music is recorded. Please please please Mr Record Executive Sir take your quality control a bit more seriously. No wonder record sales continue to fall, so does the quality of the product.

If there is anyone out there involved in the industry, engineers, technicians, producers, mixers, or even artists themselves, HELP. It's about time we all stood up and got counted. It seems everyone from us poor consumers back down the line wants something done, but no-one is actually doing it!

Well, having added one more small voice to all those already crying into the wind I'll cease and desist — after a quick wave of the fist in the appropriate direction.

MDR-3 Headphones

Open headphones seem to have continued to gain popularity steadily in recent years and it is never a surprise to see a new pair released. Some years ago Sony had a pair on the market, entitled DR-15s, which I thought to be excellent value for my money. About three weeks ago I was very interested, therefore, to see the new MDR-3 open headphones from the very same Sony.

These units are incredibly small and light, and thus comfortable. At first glance they look just *too* small to complete. At first *listen*, however, the universal reaction so far has been dropping of chins onto chests. My first thought was to go scrambling through the accompanying paper to find the price. I had expected somewhere in the region of £30-£40.

It came as a shock to read only £16 in the blurb.

The MDR-3 is a revolution at that price. The sound quality is truly amazing and will satisfy most types of listener. Rock followers who are made a little uneasy by the slightly 'light' balance can apply bass boost all they want with little or no complaints from the MDR-3.

Compared against Koss ESP-10 electrostatics, the transducers are shown to be adding a certain amount of 'warmth' to the sound, especially in the midrange, but this is no bad thing on headphones, I feel, and is certainly preferable to a hard, colder approach with no room effects to temper it. The treble is well extended and smooth and showed no tendency to harshness or a brittle nature.

The bass is obviously going to be less plentiful than on the much heavier 'can' type of phone but that diaphragm must be moving a long way indeed to produce bass as well as it does.

I have no complaints to make of the bass overall.

Cryptic Comments

Fitting the phones to the head is simple enough, the cups are angled back so they naturally lie in the same direction as your ears on your head (statement only valid for human subjects. Aliens can figure it out themselves) and have a certain degree of freedom to move and thus align themselves better.

The MDR-3s really are *small.* We tried several young ladies heads, in an attempt to convey just how small — but each time the headphones got lost! Those earpieces are about the size of a 50p piece. But no-one at ETI had one of those either.

As Sony say in their little leaflet, positioning is vital for best performance, so it is advisable to bend the headband to get the best fit with the pads exactly over the ears. Once set, they'll stay there until the moon falls, if necessary, although I doubt if you'll find an LP that long.

The chord is supposed to be oxygen-free copper — a chemical impossibility I would have thought — and is not of the usual coiled spring variety. This I found an absolute pest, as, oxygen free or not, it is pretty good at getting tangled and twisted around the most unlikely of objects.

Cobalt magnets are used to achieve the very high field density required to get the sound out of such a small diaphragm, although the leaflet insists that cobalt is used *instead* of magnets. The diaphragm itself is 12 um thick (so don't go trying to tap it!) and this very small mass undoubtedly confers upon the MDR-3 their quite incredible transient reponse.

Overall, the headphone market at anywhere from £17 to around £35 should take quite a beating from the MDR-3 if there is *any* justice in the world at all, and I stand by my comment last month that you'd be mad to buy a pair of headphones in this price range unless you had at least given the MDR-3 a chance to impress you as much as it impressed us.

Quick Summary

- Small and lightweight (40g)
- Open type — do not exclude surroundings totally.
- Good extended treble, warm mid-range, good bass for type.
- Will take bass boost without deterioration of sound.
- Impedance 32R, thus needs to be driven hard.
- Cord not usual type — inconvenient.
- Excellent value for money, highly recommended.

Guest Moaner

Help! I'm being invaded by people. Ian Graham, ETI's new Celtic Assistant Editor, has cajouled his way into an Audiophile in order to have a moan about racking systems with no racks. Seems a valid point and besides he bribed me with a picture of Felicity Kendal.

So here you go Mr Graham, take it easy at first lad . . .

Put yourself in my position — you're building up your first decent hi-fi system. You save up your pennies, raid your little brother's piggy bank, collect the deposits on every lemonade bottle in sight and generally economise until friends start counting your ribs through your duffle coat. Unit by unit budget lo-fi gradually gives way to higher-fi than you've ever had.

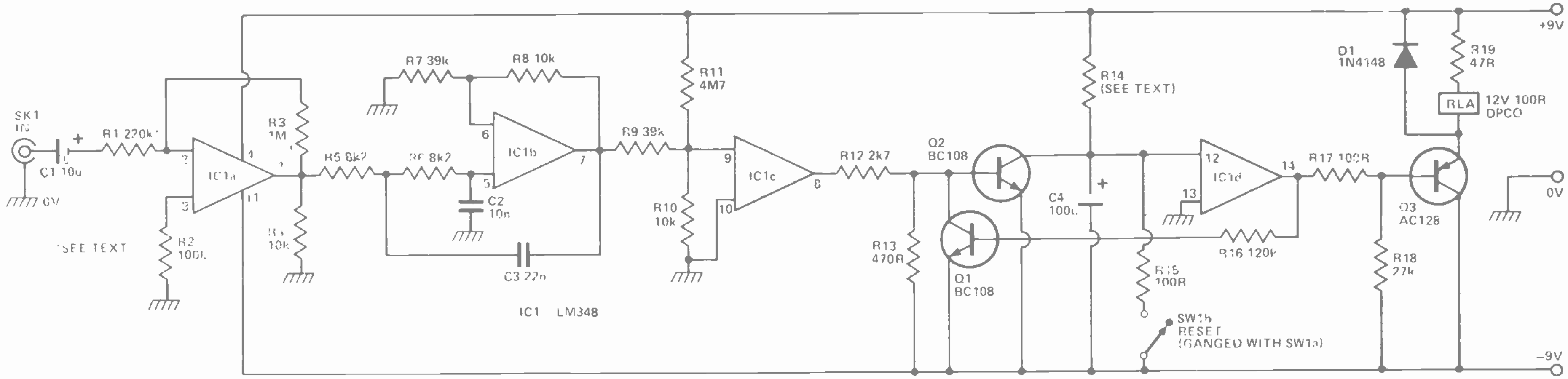
Now, the system looks a bit out of place piled up on the coffee table and, besides, it's beginning to sag a bit under all the watts. What about a rack to put it all in — like the one you saw your very own system in in the shop. A quick phone call brings the answer — no, we only supply a rack when you shell out £400 or so on a complete system. Another call to the UK importer brings the same response.

How much nicer and dust-free my Pioneer system would be in the smart, glass-fronted rack where I first saw it. I wonder how many other hi-fiers there are, who must now remain rackless and didn't find out until it was too late? For Pioneer-lovers, at least, I can bring news of a light at the end of the tunnel. Shriro (UK), the importers of Pioneer equipment, have told me that Pioneer racks will be available as separate units in about five months.

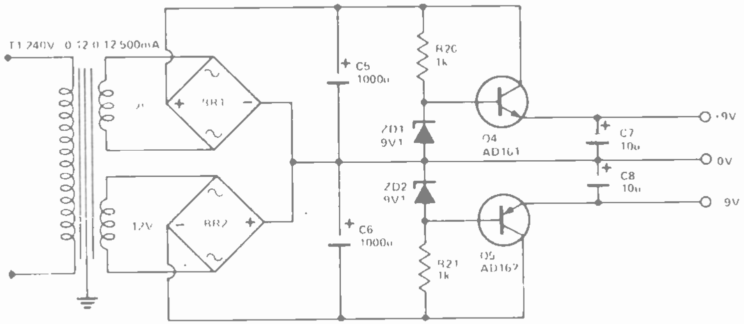
Keeping the Homeleds Burning

Battery powered equipment is a nuisance. More than that is a guilty-of-incestuous behaviour nuisance. Mainly because I keep leaving it on and flattening the batteries — and on my headlamp that means two days without moving-coil type music — leading to withdrawal symptoms such as shortened tempers and kicked cats.

What is needed is a machine which knows when you're using the box and when you're not — and makes an appropriate fuss if you leave it on. After several periods of non-musical evenings I finally overcame my inertia and DID SOMETHING ABOUT IT. Some moons ago ETI ran a project called the Watchdog which was designed to prevent you leaving on teles, hi-fis and other (mains driven) equipment. This was also born of my desire to be lazy electronically. ▶



Above: the faithful old Watchdog circuit. Rover here has saved me many a long evenings 'turning off'! The relay contacts can be wired easily enough to switch on an audible alarm, or even to de-power the equipment in question if need be, although this is less applicable to battery powered devices.



Above: a possible PSU for use with the Watchdog circuit, which will supply the needed 9-0-9 volts. A 500 mA in the mains rail will improve safety!

With a little modification Watchdog can be amended to sound an audible alarm. The circuit is given below, and note that, in order that the box is 'fail-safe', the switching relay is under power as long as the equipment is operating. This means that rather than replacing the relay with an audible 'bleeper' or the like 'twould be better to wire up one set of contacts to power said device once the relay tripped 'Keeps open your options too. And I'm all for keeping me options open — except on cold days. ETI

HOW IT WORKS

SKI feeds the input audio of around 50mV minimum to the buffer amp formed by IC1a and associated components. The gain of this stage is determined by the ratio of R3 to R1, and may be changed to vary the unit's sensitivity. IC1b is a second order Bessel low pass filer with break frequency set around 800Hz (when loaded). This is to cut the response to high frequencies such that continuous white noise will not keep the unit switched on.

IC1c and the potential divider R12, R13, square the incoming audio signal and feed this to the base of Q2, keeping it switched on as long as audio is present at SK1. IC1c is an op-amp working at its full open-loop gain such that it will 'clip' any intput into a square-wave.

While Q2 is turned on, C4 cannot charge up above earth potential. Once the pulse train is no longer present at the base of Q2, C4 begins to charge via R14. IC1d acts as a comparator, and after the time-delay has elapsed, the output swings high, turning off the relay driver Q3, and disabling the relay which controls the mains to the equipment under consideration. D1 is protection against back EMF generated in the coil. Q1 is wired across Q2 as a 'Shut-down' component, in such a way that as soon s the output goes high, this turns on Q1 which then prevents any transient audio, such as switch-off 'thumps' etc re-triggering the Watchdog and keeping it from closing down.

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22pF to 50nF **2p**
POLYSTYRENE CAP (50V)
10pF to 1,000pF **5p**
POLYESTER CAP (100V)
1nF to 100nF **5p**
.15, .22, .33, .39μF **6p**
.47, .68μF **10p**
1μF **12p** 2.2μF **20p**
3.3μF **26p** 4.7μF **28p**
ELECTROLYTIC CAP (μF/V)
1/25 to 47/25 **6p**
68/50, 100/35 **8p**
150/25, 200/12 **9p**
220/25, 250/12 **10p**
470/25, 500/30 **13p**
1000/10 **14p**
1000/25 **22p**
1500/25 **26p**
2200/6.3 **20p**

BRIDGE RECTIFIERS
0.75/200V **25p**
0.75/600V **30p**
1A/50V **22p**
1A/100V **27p**
1A/200V **32p**
1A/400V **34p**
2A/50V **40p**
2A/100V **42p**
2A/200V **48p**
2A/400V **55p**

VOLTAGE REGULATORS
320H-05 **40p**
320H-24 **40p**
7805 **70p**
7812 **70p**
7815 **70p**
7818 **70p**
7824 **70p**
7905 **90p**
7912 **90p**
7915 **90p**
7918 **90p**
7924 **90p**

OPTO/DISPLAY
2N5777 **55p**
OCP71 **65p**
ORP12 **60p**
MAN72 **110p**
MAN74 **110p**
.125" & .2"
LEDs: —
Red **10p**
Green **14p**
Yellow **14p**
.125" clip **3p**
.2" clip **4p**

DIODES
BY127 **10p**
OA47 **8p**
OA91 **8p**
OA200 **6p**
OA202 **9p**
1N916 **5p**
1N4148 **4p**
1N4001 **4p**
1N4002 **4p**
1N4003 **5p**
1N4004 **6p**
1N4005 **6p**
1N4006 **8p**
1N4007 **8p**
1N5400 **13p**
1N5401 **14p**
1N5402 **15p**
1N5404 **16p**

DIL SOCKETS
8 pin **11p**
14 pin **13p**
16 pin **14p**
18 pin **18p**
22 pin **22p**
24 pin **24p**
28 pin **28p**
40 pin **40p**

LINEAR CIRCUITS
709 **40p**
710-14 **33p**
741-8 **22p**
747-14 **48p**
748-8 **44p**
CA3018 **70p**
CA3028A **85p**
CA3046 **70p**
CA3054 **70p**
CA3080 **75p**
CA3130 **90p**
CA3140 **45p**
LF351N **65p**
LF356N **85p**
LM301AN **32p**
LM308N **60p**
LM318N **200p**
LM324N **74p**
LM339N **60p**
LM348N **90p**
LM377N **175p**
LM380N **90p**
LM381N **140p**
LM382N **130p**
LM1310N **150p**
LM3900N **55p**
LM3909N **70p**
MC1496P **85p**
NE531 **140p**
NE555 **25p**
NE556 **60p**
NE566 **140p**
TBA641A **200p**
TBA641B **200p**
TBA800 **75p**
TBA810S **110p**
ZN414 **100p**
ZN1034 **200p**

CMOS
4000 **18p**
4001 **18p**
4002 **18p**
4006 **70p**
4007 **18p**
4008 **84p**
4009 **34p**
4010 **42p**
4011 **18p**
4012 **18p**
4013 **40p**
4014 **85p**
4015 **70p**
4016 **40p**
4017 **57p**
4018 **68p**
4019 **45p**
4020 **90p**
4021 **85p**
4022 **82p**
4023 **18p**
4024 **58p**
4025 **18p**
4027 **35p**
4028 **60p**
4029 **75p**
4030 **60p**
4035 **107p**
4041 **75p**
4042 **58p**
4043 **80p**
4044 **84p**
4047 **87p**
4048 **55p**
4049 **35p**
4050 **35p**
4066 **38p**
4069 **18p**
4070 **18p**
4071 **18p**
4072 **18p**
4073 **18p**
4081 **18p**
4082 **18p**
4086 **80p**
4510 **73p**
4511 **99p**
4516 **95p**
4518 **72p**
4520 **94p**
452B **99p**

TTL
7400 **13p**
7401 **13p**
7402 **13p**
7403 **13p**
7404 **13p**
7405 **13p**
7406 **24p**
7407 **24p**
7408 **13p**
7409 **13p**
7410 **13p**
7411 **18p**
7412 **15p**
7413 **27p**
7414 **31p**
7416 **25p**
7417 **25p**
7420 **14p**
7421 **17p**
7422 **17p**
7427 **20p**
7428 **25p**
7430 **14p**
7432 **20p**
7433 **24p**
7437 **20p**
7438 **20p**
7440 **13p**
7441 **56p**
7442 **51p**
7443 **80p**
7444 **80p**
7445 **75p**
7446 **65p**
7447 **55p**
7448 **62p**
7450 **13p**
7451 **13p**
7453 **13p**
7454 **13p**
7460 **13p**
7470 **28p**
7472 **21p**
7473 **28p**
7474 **24p**
7475 **34p**
7476 **30p**
7480 **32p**
7485 **80p**
7486 **25p**
7490 **36p**
7491 **55p**
7492 **40p**
7493 **35p**
7494 **57p**
7495 **46p**
7496 **56p**
7497 **200p**
74100 **90p**
74105 **43p**
74107 **26p**
74109 **44p**
74110 **40p**
74118 **90p**
74121 **26p**
74122 **40p**
74123 **45p**
74125 **37p**
74126 **37p**
74132 **48p**
74141 **60p**
74145 **55p**
74150 **78p**
74151 **48p**
74153 **43p**
74154 **90p**
74155 **56p**
74156 **46p**
74157 **43p**
74160 **64p**
74161 **64p**
74162 **64p**
74163 **64p**
74164 **78p**
74165 **78p**
74166 **85p**
74173 **77p**
74174 **75p**
74175 **60p**
74176 **64p**
74177 **65p**
74180 **57p**
74181 **99p**
74182 **57p**
74190 **75p**
74191 **70p**
74192 **65p**
74193 **64p**
74194 **70p**
74195 **57p**
74196 **100p**
74197 **100p**
74198 **135p**
74199 **120p**

TRANSISTORS
AC126/7 **23p**
AC128 **23p**
AC128/176
Mt. pr. **42p**
AC176 **23p**
AC187/8 **23p**
AD149 **70p**
AD161/2 **40p**
AF124 **45p**
AF139 **40p**
AF239 **47p**
BC107 **10p**
BC108/9 **10p**
BC147 **10p**
BC148 **10p**
BC149 **10p**
BC157 **12p**
BC158/9 **12p**
BC167 **14p**
BC169C **13p**
BC173 **8p**
BC177/8 **18p**
BC179 **20p**
BC182/3 **12p**
BC184 **12p**
BC209 **13p**
BC212/3 **12p**
BC214 **12p**
BC214L **14p**
BC261B **14p**
BC461 **40p**
BC477 **27p**
BC478/9 **27p**
BC547/8 **14p**
BC549 **14p**
BC557/8 **15p**
BC559 **15p**
BCY70 **18p**
BCY71 **18p**
BCY72 **18p**
BD115 **58p**
BD131/2 **42p**
BD135/6 **42p**
BD137/8 **42p**
BD139 **42p**
BD140 **42p**
BF180 **30p**
BF181 **8p**
BF184 **25p**
BF185 **25p**
BF194 **12p**
BF195 **12p**
BF196 **12p**
BF197 **12p**
BF244B **35p**
BF259 **40p**
BFR39 **32p**
BFR79 **32p**
BFX29 **25p**
BFX84 **25p**
8FX87 **25p**
BFX88 **25p**
BFY50 **22p**
BFY51 **22p**
BFY52 **22p**
BRY39 **60p**
BSX20 **22p**
BU205 **150p**
BU208 **210p**
MJ2955 **110p**
MJE340 **70p**
MJE2955 **110p**
MJE3055 **85p**
MPF102 **40p**
MPF103 **40p**
MPF104 **40p**
MPF105 **40p**
MPF106 **50p**
MPSA06 **26p**
MPSA56 **26p**
MPSU06 **61p**
OC35 **92p**
TIP29 **40p**
TIP29B **48p**
TIP30 **40p**
TIP30B **48p**
TIP31 **40p**
TIP32 **40p**
TIP33 **60p**
TIP33C **80p**
TIP34A **90p**
TIP35B **240p**
TIP36B **280p**
TIP41A **60p**
TIP42A **60p**
TIP2955 **70p**
TIP3055 **55p**
ZTX107 **13p**
ZTX108 **13p**
ZTX109 **13p**
ZTX300 **16p**
ZTX301 **18p**
ZTX302 **20p**
ZTX303 **24p**
ZTX304 **27p**
ZTX311 **19p**
ZTX341 **22p**
ZTX500 **16p**
ZTX501 **16p**
ZTX502 **21p**
ZTX503 **17p**
ZTX504 **28p**
2N696 **35p**
2N697 **25p**
2N698 **35p**
2N706 **14p**
2N914 **20p**
2N918 **35p**
2N1131 **20p**
2N1302 **35p**
2N1303 **40p**
2N1304 **50p**
2N1613 **25p**
2N2222A **25p**
2N2369 **17p**
2N2484 **30p**
2N2646 **55p**
2N2904 **23p**
2N2905 **23p**
2N2906 **20p**
2N2907 **20p**
2N2926G **11p**
2N3053 **20p**
2N3054 **50p**
2N3055 **50p**
2N3442 **140p**
2N3702 to
2N3711 **11p**
2N3772 **150p**
2N3773 **250p**
2N3819 **22p**
2N3820 **40p**
2N3823 **70p**
2N3866 **90p**
2N3903 **10p**
2N3904 **10p**
2N3905 **10p**
2N3906 **10p**
2N4037 **45p**
2N4058 **14p**
2N4059 **14p**
2N4060 **14p**
2N4061 **14p**
2N5457 **40p**
2N5458 **40p**
2N5459 **35p**
2N6027 **40p**

ETIPRINTS

ETIPRINTS are a fast new aid for producing high quality printed circuit boards. Each ETIPRINTS sheet contains a set of etch resistant rub down transfers of the printed circuit board designs for several of our projects.

ETIPRINTS are made from our original artwork ensuring a neat and accurate board. We thought ETIPRINTS were such a good idea that we have patented the system (patent numbers 1445171 and 1445172).

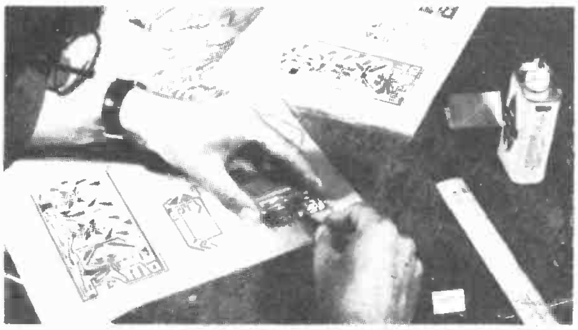
PARTS LIST

Shown below is the listing for the last year's ETIPRINTS.

Earlier sheets are available, ring Tim Salmon for details.

026	Motor Speed Controller (2 Boards For Controller) Battery Indicator	July 79
027	CCD Phaser Rev. Monitor	Project Book Seven
028	Race Track, Spirit Level Egg Timer, Bongos Bench Supply, Oscillator	Project Book Seven
029	Bass Enhancer Digital Freq. Meter (4 boards)	Project Book Seven
030	ETIWET, Continuity Tester Metal Locater, Light Dimmer Ultrasonic Switch (2 boards)	Project Book Seven
031	Tone Control House Alarm (2 boards) Torch Finder	Project Book Seven
032	LED Audio Display (2 boards) (underside pattern)	Aug 79
033	LED Audio Display (2 boards) (topside pattern) Bench Amp NICD Charger	Aug 79
034	Cable Tester Reaction Tester Speech Compressor Preamp Power Supply Rectifier & De-Thump Board Power Amp (2) (price £1.60)	Nov 79
035	Oven Leakage Detector Pinball Wizard	Nov 79
036A	3 x Display Board Relay Activator Points Controller	Nov 79
036B	Data Distributor (double sided)	Nov 79
036C	Train Speed Controller Track Cleaner & Electronic Pot (double sided)	Nov 79
036D	Power Switch Selector (double sided)	Nov 79
037A	Encoder (double sided)	Dec 79
037B	Decoder (top side)	Dec 79
037C	Decoder (bottom side)	Dec 79
038A	Long Period Timer Rain Alarm Touch Switch Flash Trigger Pseudo Random Noise Gen	Dec 79
038B	Hum Filter Dice Logic Probe	Dec 79
038C	Function Generator	Dec 79
039	Buffer Moving Coil Preamp Process Controller	Jan 80

HOW IT WORKS



Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

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MICROFILE

Henry Budgett has news of the long-awaited Nascom 2, a pretty potent Petsoft program party and an expensive Communicator.

IF micros are the food of life eat on would be a fair description of this month's ramblings through the world of small systems. The spirit of Christmas also seemed to take quite a bashing as well! The old adage about it being human to err has struck again. Yours truly has made a box-up. Having rambled extensively on the subject of standards in the November offering, Mr Henry Law has raised the valid point about the usage of the word Baud. I tend to use both Baud and bits per second to mean the same thing and he points out quite rightly that they don't. The term "bits per second" means exactly what it says, but the term Baud is defined as being "a unit of signalling speed equal to the number of code elements transmitted per second." Some transmission systems such as phase modulation actually carry more than one bit in each signal element so in Mr Law's case his 9600 bps transmission runs at 2400 Baud. In future I'll stick to bps unless the actual Baud rate is defined, honest.

Would you buy 50,000 programs from this man?

The Long Wait (Is Over)

The first gastronomic offering of the month was digested after the delivery of our Nascom 2. Not bad really, we have been waiting since June along with the rest of you for the machine. The hardware is certainly impressive. There are options galore for both memory and I/O and the packing density of chips is almost unbelievable. The lack of 4118 memory chips has caused Nascom to offer the 16K RAM board with the "2" but if you wish to use it in a dedicated system the missing 4118s can be replaced with 2708 EPROMs holding your own software. The BASIC is the 'standard' Microsoft version, but it has one or two added extras to make periperheal handling easier.

The other interesting feature is that the BASIC is blown in a 64K ROM chip, one of the first uses for this device, and is actually removable so you can use the memory space for something else. Both the new NAS-SYS monitor and the BASIC can be used on the "1" and I feel that the NAS-SYS should become the standard operating system for the "1" rather than the T2 or T4.

The instruction manual is a loose leaf binder making it easy to alter or insert new information. There are one or two poor areas, but Nascom have promised to change these if demand is sufficient. The price may seem high but you are getting a very high quality product that makes certain other "single board computers" look rather like toys.

A very strong whisper on the Nascom front is that the price of the "1" may well be coming down, look out for bargains. The lunch was very good but it's the first time I've had to pay for doing someone a review of their own product!

The Second Belch

The second gastronomic wonder was given by Petsoft to celebrate, among other things, the sale of the 50,000th program. They have even had it gold plated and presented to the author. I rather suspect that the dreaded LOAD ERROR message may come up if it is ever used. Gathered at the lunch were many of the editors and publishers of the Computing Press and after the dinner discussions ranged far and wide on the subject of machines and languages. As usual in these meetings nobody managed to agree on anything apart from the excellence of the wine and the quality of the food!

The fact that Petsoft has become a part of the giant ACT doesn't seem to have detracted from the quality of their product. If anything, it has dramatically improved. The achievement of selling 50,000 programs has only left them with one slight problem, do they go for platinum plating on the 100,000th?

Fresh Air

We have had a small box called the Communicator, in the office for review. The device hangs on the parallel user port of the PET and provides eight user accessible input or output lines. The voltage of the power supply that you connect determines the output swing. The box derives five volts internally for the input lines. The circuit is based around two Darlington transistor arrays, each containing seven transistors that are connected to provide two channels with a drive capability of 500 mA and six channels that can drive 1 A. The box can be directly called from BASIC using either POKE for output or PEEK for input. The manual is not too specific, but interrogation of the PET manual, the one with the blue writing on the cover, reveals that there are a few extra things that you can do. Unfortunately the unit has no handshaking capability at all so most of your program will be taken up with loops to interrogate the device.

The other contention that I have with the device is that for a grand total of £92.85 including VAT and p&p you don't really get value for money. The Communicator is available from Mektronic Consultants, Linden House, 116 Rectory Lane, Prestwich, Manchester M25 5DB.

The Communicator performs well, but does it represent value for money?

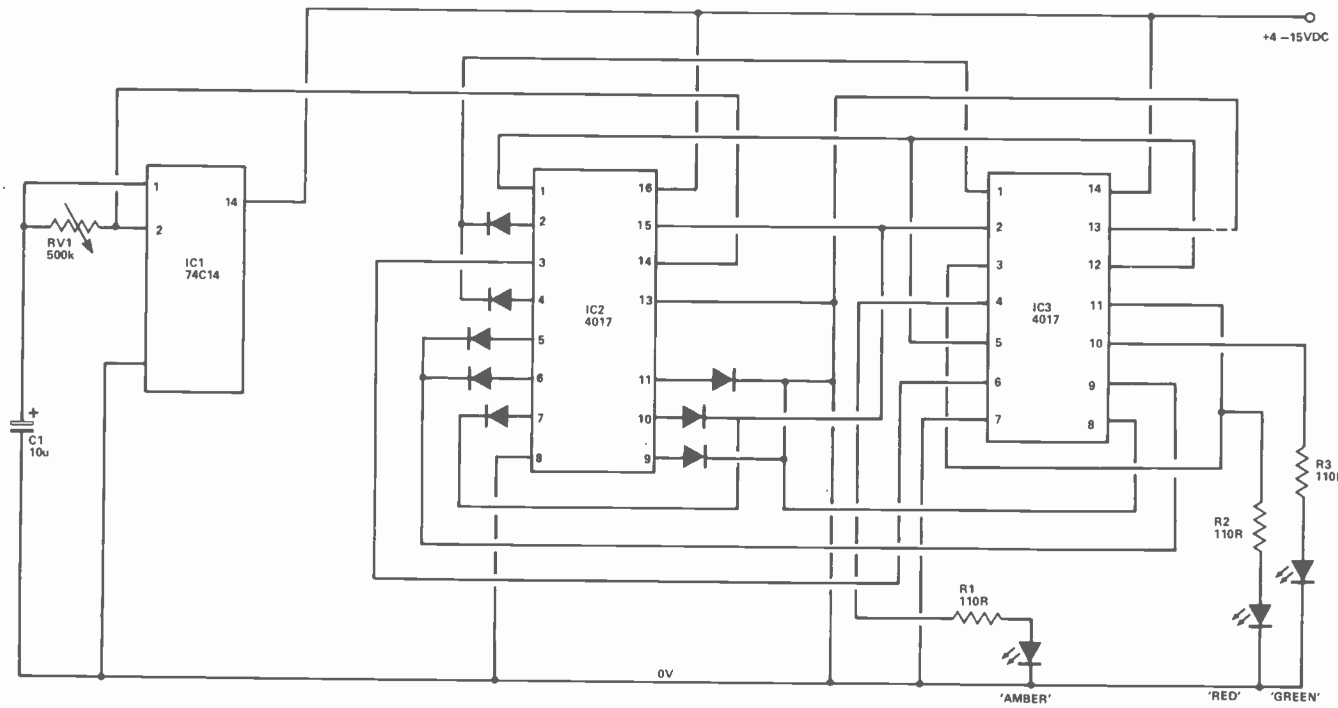
Exhibitionitis Strikes Again

There was one ray of sunshine in the gloom of computer shows this month, no it wasn't Compec. The Professional Viewdata Exhibition held at the West Centre Hotel last month was the one that rates high on my list for a visit next time. A grand total of 28 exhibitors, all doing their utmost to be helpful, plenty of space to move around, comfortable seats for tired journalists — in fact everything you could wish for. Among the notable were Tecnalogics who are doing very well with their TECS system, Logic Box with their screen treatments — amber is the IN colour — and Video Electronics with their intriguing real time graphics display system.

Make a note in your diaries to go to this one next year, it's well worth it. The same cannot be said of Compec which was incredibly hot, crowded and boring. A companion of mine, who was there to check out some hardware, reckoned the pub was less crowded at lunchtime, so we all went there instead. About the only points of interest were the new Sharp machine, but no-one seemed to be very impressed, and the Texas machine which is expensive. One day someone will organise a true home computer show with no big business computers, lots of room to walk around and a friendly atmosphere in which one can actually talk to the people you've gone to see. Surely it's not too much to ask.

ETI

TECH TIPS

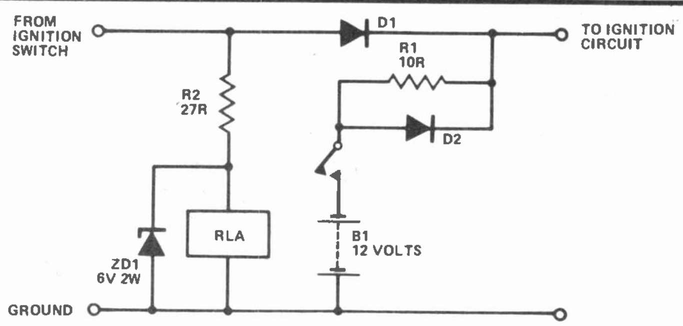


Traffic Light Controller

Michael Miller

This circuit is relatively simple and gives a realistic timing sequence. IC1 sets the timing clock pulse and can be adjusted by RV1. IC2 is a decade counter, whose output pulses are mainly fed through diode buffers (any small cheap diodes will do), to IC3, a quad OR gate, which sorts the consecutive decade pulses into three groups, monitored by the three coloured LEDs.

To couple this circuit to a similar one, for the other intersection of the crossroads, the pulse from pin 1 of IC2 should be taken to pin 15 of the IC2 of the other circuit. This second circuit should have pin 15 biased to 0V via a 100 k resistor. When the first circuit is showing red, the second circuit will be showing green.



Cold Start Ignition

M. C. Polgreen

The heart of the circuit is a small auxiliary battery with a capacity of one or two amp hours. If a nickel cadmium battery is used then R1 should be increased in value so that the maximum trickle charge current is not exceeded. R2, ZD1, and RLA connect B1 into circuit when the ignition is switched on, thereby reducing the amount of additional wiring. Any small 6 volt relay with a contact rating of 5 amps will do, and ZD1, R2 ensure that the relay will remain energised when the starter motor causes the main battery voltage to drop. When the main battery voltage falls, D1 becomes reverse biased and D2 forward biased, therefore allowing B1 to supply current to the ignition circuit. When the engine is running, the main battery voltage rises, forward biases D1 and reverse biases D2. Therefore the ignition current comes from the main battery, and B1 is trickle charged via R1. The two diodes D1, D2 should be rated at 50 V, 10 A.

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

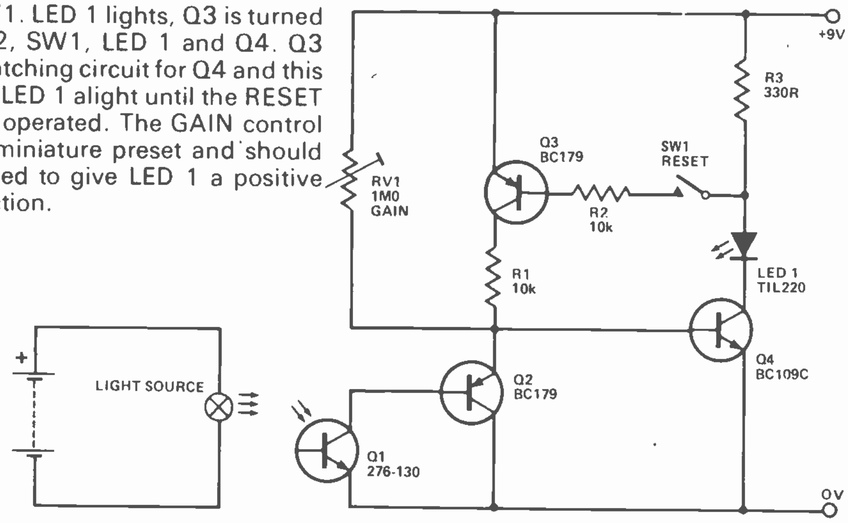
ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

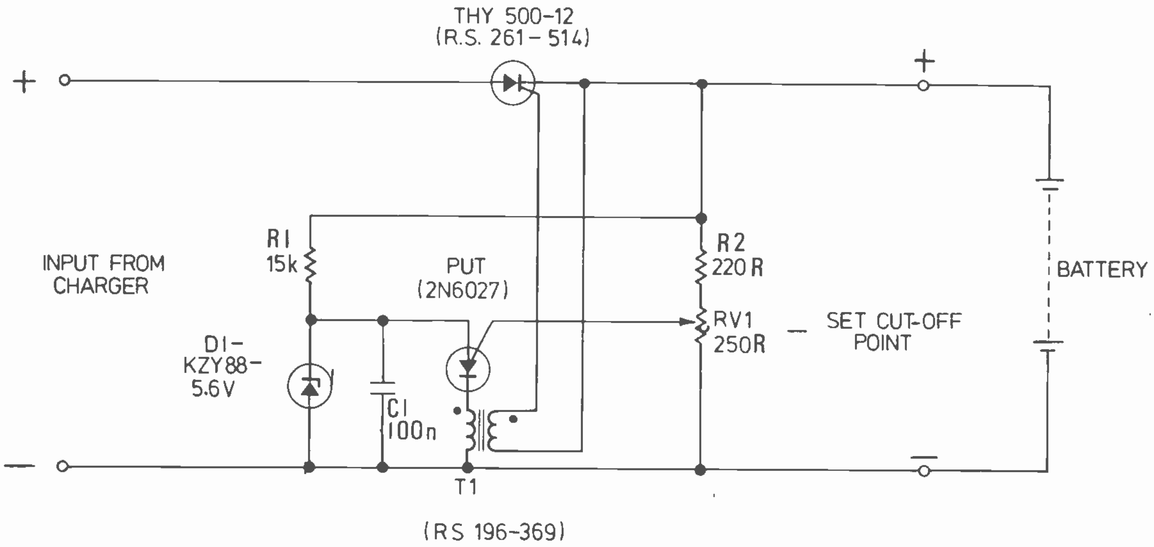
Silent Sentry

B. J. Lowery

The 'Silent Sentry' is a form of intrusion alarm. It will indicate the breaking of a light beam by means of lighting a Light Emitting Diode, which will remain lit until the RESET switch is activated. Q1 may be any suitable NPN photo-transistor available, eg 276-130 (Tandy) and BPX 25 (Maplin).

When light from the light source is falling on Q1, Q2 is turned on, causing both Q3 and Q4 to be turned off, therefore LED1 will not light. As soon as the light beam is broken Q2 is turned off, allowing Q4 to be turned on via RV1. LED 1 lights, Q3 is turned on via R2, SW1, LED 1 and Q4. Q3 forms a latching circuit for Q4 and this will keep LED 1 alight until the RESET switch is operated. The GAIN control is a sub-miniature preset and should be adjusted to give LED 1 a positive on/off action.





Battery Charger Controller

D. Wedlake

The battery charger circuit illustrated was designed to be incorporated in any conventional battery charger rated up to 10 amps, where the output is full-wave rectified and unsmoothed. It is fully protected as it cannot be damaged by short circuit or reverse battery connection. Furthermore, charging ceases when the battery voltage reaches a pre-set voltage (normally 13V8 for a fully charged battery).

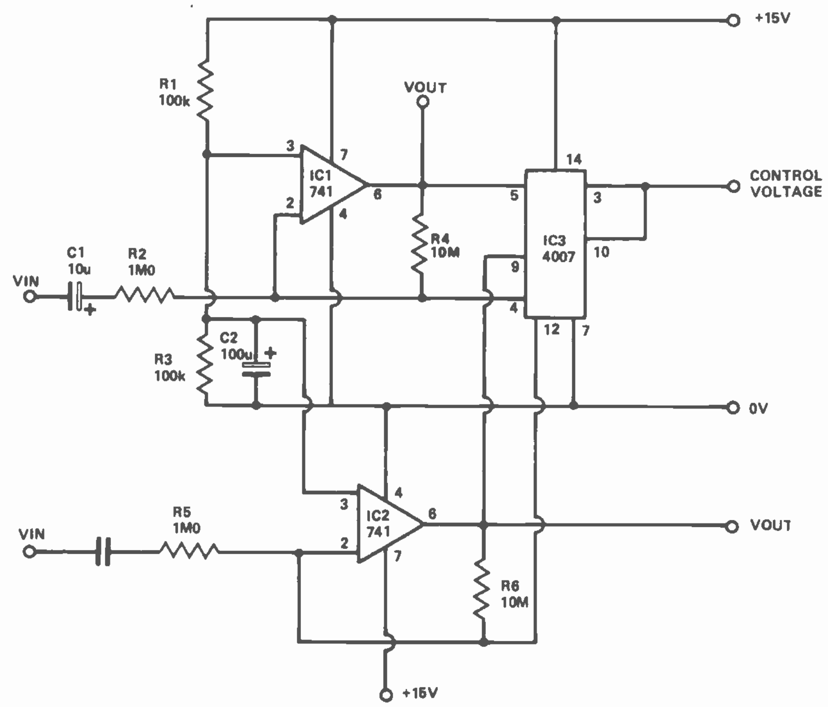
The design is based on the Programmable Unijunction Transistor (PUT) oscillator which senses the battery voltage to determine when charging should cease. The battery being charged provides the power for the oscillator which, in turn, triggers the thyristor via the pulse transformer T1. As the anode of the PUT is clamped to 5V6 by the Zener Diode, ZD1, it follows that the circuit will not oscillate if the potential at the slider of RV1 is correspondingly higher. Therefore, RV1 controls the cut-off point which should be set to 13V8. This is best set under actual operating conditions and the charging current will gradually reduce as this voltage is approached.

The charger is fully protected as the circuit cannot oscillate under short circuit conditions or reverse battery connections. However, as the power for the oscillator is derived from the battery, the circuit will naturally not be self starting if the battery is completely flat or charged to less than about 7 volts. This problem could be overcome by providing a push-button shorting switch across the thyristor to initiate charging. In a short while the battery voltage should have risen sufficiently to maintain normal operation. However, one should bear in mind that the charger will not be protected when the start push button is pressed, so if included, one should provide a fuse as additional protection.

If used at full load current, the thyristor should be mounted on a suitable heat sink having a thermal dissipation of 4 C/W (eg RS 401-497).

Stereo VCA

J. Macaulay



The circuit shown is of a stereo VCA whose gain can be varied over a 90 dB range by the application of a control voltage between 0-15V.

Maximum gain is limited to 20 dB and occurs when the control voltage is 0V. Minimum gain occurs with the application of +15V at the control input.

The circuit works as follows. IC1/2 are 741 op amps operated in the virtual earth mode with R1, R5 determining the input impedance at 1M, regardless of gain. The feedback loop from the output of the IC's are completed by the resistors R4, R6. A pair of MOSFETs, internal to IC3, are connected in parallel with these resistors and the control voltage is applied to their gates, pins 3 and 10.

When zero volts are applied to the gates the resistance across the feedback loop is some 10^9 ohms in all with R4-6. In consequence these latter components determine the gain of the stage. When the control voltage is increased in a positive direction the impedance across the FETs decreases and the gain of the amplifier decreases in sympathy. Once the voltage is increased to 15V the impedance across the FETs lowers to roughly 300R.

The frequency response of the amplifier extends from approximately 5 Hz-100 kHz at the −3 dB points whilst the distortion at maximum gain is about 0.1% at 1 kHz. If the feedback resistors are close tolerance types, 2%, the gain will be found to be within ±1 dB between channels due to the closely matched characteristics of the FETs within IC3.

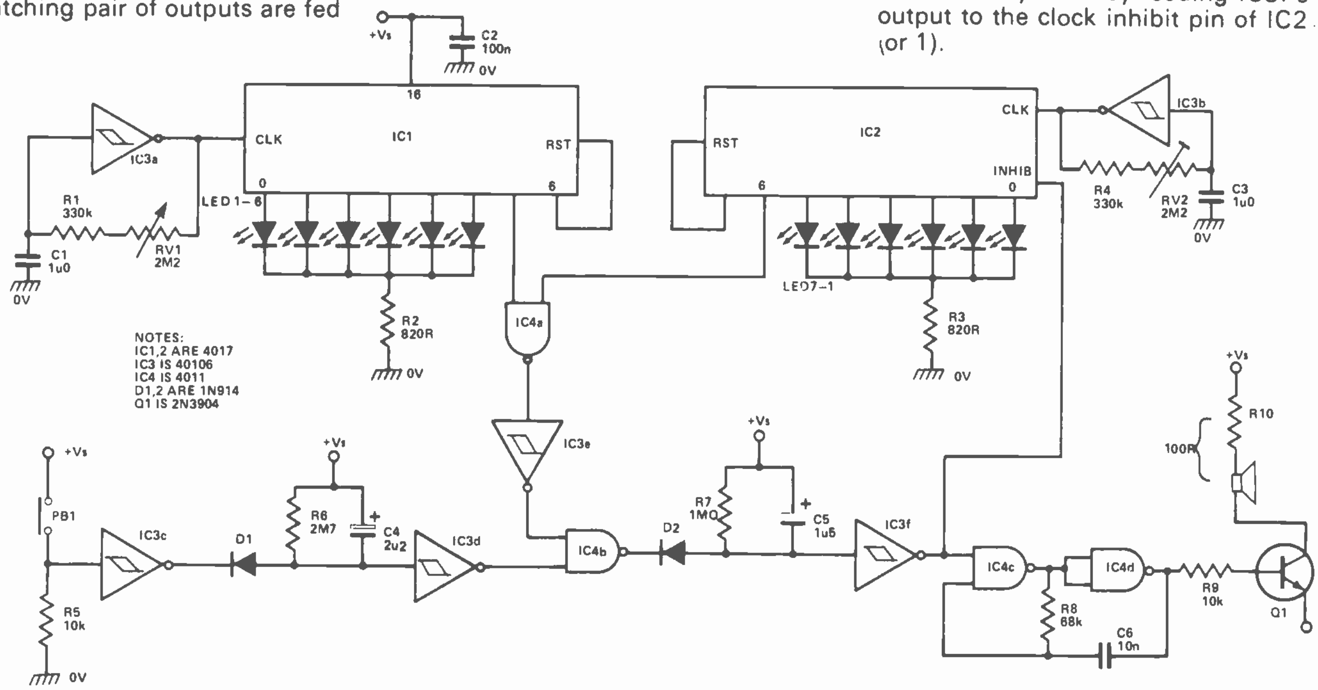
LED Chaser

P. Davidson

This game is a test of skill and patience. The aim is to align a LED chaser (under your control), with another preset chaser.

A matching pair of outputs are fed to an AND gate (IC4a, IC3e). This gate feeds the NAND gate IC4b, its other output taken from the monostable formed around IC3d. This has a duration of about 6 seconds to ensure the display is fully counted.

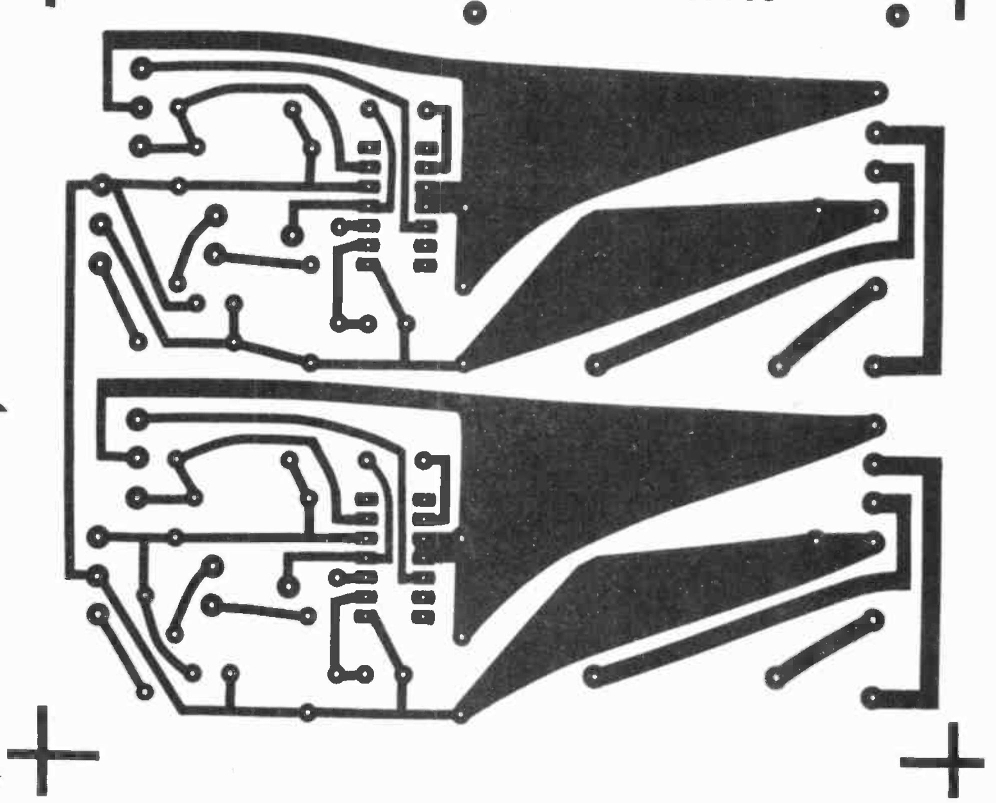
When you think you've matched the displays up PB1 is pressed. IC3d output goes high and if, while this is high, the two matching outputs both go high, the monostable formed around IC3f is triggered. This enables the astable formed by IC4c,d, to signal success. The unit can also be automatically reset by feeding IC3f's output to the clock inhibit pin of IC2 (or 1).

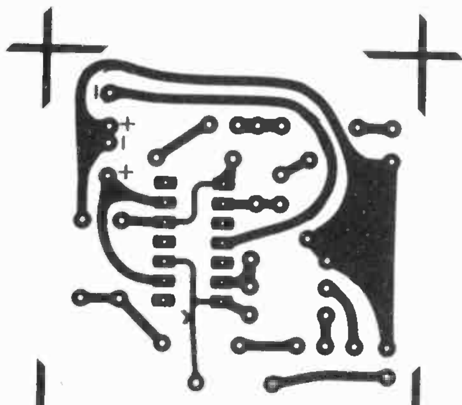


PCB FOIL PATTERNS

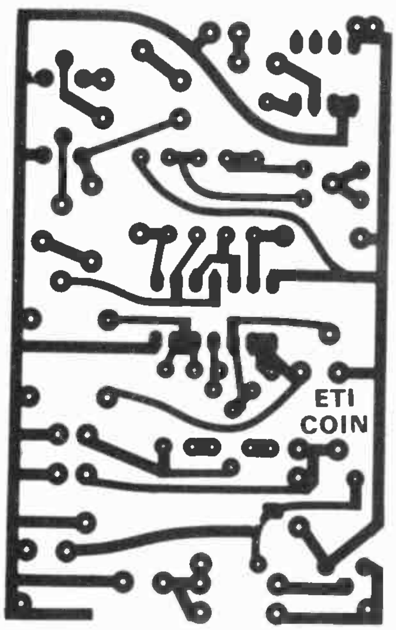
A small departure this month. We are giving the front panel layouts for the Project 80 modules, just to see whether or not it is really of use to our readers. Let's have your opinions.

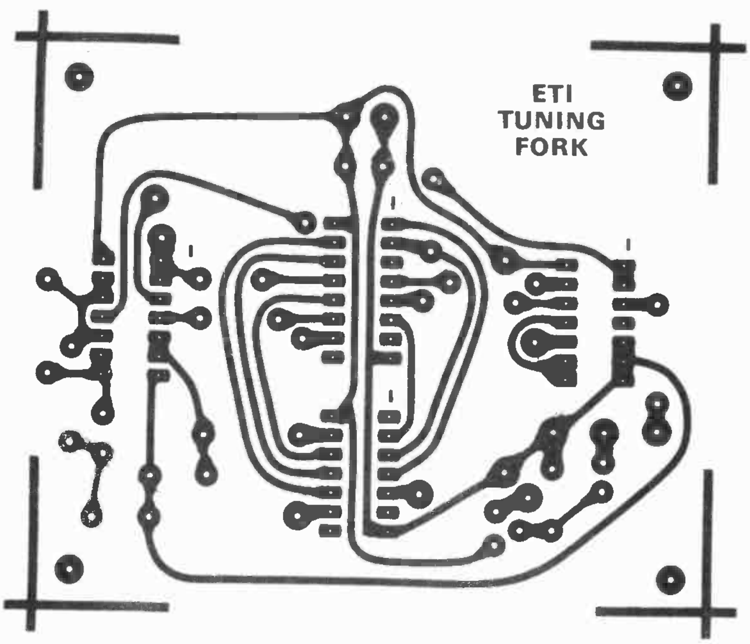
ETI 80 PSU

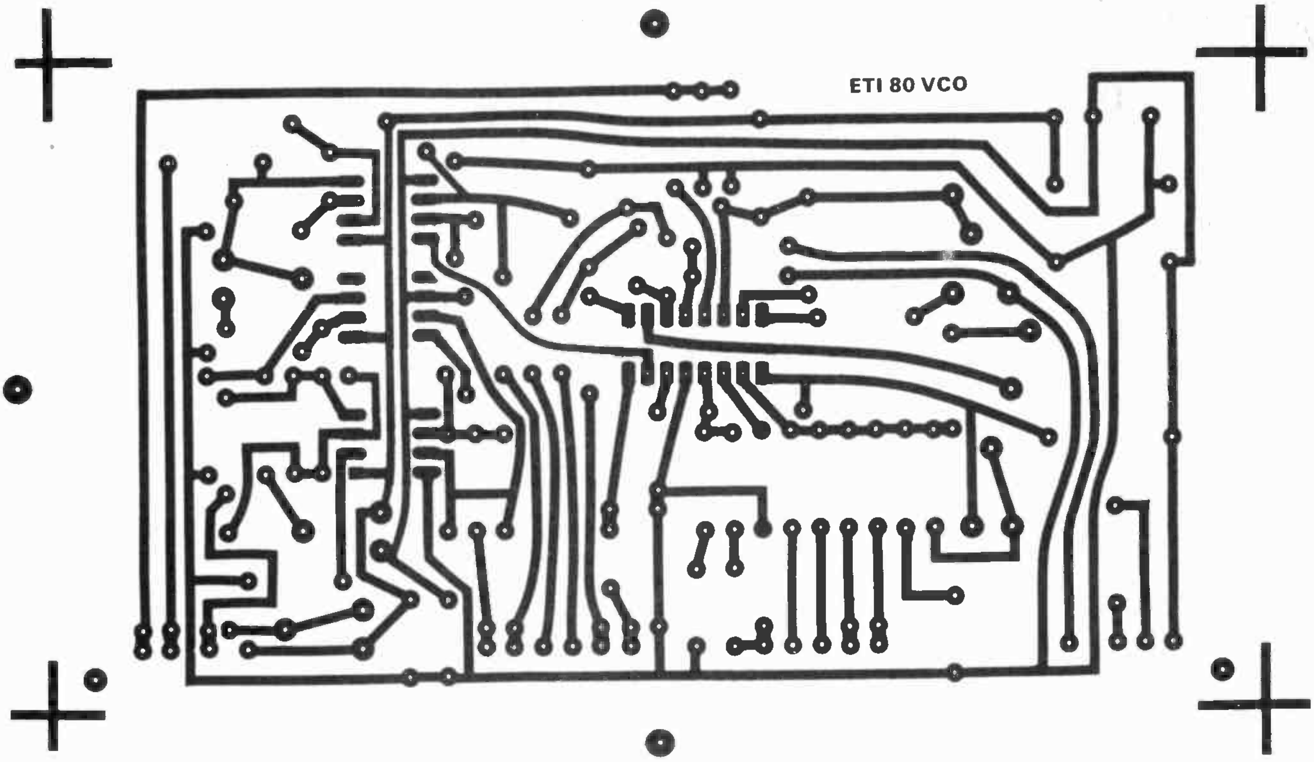




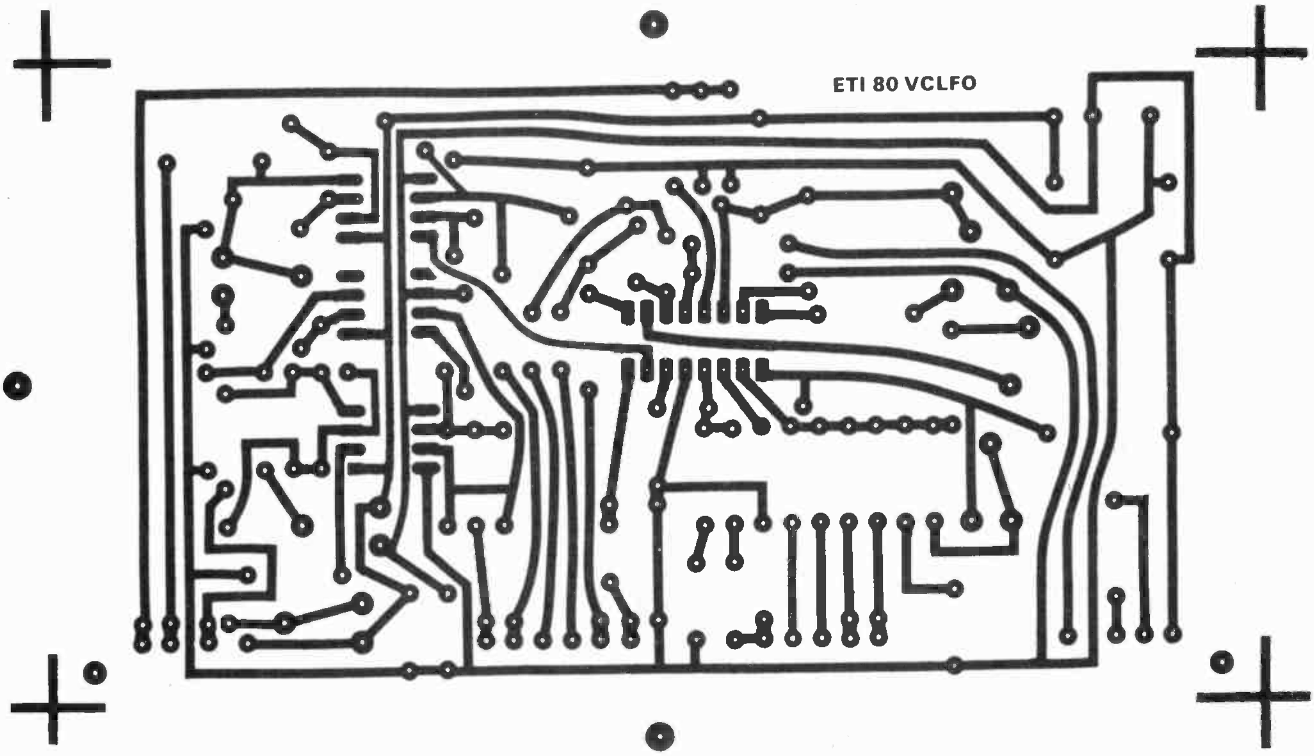
ETI FILTER

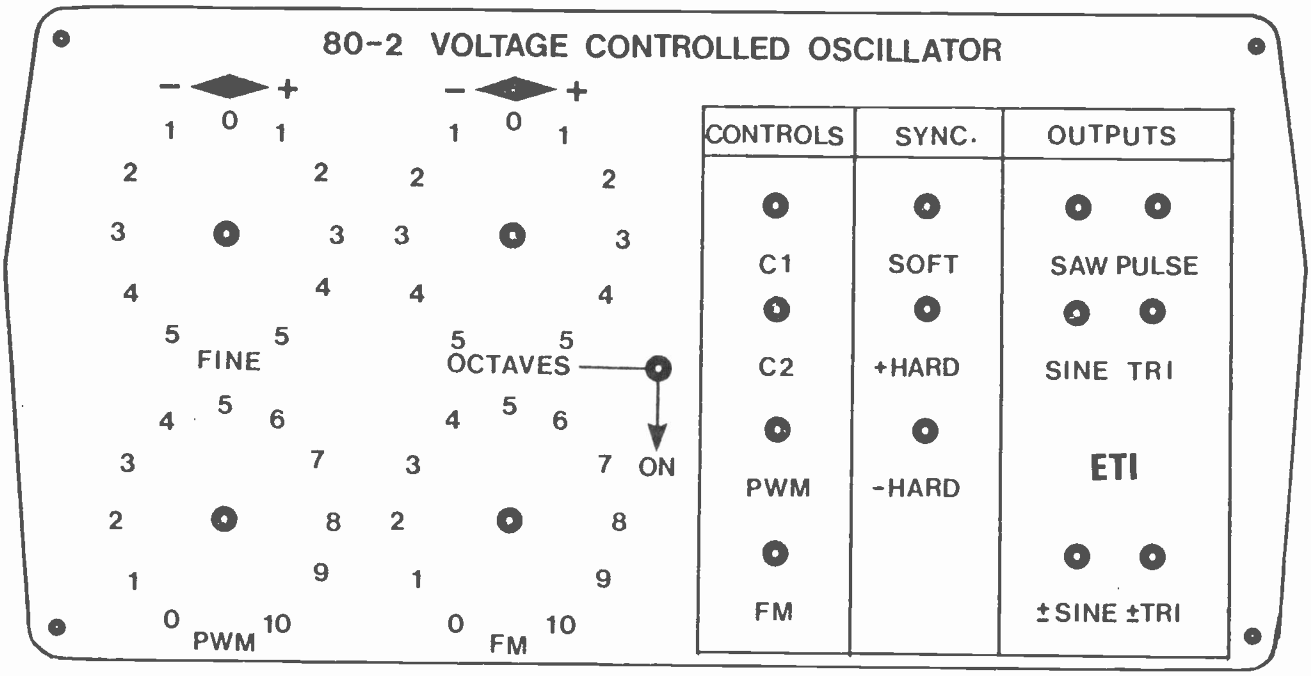




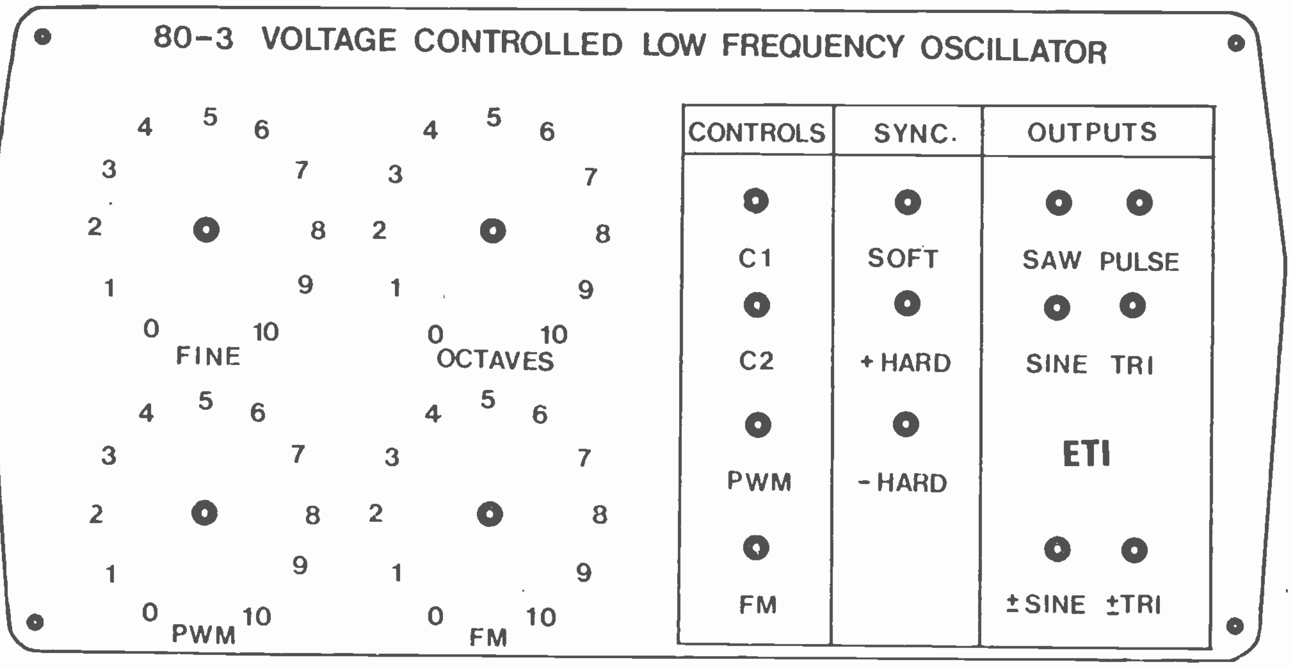


Above and below: PCBs for the VCO and VCLFO modules. Yes we know the boards are very similar, but you'll need both — won't you?





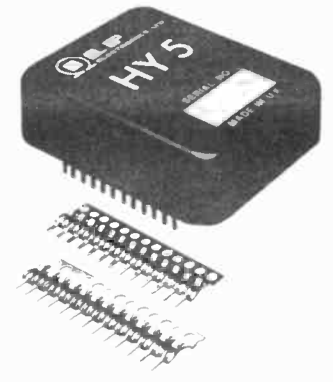
Above and below: front panel layouts for both the oscillator modules. The PSU artwork is not shown here, as this is not panel dependent — nor on show!

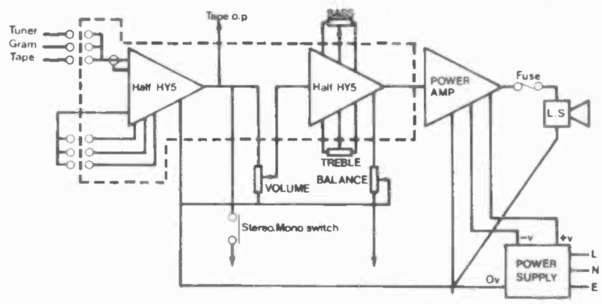


and staying there

PERFORMANCE MODULAR UNITS

HY5 PRE-AMPLIFIER





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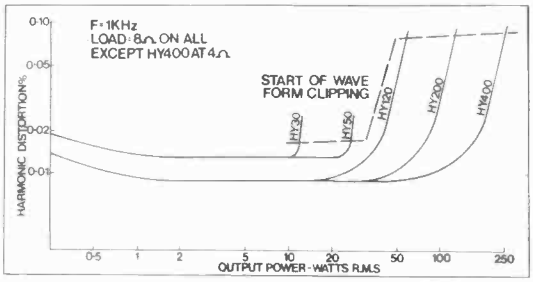

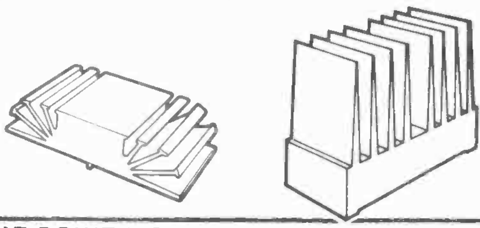

Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
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HY50	30 W into 8 Ω	0.02%	90dB	-25 -0 +25	105x50x25	155	**£7.24** + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35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

Load impedance — all models 4 - 16Ω
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Input impedance — all models 100KΩ
Frequency response — all models 10Hz - 45Hz - 3dB

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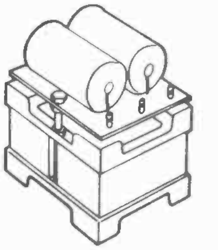

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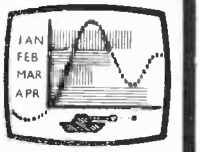

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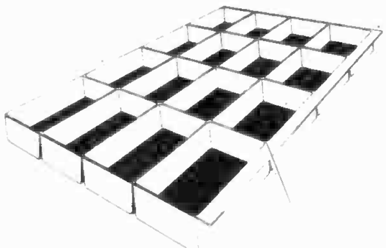

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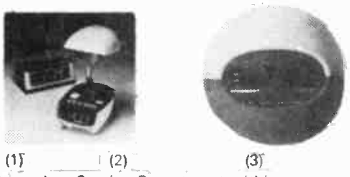

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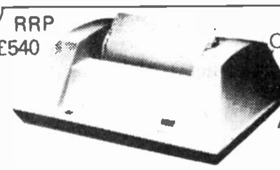

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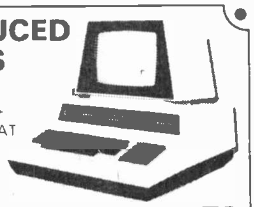

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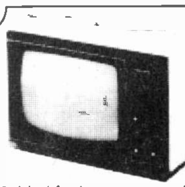

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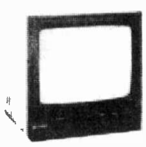

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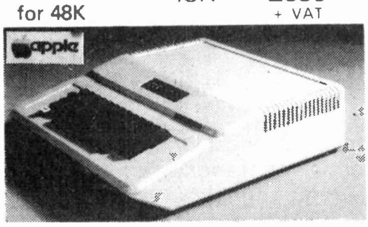

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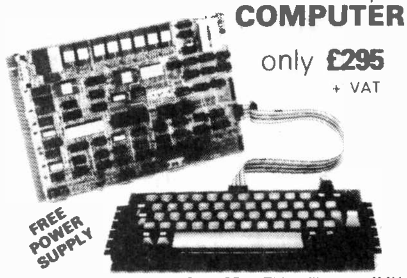

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I.O. On-board UART (Int 6402) which provides serial handling for the on-board cassette interface or the RS232/20mA teletype interface.
The cassette interface is Kansas City standard at either 300 or 1200 baud. This is a link option on the NASCOM-2.
The RS232 and 20mA loop connector will interface directly into any standard teletype.
The input and output sides of the UART are independently switchable between any of the options – i.e. it is possible to house input on the cassette and output on the printer.
PIO There is also a totally uncommitted Parallel I/O (MK3881) giving 16, programmable, I/O lines. These are addressable as 2 x 8 bit ports with complete handshake controls.
Documentation Full construction article is provided for those who buy a kit and an extensive software manual is provided for the monitor and Basic.
Basic The Nascom 2 contains a full 8K Microsoft Basic in one ROM chip with additional features like DEEK, DOKE, SET, RESET for simple programming.
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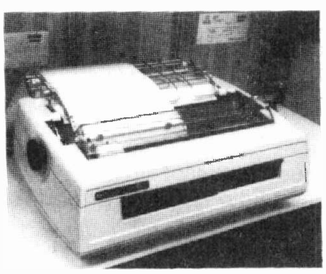

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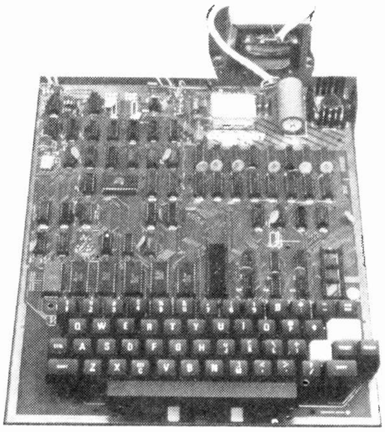

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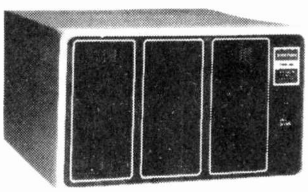

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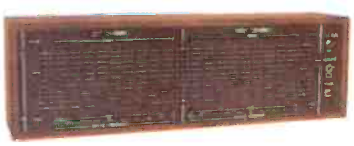

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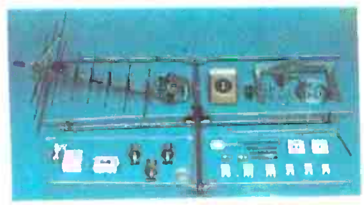

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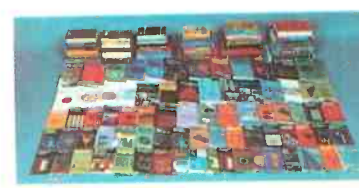

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