AN ARGUS SPECIALIST PUBLICATION
MARCH 1984

Hobby Electronics

Project Electronics For Everyone

90p

OFF-BEAT METRONOME

March to the beat of a different drummer

Memotech MTX500 Computer Reviewed

High-purity 3Hz-3MHz Sine Wave Generator to build

Lightning Chess Timer Make your move...or lose!

The Hobbit – Tolkien experts ring the changes on this popular game

SPRING HAS SPRUNG!

Ambit's Spring '84 catalogue brings all the parts you need for electronics, radio, audio and computing to your front door.

There's details about an exciting new range of kits and modules being launched into the UK in conjunction with the leading German hobby supplier; full information on our two new regional sales counters in Portsmouth and Broxbourne; new low cost instruments from Black Star -plus all your old favourites:

NiCads, chargers, TOKO coils, filters, and communications ICs, crystal filters, Audio and RF semiconductors - including the biggest range of low cost varicap diodes for all types of electronic tuning.

Available from all good newsagents, or direct from ambit
Order as Stock Number: 02-00009

More than ever, Ambit's concise 'price on the page' Spring catalogue is the one that you cannot afford to be without. It's fully indexed, precise and up to the minute -get a copy now!
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Hobby Electronics

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Note: This month Hobby Electronics and Digital & Micro Electronics welcomes Terry Johnson as Technical Editorial Assistant. The gent has extensive experience both in journalism and the components trade and is a long-awaited and much-needed addition to our team. Now, about that box of technical enquiries, Terry . . .

Editor: Ron Keeley
Deputy Editor: Helen P. Armstrong BA
Technical Editorial Assistant: Terry Johnson
Technical Illustrator: Jerry Fowler
Advertisement Manager: Joanne James
Copy Control: Lynn Collis
Managing Editor: Ron Harris BSc
Chief Executive: T. J. Connell

We are not normally able to deal with technical enquiries by 'phone, so please don't ring. Write to us with an SAE.

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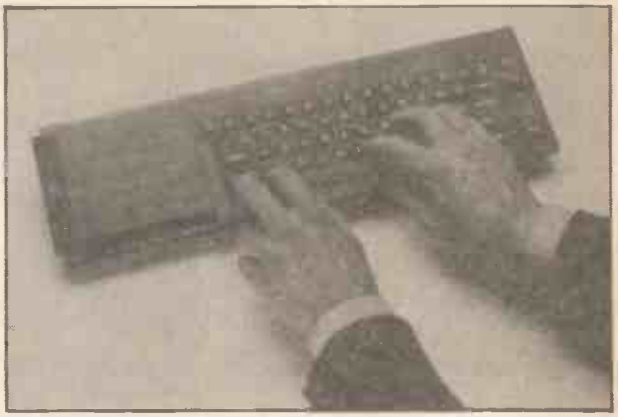

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PREVIOUSLY ADVERTISED STILL AVAILABLE

Tape punch and reader	£22.50
Bench isolating transformer 250 watt	£7.75
BOAC in-flight stereo unit	£1.50
Drill assortment 4 each 25 sizes between .25mm & 2.5mm	£11.50
Battery condition tester, less box	£1.75
Nicad chargers, mains	£0.75
Flourescent inventor 13 watt from 12v	£3.50
Ten digit stitch pad-pb phone etc.	£1.95
Uniselector 2 pole 25 way	£4.60
Water valve mains operated	£2.50
Counter 6 digit mains operated	£1.15
ditto 12v resettable	£3.45
Double glazing clear PVC sheet, 23½" wide-per running ft.	£0.15
Locking mechanism with 2 keys	£1.15
Magnetic Clutch	£4.50
Mouth operated suck or blow switch	£2.30
Solenoid with slug 8 - 12v battery op.	£1.82
ditto 230v mains	£2.30
Timer Omron STP NH 110v AC Coil	£6.90
Key switch with 2 keys dp mains	£1.75
Air valve mains operated	£3.75
Latching relay mains operated	£3.50
Dry film lubricant aerosol can	£0.65
Coin op switch, cased with coin tray	£4.60

8 POWERFUL MODEL MOTORS (all different)

for robots, meccanos, drills, remote control planes, boats, etc. **£2.95.**

Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two-tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four-pin plug and socket facilitate ease of connecting lamps. Special price is **£14.95** in kit form or **£25.00** assembled and tested.

12 volt MOTOR BY SMITHS

Made for use in cars, etc. these are series wound and they become more powerful as load increases. Size 3½" long by 3" dia. They have a good length of ¼" spindle — **Price £3.45.**

Ditto, but double ended **£4.25.**
Ditto, but permanent magnet **£3.75.**

EXTRA POWERFUL 12v MOTOR

Probably develops up to ¼ h.p. so it could be used to power a go-kart or to drive a compressor, etc. **£7.95 + £1.50 post.**

THERMOSTAT ASSORTMENT

10 different thermostats. 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits, etc., or when fitted say in front of the element of a blow heater, the heat would trip the stat if the blower fuses; appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0 — 100°C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately, these thermostats could cost around **£15.00** — however, you can have the parcel for **£2.50.**

MINI MONO AMP on p.c.b., size 4"x 2" (app.)

Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amp. Brand new, perfect condition, offered at the very low price of **£1.15** each, or **10** for **£10.00.**

— BARGAIN OF THE YEAR —
The AMSTRAD Stereo Tuner.

This ready assembled unit is the ideal tuner for a music centre or an amplifier, it can also be quickly made into a personal stereo radio — easy to carry about and which will give you superb reception.

Other uses are as a "get you to sleep radio", you could even take it with you to use in the lounge when the rest of the family want to view programmes in which you are not interested. You can listen to some music instead.

Some of the features are: long wave band 115 — 270 KHz, medium wave band 525 — 1650KHz, FM band 87 — 108MHz, mono, stereo & AFC switchable, tuning meter, to give you spot on stereo tuning, optional LED wave band indicator, fully assembled and fully aligned. Full wiring up data showing you how to connect to amplifier or headphones and details of suitable FM aerial (note ferrite rod aerial is included for medium and long wave bands. All made up on very compact board.

Offered at a fraction of its cost: **only £6.00** + £1.50 post + insurance.

THIS MONTH'S SNIP

WHY PAY £10 OR MORE — Make yourself a Joystick — full details were given in Dec/Jan 'Sinclair Projects'. We will supply complete kit for **£2.30.** Although designed for the Spectrum or **ZX81** it is equally suitable for any home computer.

REVERSIBLE MOTOR with control gear Made by the famous Framco Company this robust motor is approx 7½" long, 3½" dia. 3/8" shaft. Very powerful, almost impossible to stop. Ideal for operating stage curtains, doors, ventilators, etc. Even garage doors if properly balanced. Offered complete with control gear as follows:
1 Framco motor with gear box — 1 push to start switch
1 manual reversing & on/off switch — 2 limit stop switches
1 circuit diag. of connections — **ONLY £12.50 + postage £2.50.**

FOR SOMEONE SPECIAL

Why not make your greeting card play a tune? It could play 'Happy Birthday', 'Merry Christmas', 'Wedding March', etc, or 'Home Sweet Home', etc. Wafer thin 3 part assemblies, for making cards musical. Mini microchip speaker and battery with switch that operates as the card is opened. Please state tune when ordering. Complete, ready to work **£1.25.**

REEL TO REEL TAPE DECKS

Ex-Language Teaching School. Second, but we understand these are in good order; any not so would be exchanged. The deck is standard with normal record, replay facilities and an additional feature is tape rev counter. Nicely finished in teak type box. We have 30 only of these. Price **£8.50** each + **£3** carriage.

TELEPHONE ITEMS

Plug and Wall socket — 4 pin or 5 pin	£3.45
Plugs only 4 pin or 5 pin	£1.15
Modern desk telephone	£7.50
Heavy black old type	£5.50
External bell unit	£6.50
Bell ringing power unit	£4.50
Pick up coil	£1.15

STABILISED POWER SUPPLY (Mains Input)

By LAMDA (USA) — Ideal for computer add-ons, d.c. output. Regulated for line volts and load current. Voltage regulation .1% with input variations up to 20% — load regulation 1% from no load to full load — or full load to no load. Complete in heavy duty case — Models available: 5v - 9A **£23.** 12v - 1.5A **£13.25.** 15v - 1.2A **£13.25.** 24v - 2A **£23.**

PRESTEL UNIT — brand new and complete except for 7 plug in IC's — Price: £19.75 + £2.00 p&p.

Note: British Telecom may not connect this equipment as there is no manufacturer to guarantee it, however it is well worth buying for its immense breakdown value — sold originally at over £150.

FROZEN PIPES. Can be avoided by winding our heating cable around them — 15 mtrs connected to mains costs only about 10p per week to run. Hundreds of other uses as it is waterproof and very flexible. Resistance 60 ohms/metre. Price 28p/metre or 15 m for **£3.95**

25A ELECTRICAL PROGRAMMER 'Learn in your sleep: Have radio playing and kettle boiling as you wake — switch on lights to ward off intruders — have a warm house to come home to. You can do all these and more. By a famous maker with 25 amp on/off switch. Independent 60 minute memory jogger. A beautiful unit at **£2.50.**

24 HOUR TIME SWITCH — Made for control of Randall Central Heating Boilers these give 2 on/offs per 24 hrs. Equally suitable for control of immersion heaters of heating systems. £4.60.

50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, multi-turn pots and notes on the 50 projects.

YOURS FOR ONLY £11.50 plus £3.00 post.

MINI-MULTI TESTER Deluxe pocket size precision moving coil instrument, Jewelled bearings - 2000 o.p.v. mirrored scale. 11 instant range measures:
DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0 — 100 mA.

Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only **£6.75** + 60p post and insurance.

FREE Amps range kit to enable you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but if you already own a Mini-Tester and would like one, send **£2.50.**

J. BULL (Electrical) Ltd.

(Dept. HE), 34 - 36 AMERICA LANE, HAYWARDS HEATH, SUSSEX RH16 3QU. Established 30 YEARS

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £12 add 60p service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted day or night. Haywards Heath (0444) 454563. Bulk orders: phone for quote. Shop open 9.00 — 5.30, mon to Fri, not Saturday.

STORE CLOSING SALE

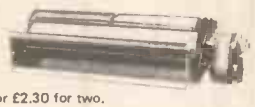
All stocks must go from one of our big warehouses. 10,000,000 items, everything from AERIALS to ZENER will be cleared at fantastically low prices - If you are a manufacturer you can save yourself a fortune - send for our Sale List, not for small buyers as minimum order £100.

EXTRACTOR FANS — MAINS OPERATED

Woods extractor.
5" — £5.75, Post £1.25.
6" — £8.95, Post £1.25.
5" Plannair extractor £6.50. Post £1.25.
4"x 4" Muffin 115v. £4.50. Post 75p.
4"x 4" Muffin 230v. £5.75. Post 75p.
All the above ex-computer, those below are unused.
4" x 4" £8.50. Post 75p.
9" American made £11.50. post £2.00.
Tangential Blower 10x3 air outlet, dual speed £4.60. Post £1.50.

TANGENTIAL BLOW HEATER

by British Solartron, as used in best blow heaters. 2Kw approx 9" wide £5.95, 3Kw either 9" or 12" wide (your choice) £6.95 complete with 'cold', 'half' and 'full' heat switch, safety cut out and connection dig.



Please add post £1.50 for 1 or £2.30 for two.

2.5 Kw KIT Still available: **£4.95 + £1.50 post.**

MINIATURE WAFER SWITCHES

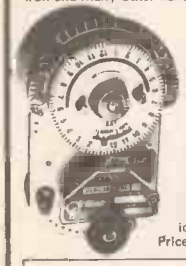
2 pole, 2 way — 4 pole, 2 way — 3 pole, 3 way — 4 pole, 3 way — 2 pole, 4 way — 3 pole, 4 way — 2 pole, 6 way — 1 pole, 12 way. All at 25p each.

BLEEP TONE These work off 12v and have an unusual and pleasant bleep. 69p each.

CONNECTING WIRE PACK 48 lengths of connecting wire, each 1 metre long and differently colour coded, a must for those difficult interconnecting jobs. 85p the lot.

RED LEDS 10 for 69p. 100 for £5.75. 1000 for £52.

IN LINE SIMMERSTAT Ideal heat controller for soldering iron and many other hand-held appliances. **£2.30.** 10 for **£17.25.**



VENNER TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only **£2.95.** These are without case, but we can supply a plastic case - **£1.75** or metal case - **£2.95.** Also available is adaptor kit to convert this into a normal 24 hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater.. Price of adaptor kit is **£2.30.**

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder — a complete mains operated kit, case included.

£11.95 plus **£2.00** post.

OTHER POPULAR PROJECTS

Short Wave Set — covers all the short wave bands using plug-in coils. Kit complete	£14.50
R C Bridge Kit	£9.95
3 Channel Sound to Light — with fully prepared metal case.	£14.95
Ditto — made up	£25.00
Big Ear, listen through walls	£9.50
Robot controller — receiver/transmitter	£9.50
Ignition kit — helps starting, saves petrol, improves performance	£13.95
Silent sentinel Ultra Sonic Transmitter and receiver	£9.50
Car Light 'left on' alarm	£3.50
Secret switch — fools friends and enemies alike	£1.95
3 — 30v Variable Power Supply	£13.80
2 Short & Medium wave Crystal Radio	£3.99
3v to 16v Mains Power Supply Kit	£1.95
Light Chaser — three modes	£17.50
Mullard Unilex HiFi stereo amplifier with speakers	£16.75
Radio stethoscope — fault finding aid	£4.80
Mug stop — emits piercing squark	£2.50
Morse Trainer — complete with key	£2.99
Drill control kit	£3.95
Drill control kit — made up	£6.95
Interrupted beam kit	£2.50
Transmitter surveillance kit	£2.30
Radio Mike	£6.90
FM receiver kit — for surveillance or normal FM	£3.50
Seat Belt reminder	£3.00
Car Starter Charger Kit	£15.50
Soil heater for plants and seeds	£16.50
Insulation Tester — electronic megger	£7.95
Battery shaver or fluorescent from 12v	£6.90
Matchbox Radio — receives Medium Wave	£2.95
Mixer Pre-amp — disco special with case	£16.00
Aerial Rotator — mains operated	£29.50
Aerial direction indicator	£6.50
40 watt amp — hifi 20hz — 20kHz	£9.50
Microvolt multiplier — measure very low currents with ordinary multitester	£3.95
Pure Sine Wave Generator	£6.75
Linear Power output meter	£11.50
115 Watt Amplifier 5Hz 25kHz	£13.50
Power supply for 115 watt amps	£8.50
Stereo Bass Booster, most items	£8.95

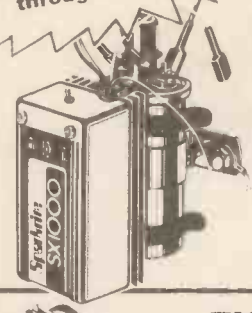
Step-by-step fully illustrated assembly and fitting instructions are included together with circuit descriptions. Highest quality components are used throughout.

Sparkrite

SELF ASSEMBLY ELECTRONIC KITS

PRICES REDUCED ON SUPER SAVE D.I.Y. KITS

SX 1000 Electronic Ignition



● Inductive Discharge ● Extended dwell circuit stores greater energy in coil ● Three position changeover switch ● Patented clip-to-coil fitting ● Easy to assemble, easy to fit ● Contact breaker triggered – includes bounce suppression circuit.

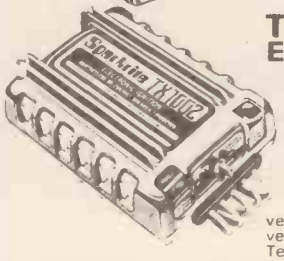
SUPER SAVE

SX 2000 Electronic Ignition

● Reactive Discharge ● Combines inductive & capacitive energy storage ● Gives highest possible spark energy ● Patented clip-to-coil fitting ● Easy assembly sequence ● Contact breaker triggered – includes bounce suppression circuit.

SUPER SAVE

TX 1002 Electronic Ignition



● Inductive discharge ● Extended dwell circuit stores greater energy in coil ● Three position changeover switch ● Contactless or contact breaker triggered ● Clip-to-coil or remote mounting ● Rugged die-cast case ● Contactless adaptors included for majority of 4 & 6 cylinder vehicles ● Easy to build ● For details of vehicles fitted by contactless trigger, ring Technical Service Dept on (0922) 611338-9.

TX2002 Electronic Ignition

● Two separate systems in one unit! ● Reactive Discharge OR Inductive Discharge, with three position changeover switch ● Gives highest possible spark energy ● Clip-to-coil or remote mounting ● Rugged die-cast case ● Contactless or contact breaker triggered ● Contactless adaptors included for majority of 4 & 6 cylinder vehicles ● For details of vehicles fitted by contactless trigger, ring Technical Service Dept on (0922) 611338-9.

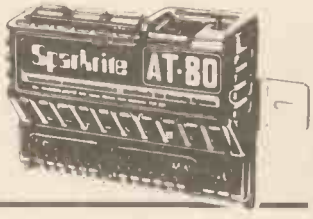
AT-40 Electronic Car Alarm

● Guards doors, boot, bonnet from unauthorised entry ● Armed/disarmed using concealed switch ● 30 second delay-to-arm : 7 second entry delay ● Can alternatively be wired to exterior key switch ● Flashes headlights & sounds horn intermittently for 60 seconds when activated ● Security loop protects accessories ● Low consumption C-MOS circuitry.

NEW

AT-80 Electronic Car Security System

● Guards doors, boot, bonnet from unauthorised entry ● Armed/disarmed from outside vehicle by magnetic key fob passed across sensor pad adhered to inside of windscreen ● Individually programmable code ● 30 second delay-to-arm ● Flashes headlights and sounds horn intermittently for 60 seconds when activated ● Security loop protects accessories ● Function lights to assist setting-up ● Low consumption C-MOS circuitry.



SUPER SAVE

ULTRASONIC Intruder Detector

● Supplementary to AT-40 & AT-80 ● Will work in conjunction with any door switch input or voltage sensing alarm ● Detects attempted break-in and movement within passenger compartment & triggers alarm ● Includes high efficiency ultrasonic transducers ● Crystal controlled for low drift ● Ingenious sensitivity control allows freedom from false alarms ● Low current consumption

NEW

VOYAGER Car Drive Computer

● 12 functions centred on Fuel, Speed, Distance and Time ● Single chip microprocessor ● Large high brightness fluorescent display with auto-dimming feature ● High accuracy distance & fuel transducers included ● Displays MPG, L/100km and miles/litre at the flick of a switch ● Visual & audible warnings of excess speed, ice, lights-left-on ● Independent LOG & TRIP functions ● Low consumption crystal controlled circuitry.

SPECIAL OFFER

"FREE" MAGIDICE KIT WITH ALL ORDERS OVER £40.00

MAGIDICE Electronic Dice

● Triggered by waving hand over dice ● Completely random selection ● Bleeps & flashes during 4 sec tumble ● Throw displayed for 10 seconds then flashes to conserve battery ● Low consumption C-MOS circuitry

SUPER SAVE

SPARKRITE (A Division of Stadium Ltd.) 82 Bath Street, Walsall, WS1 3DE England Tel: (0922) 614791 Allow 28 days for delivery

	KIT	OLD PRICE	NEW PRICE
	SX 1000	~~£12.95~~	£11.95
	SX 2000	~~£19.95~~	£18.95
	TX 1002	£22.95	£22.95
	TX 2002	£32.95	£32.95
NEW!	AT-40	—	£9.95
NEW!	AT-80	~~£32.95~~	£24.95
NEW!	ULTRASONIC	—	£17.95
	VOYAGER	£64.95	£64.95
	MAGIDICE	~~£9.95~~	£6.95

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I ENCLOSE CHEQUE(S)/POSTAL ORDERS FOR

£ _____ KIT REF. _____

CHEQUE No. _____

PHONE YOUR ORDER WITH

BRAND LEADING BRITISH ELECTRONICS

CUT OUT THE COUPON NOW!

MONITOR

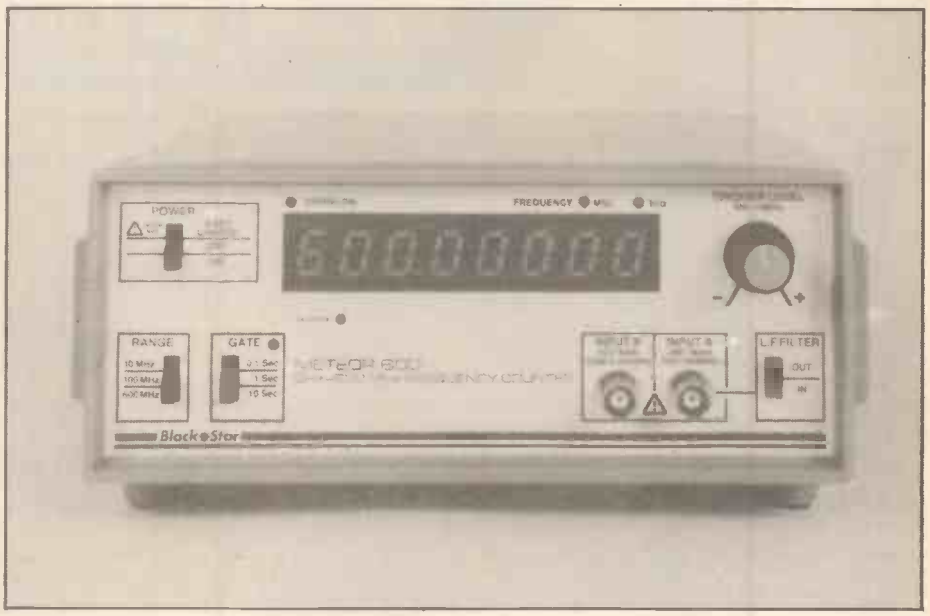
On The Counter

The Meteor 600 is the first in a series of digital frequency counters announced by **Black Star.** With typical frequency measurement range of 2Hz-700MHz, sensitivity of <25mV at 600MHz and resolution down to 0Hz1, the Meteor 600 also features 8 x ½in bright LED displays, three gate times, two inputs, trigger level control and an integral low pass filter.

The counter is housed in a sturdy, custom-moulded ABS case with a tilt stand. The Meteor 600 can be operated from rechargeable batteries or mains and is supplied complete with mains adaptor/charger and comprehensive instruction manual. A wide range of optional accessories is available.

The combination of high specification and reliability together with low cost plus flexibility of bench or field use makes the Meteor 600 useful for anyone involved in the design or service of CB, audio, communications systems etc. The price (excluding VAT) is £115. A 100MHz and a 1GHz version are also available.

Further details are available from **Black Star Ltd., 9A Crown Street, St. Ives, Huntingdon, Cambs PE17 4EB Tel: (0480) 62440.**



New Vintage

The **Vintage Wireless Company**, purveyors of obsolete electronics, radio TV and industrial valves, antique wireless equipment, industrial electronics and valve hifi have now established themselves at their new address: **Tudor House, Cossham St., Mangotsfield, Bristol BS17 3EN. Tel: (0272) 565472** (24hr Ansaphone).

Their new business hours are Monday to Friday 9.5 to 5.30, excepting lunch 1.15 to 2.15, callers by appointment for collection and delivery only till further notice (they are only dealing by mail order at present).

The **Antique Wireless Newsheet,** their newsletter/catalogue is available at twelve issues for £3.50 UK and Eire, £5.00 overseas (air mail).

Putting Pen To Circuit

With the introduction of the new 3211 Pen Digital Multimeter, **Dorman Smith Instruments** reckon they have the last word in portable measuring equipment. The 3211 is built like a pen which can be held in one hand and touched to the circuit to obtain a reading. Advanced design and the "touch-to-circuit" concept has enabled this portable digital multimeter to take readings in previously hard-to-reach locations and with an additional HOLD function a reading can be obtained until the operator is able to record it easily.

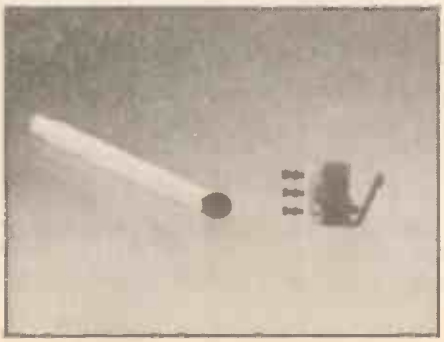
All controls are arranged for operational use, including the easy to read digital display — ideal for trouble-shooting and maintenance work on computer systems, the 3211 will also make fast, reliable readings possible on other microcircuits and standard electrical devices. An audible tone of sounds reports the results of the continuity tests, function switching and overrange input.

For further information contact **Dorman Smith Instruments, Group Publicity Department, Blackpool Rd., Preston PR2 2DQ. Tel: (0772) 728271.**

Mighty Mite?

An ultra miniature 50V microswitch with an actuator arm has been announced by **Semiconductor Supplies International.** The switch's dimensions are height 10mm (including the pins, and with the lever compressed), width 8mm and thickness 3mm.

The lever on the switch is designed for cam follower applications as well as ordinary compression. Possible uses are tamper proofing or safety switching of small equipment including security equipment such as sensors and for switching scale models and any other miniaturised equipment.



The switch weighs 0.3gm, and is possibly an example of unusually advanced technology, as according to SSI's new release it has a 300MA single pole changeover, which is probably enough to handle the entire national grid. Anyone intending to use it for 300*m*A applications, however, is probably safe to go ahead without making further enquiries as to specification! The price is £4.00 for ten, p&p inclusive.

Orders and enquiries to **Semiconductor Supplies, 128/130 Carshalton Rd., Sutton, Surrey SM1 4RS. Tel: 01 643 1126.**

Portable Test Gear

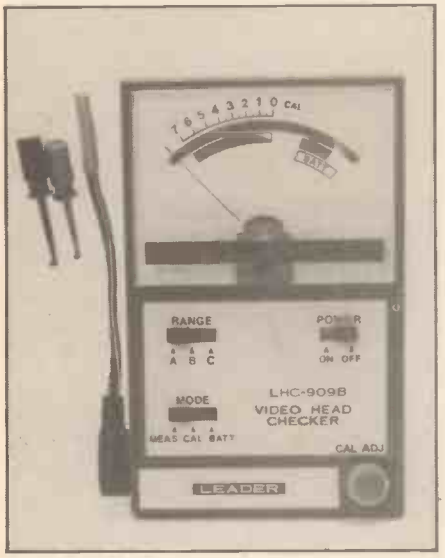
Professional test equipment from **Thandar Electronics Ltd.,**: the TG101 is a mains-operated **function generator** working from 0.02Hz to 200Hz.

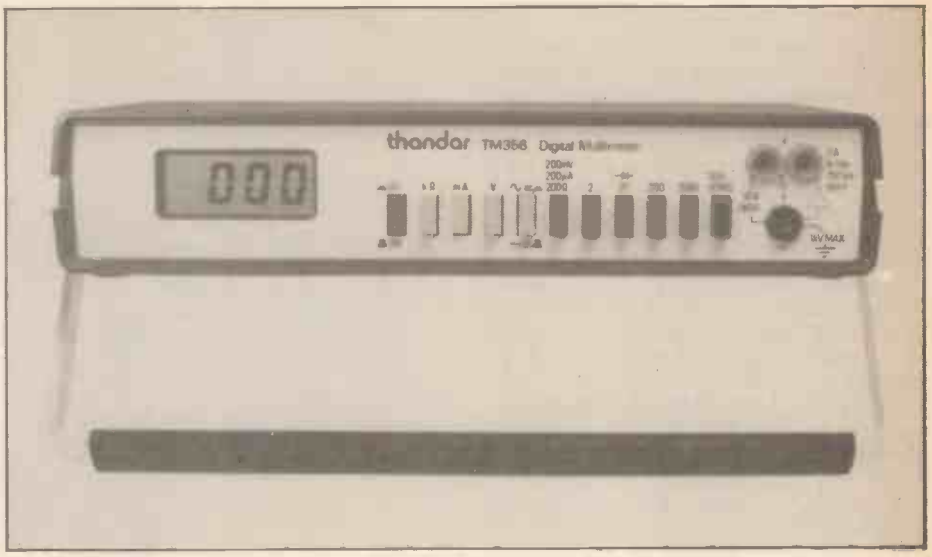
The frequency is selectable via a five-position range switch and a calibrated vernier, or by the sweep input which enables the generator frequency to be adjusted via an external control voltage. Both vernier and sweep input can give more than 1000:1 frequency change within the selected range. A typical external sweep range is 10,000:1.

A variable output of 600R is controlled over a range of more than 80dB up to a maximum of 10V peak to peak via a single vernier plus two position switched attenuator. The DC offset is switch selectable and the vernier provides adjustment of up to ±5V from 600OR.

Square, sine, triangle and the DC waveforms can be selected, and a TTL output is provided. The unit measures 255 x 150 x 50mm in its ABS case and weighs 1200 gms. It will operate from a 50/60Hz supply of 100-120VAC or 200-240VAC. Price is £99 plus VAT.

MONITOR





The TM356 is a battery-operated **lab multimeter**. With twenty nine ranges it can measure voltage from 100uV-1000V (750VAC), current from 100nA-10A and resistance from 100mR to 20MR. Battery life from alkaline 'C' cells is over 3000 hours, and a low-battery indicator shows when 10% battery life remains. The ABS case has a handle and stand for portable and bench use, and the weight is 1200gm with full batteries. The price is £85 plus VAT.

A **video head tester**, priced at £45 plus VAT, is available in two models, the KNC-909V (for VHS) and LHC-909B (for Betamax) is also available to measure the wear in VCR heads.

For further information about any of these, contact **Thandar Electronics Ltd., London Rd., St. Ives, Huntingdon, Cambs PE17 4HJ. Tel: (0480) 64646.**

New For Glue

A new heater called the PTC (Positive Temperature Co-efficient) means that an operating temperature is maintained without a thermostat. This is the new technology incorporated in **BetA Fastening Systems'** latest addition to their range of four hot-melt glue applicators — a new baby, the BeA Hotfix 180 which brings instant bonding to most materials.

Operating on a 100-240V power supply, it can be used within three or four minutes of being plugged in. By simply feeding glue sticks into the back of the tool and squeezing the trigger, application of hot-melt glue becomes easy, quick and accurate. The adhesive not only bonds, but seals, insulates, fills and reinforces. There is a range of nozzles for the machine and a variety of glues for different materials. The Hotfix 180 is double insulated, has a power warning light, and a fully enclosed heater housing. The clip-on stand provides stability.

The price is £16.95 plus VAT. Enquiries about the range to **BeA Fastening Systems Ltd., Swinemoor Industrial Estate, Beverley, Humberside HU17 0LA. Tel: (0482) 861075.**

Clean Screen

The introduction of anti-glare filters, manufactured from nylon or such material and in the form of a very fine mesh to defuse reflected light from VDU screens is an excellent idea but one that presents a cleaning job. These filters, manufactured from man made fibres, are now being fitted in contact with the glass VDU screen which accentuates the build up of static. This fine mesh becomes clogged with contaminants, making the screen even more difficult to see.

If water only is used, some of the water penetrates the filter and deposits water marks and contaminants on the screen. There is also the risk of water running down the front of the filter and seeping into the surrounding cabinet. The new 'Data Care' product Anti Static Screen Cleaner is a specially prepared formula of solvents, with anti-static properties, and is used in such a way as to remove contaminants from meshed surfaces.

Anti-Static Screen Cleaner is available in 340g/400mls aerosols or in kit form, incorporating an anti-static foam cleaner, anti-static screen cleaner and one hundred lint free wipes. To control static build-up, keep filter/screen in good condition and for general cleaning of hard surfaces found in a computer environment.

More information from **Sapona Chemicals Ltd., 46-50 Upper Dean St. Birmingham B5 4SG. Tel: 021-622 6442.**

MONITOR

Culture Club

The autumn issue of the **British Amateur Electronics Club's** newsletter is mostly taken up with part four of their series by C. Roper, *Electronics A-Z*, which covers Resistor/Capacitor circuits, AC circuits, series circuits and many permutations. There is also the usual letters page and *Notes From An Experimenter's Workshop* by H. F. Howard.

The Winter issue should appear in January. The BAEC, apart from its newsletter provides a loan library of electronics books and periodicals, an annual exhibition, and various other membership benefits. Membership for UK and Eire members is £5.50, overseas surface mail is £7.00, all European memberships £6.00, and other airmail memberships £8.50. Memberships run from January 1st to January 1st, and members receive all the newsletters for the year they join regardless of which month they join in.

Chairman and editor Cyril Bogod and his helpers were much in evidence at **Breadboard** this year. Keep up the good work, chaps. Subscriptions and enquiries should go to the **Chairman, Mr. Cyril Bogod, "Dickens", 26 Forest Rd., Penarth, S. Glam CF6 2DP**.

I Have Seen The Future Of Television, But They Won't Let Me Near It.

We can look forward, in the as-yet-unscheduled future, to being able to watch two television programmes on one screen: either a step closer to heaven or the ultimate horrorshow, depending on what your attitude to television is. Remembering early catfights around the subject of whether we were going to watch *Match Of The Day* or *The Old Grey Whistle Test*, I veer towards the former opinion. At least then you can see what you're fighting about.

The machine in question is a 'new multifunctional digital TV' by **Matsushita** of Japan, the people who market under the name **National Panasonic** in the UK. By 'multifunctional', they mean

that it's a member of the modern generation which can accommodate teletext, viewdata, video equipment, hifi and all the rest.

The 'second screen' is a digitally processed 6in colour picture which can be inserted in the main 20in screen (see picture). The TV has its own CPU and, being digital, boasts 'crisper, cleaner images due to the reduction of spots, screen flickering and colour saturation which exist in analogue sets'. Panasonic also say that the set has 30% fewer components than the normal analogue set, which increases reliability and reduces cost. As we have no prices to compare, it remains to be seen whether the reduction in cost will be actually or purely relative.

The infra-red remote controller controls sixty-one functions, including both the picture qualities (brightness, saturation etc) of the television, and any other equipment hooked up to it, and, since the control signal is generated by an 11 bit digital system, it is, they say theoretically capable of controlling up to 2,048 functions.

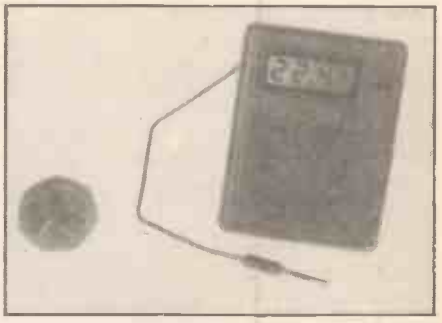
The development of the household television into the home information centre of the future seems to be well under way, though it is still a minority of houses that have teletext, home computers and VCRs, let alone use them for anything more solemn than light entertainment. Mind you, my mother-in-law gave my granda two winners which she saw tipped on the teletext while she was setting up the VCR for Christmas . . . a few more like that and she'll have covered the cost of the television. Be that as it may, I still remain sceptical that you can afford to budget for more than two people squabbling over the TV (let's be modern and call it a *monitor*) screen at one time. If we're going to have a VCR, video player and a video camera hooked up to the telly, then the games console and the home computer will have to go in the other room with their own monitor, the hifi will have to go in the cellar or the attic, and we can soundproof the lot while we're about it. Alternatively, the lounge can be fitted out with individual booths for all the family . . .

So why can't we have the two-screen television right away? If Panasonic don't move soon, every household will have a second telly, or even a third telly, and we won't need one which shows two progs at once. Maybe it's happened already . . . everyone I know seems to be rescuing discarded black and whites off rubbish tips. We're still looking for a VCR, but no luck yet. . . .

For people who can't afford (or face) even one full-sized TV screen, let alone two in one. Matsushita are also developing a portable 6½in rear-projection colour TV which folds down into an attache case weighing 3kg and measuring 25 x 8.5 x 31cm, about half the size and weight of a normal 7in screen TV, uses 12W and can be used as a monitor for other video equipment. Ideal for closet TV addicts, but you can't fold it in half and put it in your back pocket, or scribble addresses on it, so don't expect multifunctional, digital (all typed by hand) HE to go teletext in the near future.

Feel The Heat

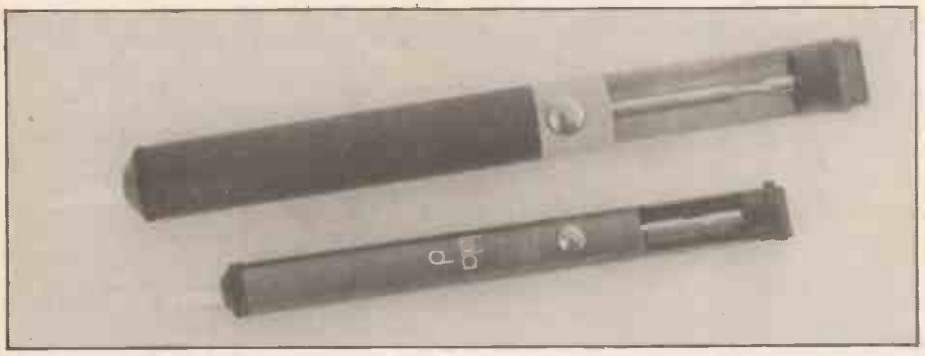
Electronic Temperature Instruments have introduced a new all electronic miniature multi purpose thermometer. The Thermotron has two unique features, price and size. At £24.95 it is half the price of the majority of its competitors, and measures up at 82 x 63 x 23mm.



This electronic instrument is an alternative to the glass thermometer for both liquid and air temperature measurement. Its advantages include its easy to read liquid crystal display, long battery life and its waterproof and non corroding sensor. The high impact ABS case is supplied complete with built in wall mounting bracket and table top stand making it truly versatile. This high precision electronic thermometer can measure 0-99°C with an accuracy of 0.1°C.

The Thermotron is particularly well suited for measuring the exact temperatures of air, liquids and semi solids. solids.

MONITOR



For further information and leaflet please contact **ETI, Highdown Avenue, Worthing, Sussex. Tel: (0903) 692161.**

What? another ETI? Can there be two?

Measure And Dismantle

A pocket-sized **Digital Thermometer** with ±0.1°C accuracy over a temperature range from –200 to +800°C, the, Ancom BLR-800 is currently available from **Electronic & Computer Workshop Ltd**. The thermometer offers a one °C, resolution, repeatability and a stability figure of 0.01°C per °C, with a wide range of standard platinum RDT temperature sensor probes. These include air temperature, liquid immersion, surface temperature, hypodermic insertion and fast response types. The sensors are available with conformity to British and DIN standards in grades, A, B, C, D and **E** and are connected to the instrument by a three-way plug/socket.

The BLR-800 uses a lower power 3½ digit LCD for data display, which also displays a low battery sign. The internal battery will give over 200 hours continuous operation and accuracy is not affected by battery condition. The BLR-800 measures 90x145x28mm and has a single on/off switch. Calibration is carried out by the user, with boiling water and melting ice references, plus screwdriver adjustments.

The Pantec Major 20K, a general purpose **Multimeter**, has a sensitivity of 20kR/VDC and 4kR/VDC, with a DC voltage range of 0.15 to 1500V and AC from 7.5 to 1500V. Current measurements range from 50uA to 2.5ADC and 2.5 to 12.5 AC. Resistance can be measured from 0.5R to 2MR in four ranges, with ballistic capacitance in the range 100-1,000uf to 10-100mf. The multimeter has a 2% accuracy for DC and resistance measurements and 3% for AC.

Full protection is provided with a quick-blow fuse, diode system and neon discharger, and the meter comes with shock-proof case and spare fuse. The Major 20k weighs 600g and dimensions are 130x125x40mm.

Effective **de-soldering guns** in standard and miniature sizes are currently available. The standard gun is 19mm in diameter, 220mm long and the miniature version has a 14mm diameter and is 165mm long. Both guns can be purchased for £5.25 each (plus VAT and P&P).

The guns can be operated with one hand. Used in conjunction with any standard soldering iron the de-soldering operation is simple — the gun is 'charged' by depressing the spring load plunger. On pressing the release button, molten solder is drawn up into the gun where it solidifies.

For further information please contact **Electronic & Computer Workshop Ltd., 171 Broomfield Rd., Chelmsford, Essex CM1 1RY. Tel: (0245) 262149.**

Relay The Message

A low-cost easy-to-use relay board is now available for ZX Spectrum users from **Ness Micro Systems.**

The NMS Relay Controller has four channels each of which has a double pole 5A relay rated at 1kW and 240V AC or 100W at 25V DC and with screw-terminal connections to the relays. Unlike other relay boards it plugs into the Spectrums MIC socket leaving the expansion port free and is powered from the Spectrum supply. The controller is extremely easy to use as any of the four relays may be turned on or off by means of a simple BEEP command, either from within a program or direct from the keyboard. Each relay has an on/off LED indicator.

The board is supplied built into a black plastic case measuring 180 x 110 x 55 mm together with 1m leads. The controllers may be daisy-chained so that more than one may be operated under the control of one Spectrum.

The NMS Relay Controller is available from **Ness Micro Systems, 100 Drakies Avenue, Inverness IV2 3SD** and costs £24.95 plus £1.50 post and packing.

Big Cat Free

A new electronic hardware catalogue, from **Supercat Electronics Ltd.**, came out in January and is free of charge. There will be a Summer edition later in the year.

Supercat say that the catalogue is aimed at hobbyists, educational and small industrial users, as well as general industry and research, and the first issue includes test equipment, power supplies, signal sources, meters, kits, connectors, leads and accessories.

Contact **Supercat at PO Box 201, St. Albans, Herts AL1 4FN. Tel: (0727) 62171,** giving your full name and address, and stating whether a business or private user, they say.

Aerial Meter

Not as cheap or simple as our recent HE project, but of possible interest to radio clubs, is **House Of Instruments'** TC40, a **field strength meter,** from Sadelta, designed to measure the performance of aerials and indicating the prime position for installation.

Aerial signals normally fed to TV or FM receivers are passed to the TC40's 75R coaxial type input connector, where coarse and fine tuning controls give complete and accurate cover over Band I TV 45 to 88 MHz, Band II FM 87 to 108 MHz, Band III TV 163 to 230 MHz and Bands IV and V TV 470 to 862 MHz.

Seven level measuring ranges from 100 microvolts full scale to 100 millivolts full scale give accurate indication of on RMS voltage and dB/microvolt calibrated scales, allowing measurement down to 20 microvolt (26 dB/microvolt). Audio monitoring of AM and FM is available via an internal detector, amplifier and loudspeaker. An Ohms range, complete with probes, is also fitted for continuity and short circuit tests.

This ultra compact, light field strength meter is fully portable with power being supplied by two internal 4V5 batteries and comes complete with carrying case and accessories . Ideal for applications, say the manufacturers, are for TV and Radio Technicians specialising in aerial installation and alignment, who need one complete reliable portable unit. The UK list price is £177 plus packaging, delivery and VAT.

For further information, please contact **Fred Hutchinson at hil, tel: (0799) 24922,** or write to **Quiswood Ltd., 30 Lancaster Road, St. Albans, Herts AL1 4ET.** A leaflet is available.

HE

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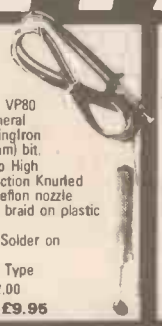

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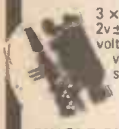

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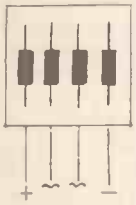

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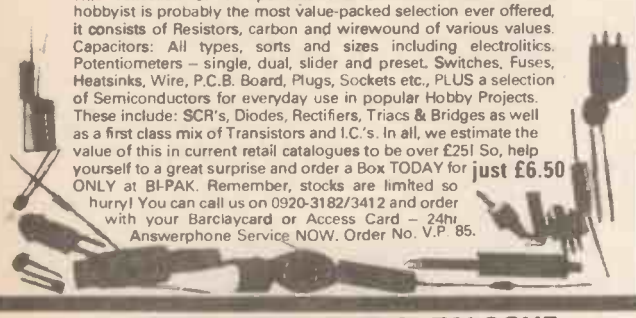

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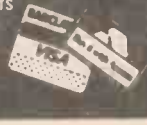

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Offbeat Metronome

Andrew Armstrong

A very basic rhythm box for musical practice and improvisation, with a tuning device built in.

THIS is a metronome with a difference. The initial requirement was for a simple metronome which would enable the musician or musicians to practice playing to an even rhythm, instead of succumbing to the inevitable temptation to play faster and faster until collapse from exhaustion ensues. The project became more ambitious when we decided to add a rhythm accent or offbeat to give a variety of rhythm 'feels' to play against. What was wanted, obviously, was a very simple substitute for a drummer. After all, drummers are usually very simple, aren't they?

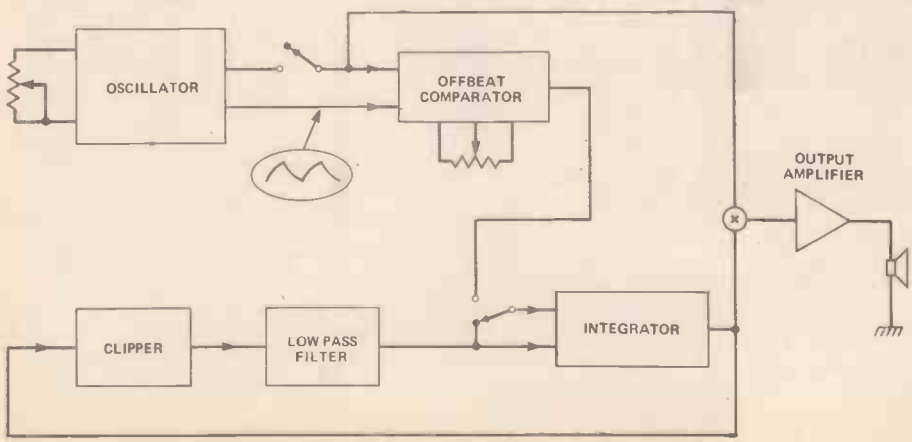
The other primary motive was to devise an electronic rhythm box which cost less than the £60 or so demanded for even the cheapest commercial device.

The required variable offbeat was achieved by inserting another note between the regular beats, which can be adjusted to fall anywhere between the two beats, or in unison with one beat to give a stronger accent on that beat, or not to occur at all.

The final embellishment was the addition of a pure "A" tone for tuning purposes.

So the owner of the offbeat metronome has no excuse for being either out of time or out of tune!

Figure 1. The block diagram of the Offbeat Metronome.



Offbeat Circuits

Figure 1 shows the basic functional blocks of the circuit. The oscillator on the top left is one that may be used in any simple metronome project. Next to it is drawn an offbeat comparator block. This is specially designed to add an extra beat between the *tock* and *tick*, so that, with the offbeat, the sound is something like *tick - bok - tock, tick - bok - tock.*

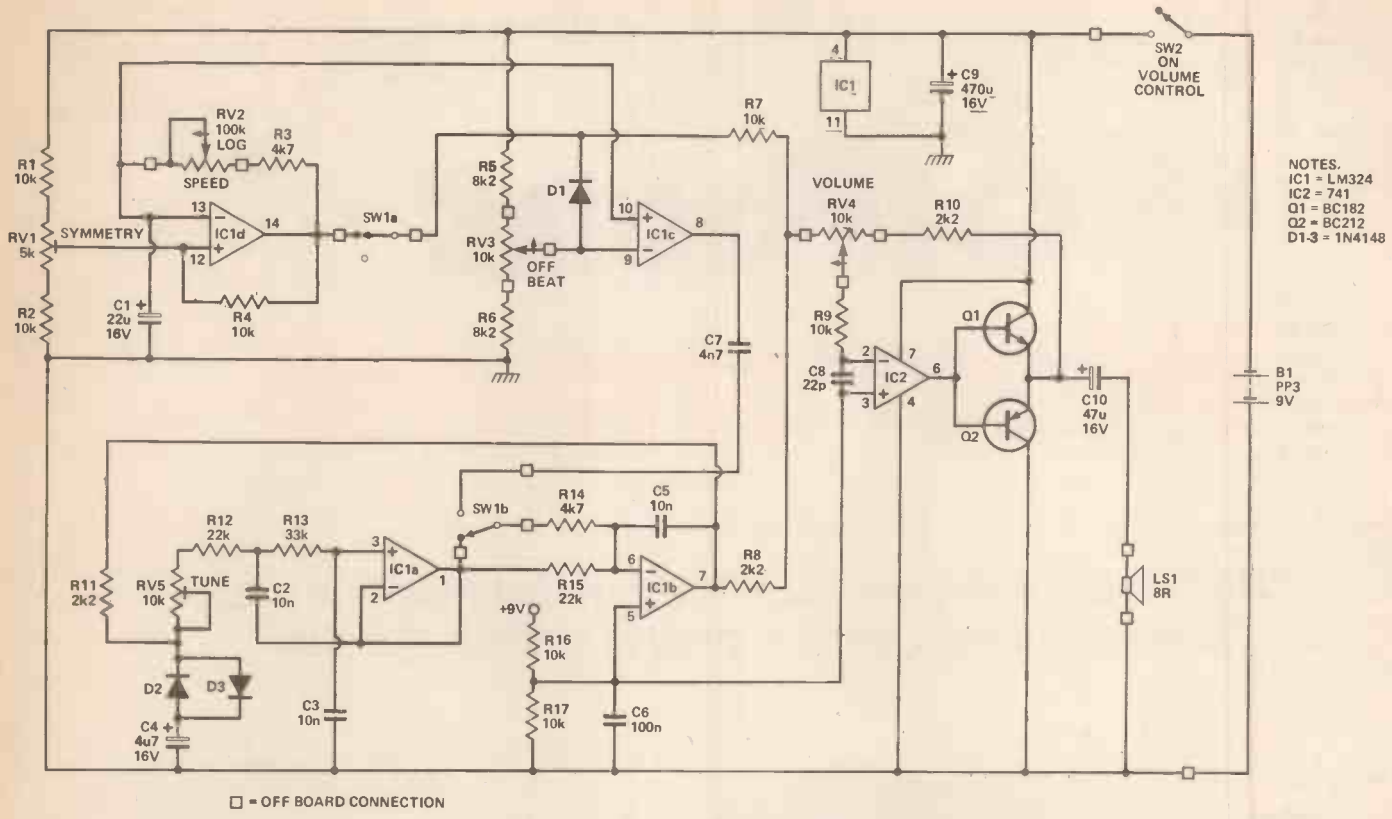


Figure 2. The circuit. The tuning oscillator also modifies the sound from the offbeat comparator.

In order to have a tuning aid available, an accurate sine wave oscillator is included, with the aid of the mode switch the oscillator can be stopped from oscillating and instead used to provide a slightly resonant sound on the signal from the offbeat comparator.

Pull And Twist

The controls (see photograph) are a pot governing the speed of the main rhythm, a small switch which pulls to turn the unit on, and rotates to control the volume; the pot which alters the relative position of the offbeat, and a two position swich which selects either the metronome or the "A" tone. The pull switch for on/off was chosen on the basis that pull switches don't wear out so fast as rotary switches with continual use, but an ordinary rotary on/off pot will do just as well.

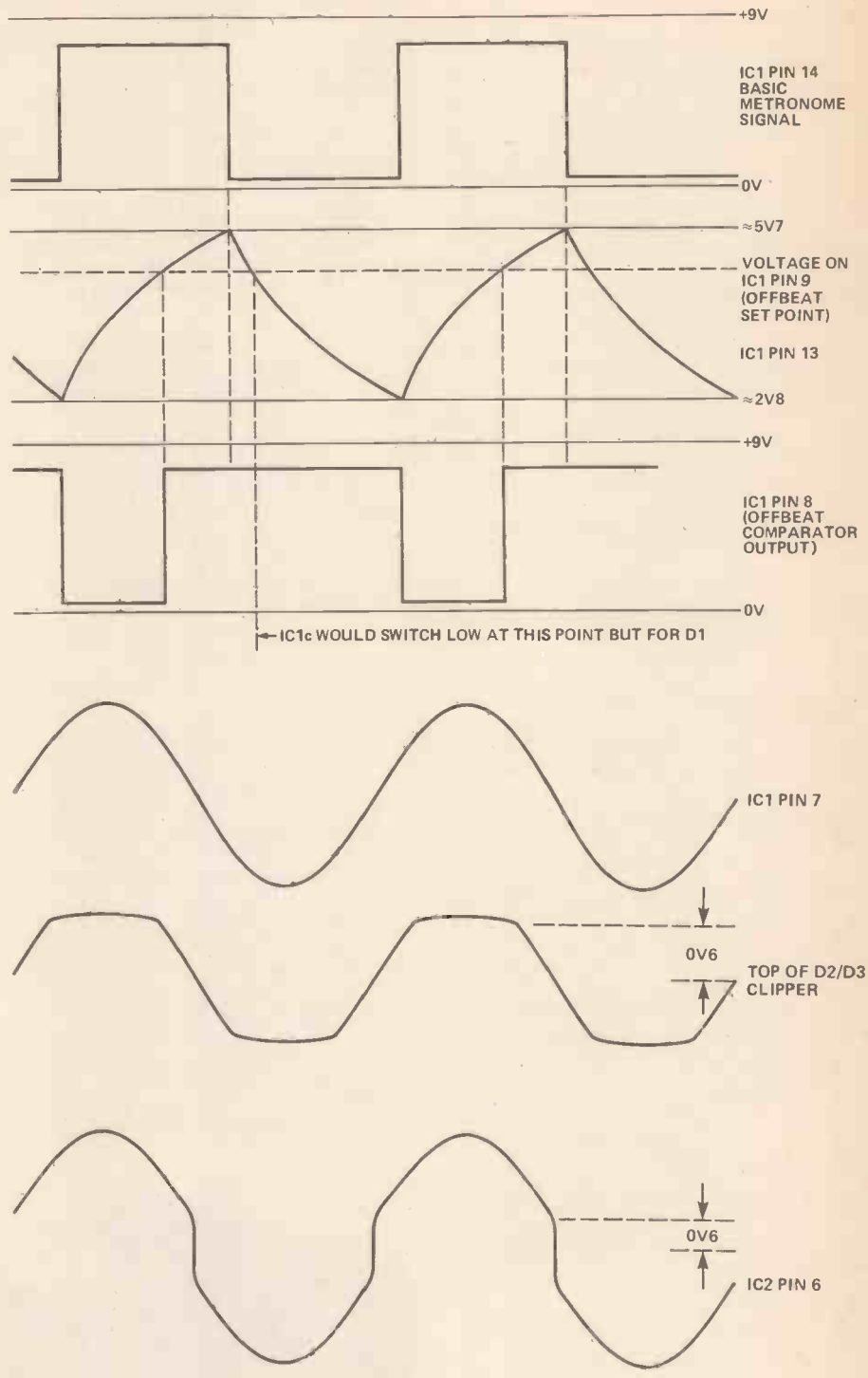
First of all, the detailed functioning of the tuning oscillator: in order for a circuit to oscillate, it must receive feedback to its input with a phase shift on it such that the phase change round the entire loop is 360 degrees. In this circuit the 360° phase shift is achieved by one inversion and two 90° phase shifts. The integrator provides both the inversion and 90° phase shift over a wide range of frequencies. The low pass filter has a phase shift which depends on frequency, so it will only provide a 90° phase shift at one specific frequency.

So that the filter and the integrator can function without clipping, the feedback is taken via a clipper. The distortion produced by the clipper is filtered out by both the filter and the integrator, so that as long as neither the filter nor the integrator themselves clip, the output sinewave is very pure. Similarly, because the circuit is working in a linear mode, the frequency is stable and little affected by battery voltage.

IC1a (see **Figure 2**) forms the filter, which is a very ordinary low pass design, and IC1b forms the integrator. The clipping action is performed by a pair of back to back diodes, D2 and D3, with capacitor C4 preventing DC current through the diodes from upsetting the bias point of the op-amps.

Figure 3. The waveform diagram. The symmetry pot is included to compensate for the unequal positive/negative swing of the metronome signal.

Figure 4. The waveform at the output of IC2 (a 741) as it compensates for distortion produced by the transistors Q1 and 2.



The gain of the integrator is switched by switch SW1b. In the low gain position, where some signal is fed into the integrator from the offbeat comparator, the loop gain of the oscillator is insufficient to permit oscillation to occur. However, when the circuit is excited by a sharp pulse, it will ring slightly, producing a somewhat hollow and resonant sound rather like striking a guitar body. In the metronome mode this resonant sound is mixed with the basic metronome tone. Resistors R7 and R8 determine the proportion of signals used.

Time Constant

The metronome oscillator itself uses IC1d. Positive feedback is applied to the op-amp: negative feedback is also applied, delayed by the time constant of C1 and the resistance of RV2 in series with R3.

The time per half cycle of the oscillator is set by the time required for C1 to charge between the voltages which can be obtained on the positive terminal of IC1d, with the output in either of its two states.

This is shown on the waveform diagram, **Figure 3**. Also illustrated on the waveform diagram is the fact that the output stage of the IC used, an LM324, cannot pull equally as close to its positive power supply as to its negative power supply. Thus, in order to maintain symmetry to keep each half cycle of the oscillator the same length, a symmetry adjustment pot has been incorporated.

The waveform on C1 is also fed to IC1c's positive input. This part of the IC works as a comparator to insert the offbeat. When the output of IC1d is high, and C1 is therefore charging towards a positive voltage, and when the volatge on C1 crosses over the voltage set by the offset pot, the output of IC1c switches in a positive direction.

If the offbeat pot is set to a high voltage, so that this switching does not occur before the output of IC1d switches low, then the output of IC1c will switch high at this moment. If the output of IC1c has switched high at all, it will switch low at the same moment that the output of IC1d switches high. Thus, the return stroke of this comparator does not insert an extra offbeat, it merely modifies the sound of the *tick* slightly. If the offbeat comparator is set at a lower voltage than that attained by C1, then the offbeat comparator will not switch at all, and in this mode an unaccented metronome sound is produced.

Output Amplifier

The only part of the circuit not yet described is the output amplifier. This very simple circuit uses a complimentary pair of transistors as emitter followers to increase the output drive available from a 741 op-amp. These transistors are not biased into class A/B, so a certain amount of distortion is produced on the output. This distortion is not significant for the use to which the circuit is put. However, it does give rise to an interesting waveform on the output of the 741 itself, as the output voltage frantically attempts to compensate for the distortion being introduced by the transistors (see **Figure 4**). As a result of this, the distortion produced is not very severe.

The volume control is of a linear type, and the way in which it is used produces an acceptable control law. Resistors R9 and capacitor C8 are included to prevent the possibility of self oscillation of the circuit due to stray capacitance of the output stage causing pickup on the wire from the wiper of RV4.

Construction

First of all, build up the PCB as shown in Figure 5, inserting the ICs last. Connect the controls to the PCB using suitable lengths of wire. Take great care to make sure that both halves of the mode switch are wired up in the correct sense. Failure to do so could result in the metronome and the tuning note being heard simultaneously! Note that the speed control of the metronome is a logarithmic pot, wired up so that anti-clockwise rotation increases the speed. This is done in order to give finer control at the higher speeds.

Once all the controls are connected up, the battery should be connected. Care should be taken to ensure that the polarity is correct! The unit should then be switched on, and then either a metronome beat or a tuning note should be heard. If the unit does not work properly, first of all check for badly soldered joints or solder bridges. If no such problems are found, but the unit still does not work correctly, then try this list of remedies for likely problems:

1. Metronome does not work at all: check connections to RV2; check that C1 is in the board the right way round; check that the wiring to switch SW1a is correct.

2. Metronome works but offbeat function does not: check connections to RV3; check polarity of D1; check wiring to switch SW1b.

3. Tuning note will not work: check connections to switch SW1c; check polarity of C4; also check polarity of D2 and D3; check that about half the battery voltage can be measured with an ordinary multimeter on IC1 pin 5; if not, check the *bias voltage* track for short circuits.

4. No sound is heard at all: check wiring to battery and switch SW2; check wiring to RV4; check wiring to loudspeaker.

Hopefully, having carried out the checks, any fault will be identified, and you will now be faced with a working unit. The next job is to adjust the symmetry control to make sure that the time between the *tick* and the *tock* and the *tock* and the *tick* on the metronome is the same.

First, set the offbeat control fully clockwise or fully anticlockwise, so that the offbeat is not heard. If you have an oscilloscope, then connect the probe to IC1 pin 14, advance RV2 to maximum speed and temporarily connect a 1k resistor in parallel with R3. You should now see on the oscilloscope a fast squarewave, and this can be adjusted visually by turning the symmetry pot. If an oscilloscope is not available, then instead turn the speed control to minimum and time the operation of the metronome with the second hand of a watch or the second count of a digital watch and adjust the symmetry pot for equal timings.

Now it is necessary to set the tuning tone. Switch to the "tune" mode, and the tone should be heard. If a frequency counter is available then the note can very easily be adjusted to 440Hz (concert pitch A). If a frequency counter is not available it will be necessary to borrow a tuning fork or to use a musical instrument known to be in tune.

Adjust the tune preset pot till a "zero beat" is heard. It may be that the tone cannot be calibrated due to tolerances of C2 and C3. In this case, R13 should be altered to bring the oscillator to within the correct range. If the frequency was too low, decrease R13 one step at a time. If the frequency was too high, increase R13, again, one E12 step at a time.

The unit is now calibrated, and final assembly can be carried out. A row of four holes needs to be drilled in the front of the case to fit the potentiometers. Four holes should also be drilled in the base of the unit, to fit the mounting bolts of the PC board. The loudspeaker should be mounted on the lid behind a grid of holes, drilled to let the sound out. The best way to make sure that the holes are neatly laid out is to lightly centre-punch the material of the lid through a piece of graph paper: 2.5 or 3mm holes should be suitable.

The loudspeaker is retained in the case by means of two M3 nuts and bolts, fitted with oversize washers, to overlap the rim of the loudspeaker. The convenient way to mount the PP3 battery is to use a couple of double

Parts List

RESISTORS
(All ¼ watt 5% carbon)
R1, 2, 4, 7, 9, 16, 17 ..... 10k
R3, 14 ..... 4k7
R5, 6 ..... 8k2
R8, 10, 11 ..... 2k2
R12, 15 ..... 22k
R13 ..... 33k

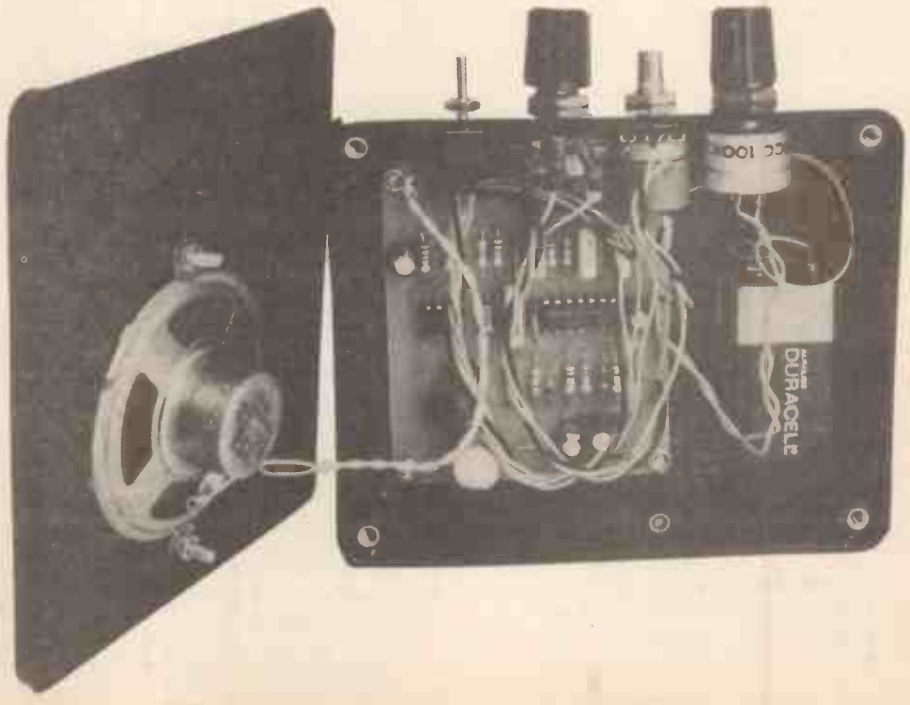
POTENTIOMETERS
RV1 ..... 5k horiz preset
RV2 ..... 100k log pot
RV3 ..... 10k lin pot
RV4 ..... 10k lin pot with SPST switch
RV5 ..... 10k horiz preset

CAPACITORS
C1 ..... 22u 16V radial electro
C2, 3, 5 ..... 10n polyester
C4 ..... 4u7 16V tantalum
C6 ..... 100n polyester
C7 ..... 4n7 ceramic disc
C8 ..... 22p ceramic disc
C9 ..... 470u 16V radial electro
C10 ..... 47u 16V radial electro

SEMICONDUCTORS
IC1 ..... LM324
IC2 741
Q1 ..... BC182 etc
Q2 ..... BC212 etc
D1-3 ..... 1N4148

MISCELLANEOUS
LS1 ..... 3½" 8R speaker
PCB; case, approximately 120 x 100 x 45mm; 6 x M3 or 6BA nuts & bolts; wire, solder etc.

BUYLINES ..... **page 26**



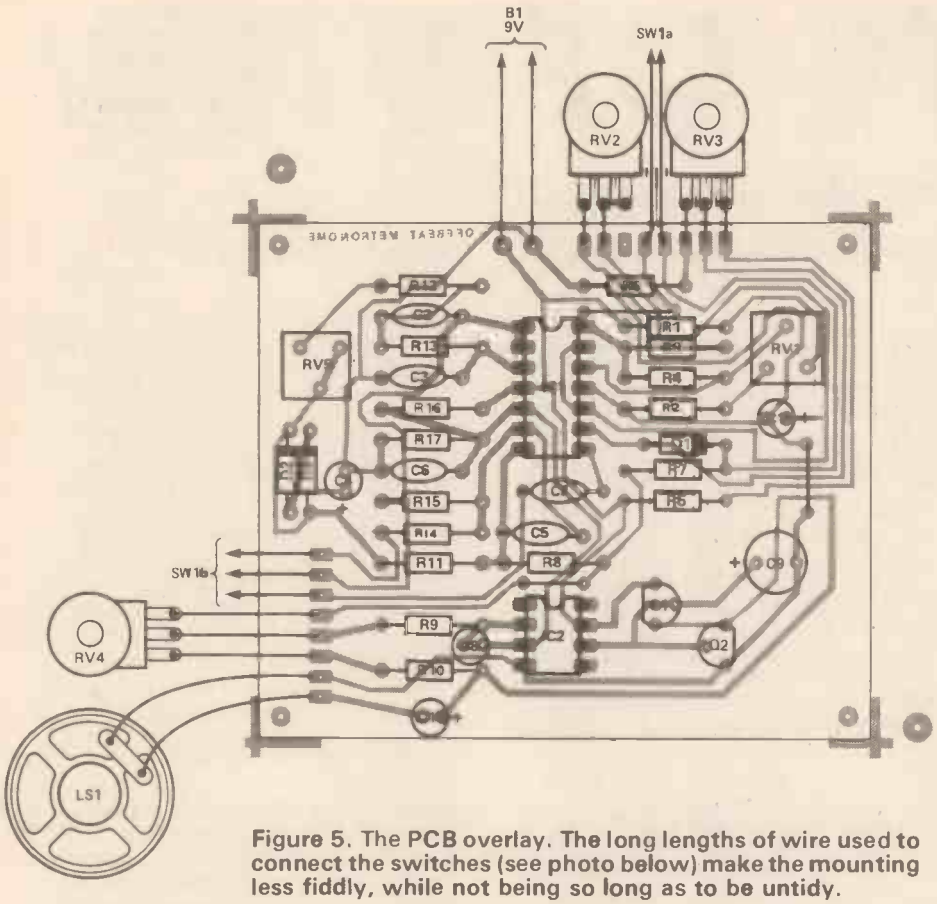


Figure 5. The PCB overlay. The long lengths of wire used to connect the switches (see photo below) make the mounting less fiddly, while not being so long as to be untidy.

sided adhesive pads, and to prise the things off with a screwdriver on the rare occasions at which it needs to be changed. For this reason, an alkaline manganese type of battery is recommended.

Our prototype uses a plastic case for cheapness and lightness; this muffles the sound a little, so if a very robust metronome is wanted, or a maximum volume, a metal case can be used.

Use Of The Metronome

For some purposes a so-called accented beat is required. If the offbeat is not required at the same time, then the offbeat can be set to occur immediately after the *tick*, thus turning it into a 'double' beat. If the offbeat function is in use, then the *tick* is automatically accented to a certain extent. If only a basic metronome function is required, without offbeat, but with very slight accent, then setting the offbeat pot fully clockwise will cause a slight accent to be heard,

If the tuning tone does not stop with the switch in either position, first, check the wiring to switch SW1b. If you are completely confident that this is correct, try increasing the value of R15 to reduce the loop gain in the metronome mode. This should cure the problem.

HE

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POINTS OF VIEW

Feel like sounding off?
Then write to the Editor stating your Point of View!

To: The Editor, Hobby Electronics.
Dear Editor,
I have obtained details of a 100W amplifier unit, designed by ETI TOP PROJECTS. I understand that I can obtain printed circuit boards made specially for the amplifier unit, direct from ETI. Unfortunately, I have not found their address anywhere. I would be grateful if you would send me the address, so that I can finish the project.
Many thanks.
Yours faithfully,
James Bedford,
Halesowen,
West Midlands.

This gentleman may be having trouble finding ETI's address, but he has the distinction of being the first reader to write direct to our new address at Golden Square. Top marks for observation. The good news is, ETI are at the same address; in fact, they sit in the same corridor. The bad news is, that the PCBs are no longer available for this project. Why not have a go at making your own?

A certain irony is inherent in the sharing of addresses, as is clear from this next letter:

To: The Editor, Electronics Today.
Dear Sir,
I came across a copy of Hobby Electronics the other day, dated December 1982, in which you illustrated a project on phase control called Phase Four, based on the November edition's Breadboard design (a copy of which I do not have).
I would be very much obliged if you could inform me if the components for this project are still available from Newrad Instruments, Tiptoe Road, Wootton, New Milton, Hants, as I am extremely interested in constructing this unit.
I noticed while reading the article that you did not mention if an actual PCB was available, as I have no etching kit at home.
I am writing to Electronics Today about the article in HE because both telex numbers are the same, which led me to believe that HE may have been closed down or amalgamated during 1983. Please accept my apologies if I am incorrect.
Your assistance in the above matter would be greatly appreciated.
Thanking you in anticipation.
Yours faithfully,
Malcolm McKenzie,
Aberdeen,
Scotland.

Injury to insult! Insult to injury! Pain in my heart! Have you any idea what it does to an Editor's feelings to see a rival Editor (and one who sits in the same corridor, at that) being pressed to accept apologies for the (possible) continued existance of his offspring? While we're on the subject, please will our Aberdeen readers nip into their local newsagents and enquire why Mr. McKenzie could not obtain a December 1983 issue of our beloved HE? In which case he would have observed that the address, distributors and phone number check, as well as the telex number. The Editors don't though. They've begged us on bended knee to let them contribute, but we won't (it's alright. They won't see this till after it's published).

That said, I'm amazed at our readers' powers of observation. We didn't think anyone would actually read the small print at the bottom of the contents page. Well done.

The observation breaks down a bit at this point. Newrad Instruments, in fact, only supplied the case for the prototype: any suitably shaped and constructed case will do. The only criterion, other than being large enough for the works, is that the Phase Four is a foot switch, so the case must be strong enough to stand up to being trodden on.

However, **Magenta Electronics Ltd.**, of 135 Hunter St., Burton-On-Trent, Staffs DE14 2ST do a kit of the Phase Four for £18.71 plus 50p p&p, case included. Magenta do kits for many HE projects, and their advertisement can always be found in current issues of Hobby.

Alternatively, the PCB is still available from Hobby's own PCB Service page.

Flasher Flash

Dear Sir,
I am currently building the hazzard flashing unit as featured in your publication of Spring 1981, and would be very grateful if you could send me a detailed expanation of how the circuit works.
Yours sincerely,
A. J. Keare,
Ringwood,
Hants.

I don't have a copy of **Electronics Digest** Spring 1981 here to refer to, but the Hazard Flasher project also appeared in HE July '80, when it included the usual construction/How It Works details, along with the circuit, overlay, parts lists, etc. Apart from this (two page's worth only) we can't give any further details. In this case, we don't have any further details (the project is too old) but in general we can't do detailed additional explanations of projects. If anyone is building a circuit and having difficulty getting to grips with one part of it, or making it work, we will as usual do our best to give an explanation.

Computer Careers

Dear Madam,
After reading your article in careers in electronics in HE October '83 I was extremely interested in the course run by the Polytechnic of Central London with five major computer companies. I would be grateful if you could tell me the address to write to for more information on this course and how to obtain an application form.
Yours faithfully,
K. R. Jones,
Norton,
Cleveland.

The address to write to with any enquiries is the **Engineering And Science School Registry, 115 New Cavendish St., London W1M 8JS.** A couple of more companies, incidentally, have entered the sponsorship scheme since we published the article.

Component Crisis

Dear Sirs,
I have been buying your mag since February 1982 and I can't honestly say that any of the projects have interested me enough to actually build one. But in HE October '83 I did find a project I wanted to build (the Audio Level Meter) after reading in the Buylines that excluding the PCB this project should cost in the region of £6.50. I thought that with my funds being somewhat limited (and whose aren't these days?) this would not only be the ideal project but the ideal price. Or so I thought, because the xxxxxxxxxxxx was £1.75, the bargraph driver £4.39, the LED display £6.50, and the tantalum bead 69p. So far I calculate that at £13.33, twice as much as quoted in the Buylines.
Alright, I know it said 'in the region'

of £6.50, but there is a somewhat substantial difference between that and £13.50, and I still have other components to get, like presets, axial caps, polycarbonate caps, resistors, diodes, and if those prices are anything to go by it doesn't look like I will be completing this project.

Finally you also say that the TL072 and the LED array are the only things the constructor should have any difficulty in obtaining. Well I managed to get the LED display but the TL072 is not the only thing I've had difficulty in obtaining, in fact most of the components I have found difficult to get hold of.
Yours,
Mr. Watson,
Noddle Hillway,
Hull.

Pardon me for being irrelevent for a moment, but I had a vision of you desperately trying to obtain components from your local greengrocer. Could anything else explain the trouble you're having?

But seriously, and it helps if you plan your buying strategy first like a minor military campaign.

Firstly, we don't know where you're buying your components, and we're not going to ask, believe me, but in that same issue of Hobby Electronics, the LM3915 was advertised for £1.95 from Rapid Electronics, who also sold 10u 26V tantalum capacitors for 20p. Someone has borrowed our Technomatic catalogue, but the most expensive display advertised by them in that issue was £2.00 (they're only £2.50 from RS Components, by the way). Lastly, we can't make out what it was that cost £1.75, but it seems reasonable to assume that it (they?) was overpriced too.

We check off the value of the components used in a project against a recent price list, then add a margin for error or change. We do not generally include the cost of a case or PCB, because there are so many options available. Nor did we include the cost of a power supply for this project, as +9-12V DC should generally be available in the equipment which the level meter is driving.

You should at least change your supplier, and carefully check through the advertisements in the magazine. Contrary to some opinions, we don't print those pages just to fill space: much useful information is there. Essential information, if you want to buy any number of components. Few areas are lucky enough to have a supplier where you can walk into the shop and buy everything you want over the counter at a sensible price. The only other solution is mail order.

There is a payoff between buying your components from several suppliers, at the lowest prices, and the convenience of buying from one or two suppliers at a slightly higher price (ever letter or phone call is part of the expense).

Car Power Boost

Dear Sir or Madam,
Could you please give me the address of West Hyde Developments who produce the Sink Box which you have used in your Car Booster Project (HE July '80). Could you also tell me if you have published any other car stereo boosters since then.
Yours sincerely,
James Bagshawe,
Medical Oncology,
Charing Cross Hospital.

West Hyde Developments were last seen at **Unit 8, Park St. Industrial Estate, Aylesbury, Bucks HP20 1ET. Tel: (0292) 20441**. Check with them first that they still do the same case or an equivalent.

We haven't published another power booster project, but if you look up the advert from **ILP Electronics Ltd.**, you may find they have what you want.

ZX81 EPROMmer

Dear Sir,
Your magazine has had many great projects over the years and recently some of these have been for the ZX81.

But as a ZX81 user it strikes me that the one project that we really need is an EPROM programmer, a unit specially designed for the ZX computer, complete with a board to connect with the ZX81 for immediate use after programming.

People should be turning to the "PROM" as a more efficient means of storing games, etc. (We have a bad time with tape, you know.) So how about it?
Yours hopefully,
R. Baker,
Trowbridge,
Wilts.

Look out for it in the third edition of our new magazine, **Digital & Micro Electronics**, especially for the computer hardware user, which will be on the newsstands in late March.

Obscured Issue

Dear Editor,
I have begun the 30V PSU project in HE September '83. However upon making my PCB, it seems to be that there is an error involving the connection of the preset to the output.

The circuit diagram shows one side of the preset connected to IC2 pin 2, and emitter of Q3. The wiper arm then feeds the output. The other leg of the preset is then shown connected to the +ve side of the meter.

However, the PCB overlay does not correspond to this, as the wiper arm is shown to 'feed' the meter instead of the output.

I have been buying HE for a long time, but the clarity of the PCB overlay in the project is diabolical!

Could you please then clarify my query, and even perhaps enlarge or clarify the PCB overlay in the preset and transistor region.
Yours gratefully,
M. S. Higgins,
Hillsborough,
Sheffield.

Unfortunately, the detail of the PCB was obscured in the area of the preset by a line representing the wire joining the emitter of Q1 to the base of Q2. It thus appears that the preset is shorted out!

In fact the lower terminal of PR1 has simply been left open circuit, ie connected as a variable resistor. The wiper of PR1 does feed the meter, but electrically this is equivalent to the arrangement shown in **Figure 1**, and therefore is of no consequence.

Uncommon Problem

Dear Sir,
I am writing to you about a problem I am having in getting hold of components for the Audio Analyser (HE September '82), because they are such uncommon values.

I am finding it hard to purchase them. I would be grateful if you can help me with this problem, if you can supply me with the components or put me on the right track.
Yours faithfully,
Paul Bridges,
Enfield,
Middx.

If these components cannot be found in the catalogue of the regular mail order suppliers (eg. Maplin, Watford, Rapid etc.) I suggest you ring around until you find someone willing to order them in from RS Components.

However, without going to the trouble of cross checking each and every value, it looks to me as if they're all fairly standard values.

The other point you might like to note is that the **Audio Analyser** will shortly be the subject of Forward Bias, since certain modifications are required to make it completely reliable.

"Acknowledgements"

Lastly, many thanks to Richard Cartmel of Cheshire — we don't often get thank you letters. Glad to hear the introduction to the HE Tape/Slide Synch was a happy one. By the way, if the PCB and the Circuit Diagram don't exactly correspond, the PCB is likely to be the correct one. We haven't had any problems reported. Cheers!

HE

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Hobby Electronics

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Tantalized by tantalum or mystified by metal films?
Then this especially helpful feature will take the worry out of dealing with different types of resistors and capacitors.

THE METRODRIVE

A Hobby Electronics exclusive, lifting the lid on the hidden details of a top secret project from you-know-who.
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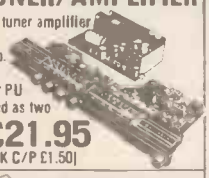

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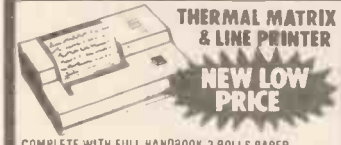

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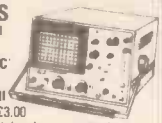

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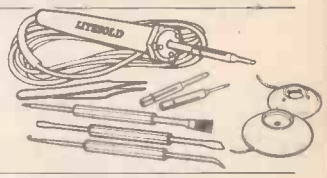

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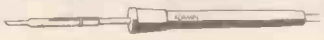

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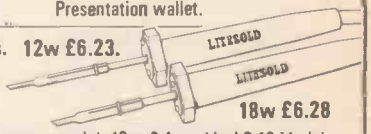

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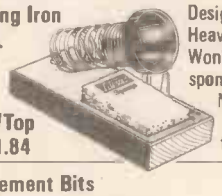

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Two months ago, *All About Electronics* concentrated on devices and circuits formed with logic gates. You saw AND gates, and NAND gates, OR gates, NOR gates and NOT gates (invertors) used individually and in circuits to give particular output logic states which depended totally on the applied input logic states (**Figure 1**). A logic state consists of either a 'I' or a 'O' — that is, it can be one of *two* options — hence the general name, *binary logic*, for such circuits.

These binary logic states can be expressed in mathematical terms and written as equations, eg:

$$A = O$$

or:

$$B = I$$

or:

$$A.B = C.D = Z$$

where the dot between letters A and B, C and D, in the last equation means AND; and the plus sign means OR. (This is binary or *Boolean* algebra, remember, not conventional algebra.)
remember, not conventional algebra.)

Similarly, the logic states can be expressed in electronic terms, as voltages. For example, the logic state 1 could be expressed as the voltage 5VDC, and the state O could be defined as OVDC. The actual voltages used are irrelevant and could be literally any voltages, as long as

1. The voltages, once chosen, are maintained as standard
2. Circuits connected before and after the logic circuit operate satisfactorily with these voltages
3. The electronic logic gates (normally in IC form) which make up the circuit operate from (and will not be damaged by) the voltages.

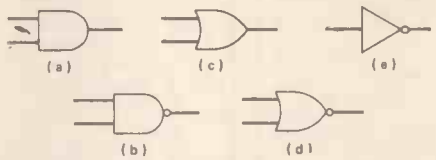

Figure 1. Typical logic gates:
a) AND gate
b) NAND gate
c) OR gate
d) NOR gate
e) NOT gate (invertor)

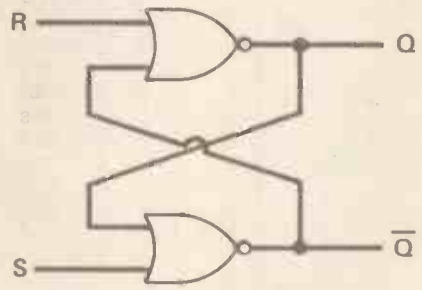

Figure 2. A simple form of electronic memory using two NOR gates — the SR-type bistable.

S	R	Q	$\overline{Q}$
⎍	L	H	L
L	⎍	L	H
L	L	Q_0	$\overline{Q}_0$
H	H	L	L

Figure 3. Function table for the SR-type bistable of Figure 2. The shaded area indicates an operation-mode not recommended for use.

Two main categories of logic gate ICs where shown to exist: TTL (transistor — transistor logic) and CMOS (complementary metal-oxide semiconductor).

ICs within each category contain individual logic gates, and choosing a particular type of gate, ie AND, NAND, OR, NOR, NOT, is simply a matter of choosing the correct IC within each category.

These types of gates and the circuits we looked at form combinational logic circuits ie, their outputs vary as a definite combination of the inputs. Such circuits, although they may be used in quite complex control equipment, are really no more than electronic switches the output of which depend on the correct combination of inputs. They display no intelligence of any kind, simply doing what is demanded of them — instantly.

Be Smart — Remember This

One of the first aspects of intelligence — whether in the animal world (including humans) or in the electronics world — is memory ie, the ability to decide a course of action dependent not only on the applied inputs but also on a knowledge of what has previously taken place.

Logic circuits can be constructed which remember logic states. We say they can store binary information. The simplest form of logic memory is shown in **Figure 2**, and is constructed using two NOR gates, cross-coupled so that the output of the first is connected to the input of the second, and the output of the second is connected to the input of the first. There are two inputs to the circuit and also two outputs.

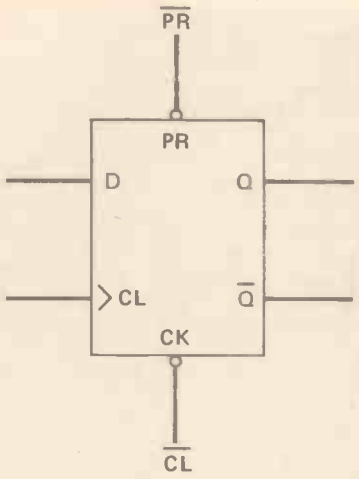

Figure 4. Circuit symbol for D-type bistable.

Now, it so happens that one output is, in most instances, the inverse of the other, so for convenience one output is labelled Q and the other output is $\overline{Q}$, to show this.

A truth table for the circuit is shown in **Figure 3**, although more correctly we call this a function table. You see, truth tables are used only for combinational circuits and this circuit, although using combinational gates, is not strictly speaking combinational — you'll see why not, later.

Account has been taken in the function table for changing from one logic state to the other by the symbol: $\sqrt{}$, which indicates that the input state changes from a logic 0 to logic 1. Also, we no longer write the logic states as '1' or '0', but H (meaning high) and L (meaning low).

The outputs indicate what happens as the input states change on these occasions. You can see that if input S goes high (ie, from 0 to 1) while input R is low, then the output Q will be high. If, however, input S then returns low, the output will be Qo — which simply means it remains at what it was. If input R then goes high while S remains low, the output changes to low and remains in that state even if R goes low again.

In other words we have constructed a form of memory, called a latch or a bistable, the output of which can be set to a high state by application of a positive-going pulse to input R. You will understand now, why the inputs are labelled S and R (set/reset) and why this type of circuit is called an S-R type bistable.

The last line of the function table is shaded to indicate that this condition is best avoided, because both outputs are the same. Designers of digital circuits would normally ensure that this condition did not occur in their circuits because confusion can arise.

Stable Vibrations

We have met the bistable before, of course. A bistable is one of a group of circuits — the other two types we said

INPUTS				OUTPUTS	
$\overline{PR}$	$\overline{CL}$	CK	D	Q	$\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H	H
H	H	$\sqrt{}$	H	H	L
H	H	$\sqrt{}$	L	L	H
H	H	L	X	Q_0	$\overline{Q}_0$

Figure 5. Function table for a D-type bistable. Shaded area indicates an operation-mode not recommended for use.

Figure 7. Function table for a JK bistable. Shaded area indicates an operation-mode not recommended for use.

INPUTS					OUTPUTS	
$\overline{PR}$	$\overline{CL}$	CK	J	K	Q	$\overline{Q}$
L	H	X	X	X	H	L
H	L	X	X	X	L	H
L	L	X	X	X	H	H
H	H	⊓	L	L	Q_0	$\overline{Q}_0$
H	H	⊓	H	L	H	L
H	H	⊓	L	H	L	H
H	H	⊓	H	H	TOGGLE	

were monostables and astables — called multivibrators and they can all be built using logic gates.

There is more than just one type of bistable and the S-R type is really only the simplest — the two types I'm going to show now are far more useful and versatile. Instead of showing their construction using separate logic gates, however, they are shown as block. If necessary they could be build using separate gates but you don't need to know how to construct them because, yes you guessed it — they can be bought ready-built in IC form. First is the D-type bistable. Its circuit symbol is shown in **Figure 4** and its function table is in **Figure 5**.

The main difference between D-type and S-R type bistables is that an input is provided for what is called a clock. Now, the clock is the name give to the output of a square-wave oscillator, of any fixed frequency, which produces definite, fixed period, pulses to operate digital circuits. It is an application of a clock pulse that a D-type bistable will perform its function — so for example if a clock is applied with a frequency of 100 Hz, the bistable will perform 100 functions every second.

Note also the S and R inputs of the S-R type bistable have been replaced by the inputs $\overline{PR}$ (preset) and $\overline{CL}$ (clear) which perform similar functions. A last input to the D-type bistable is the D (data) input.

You should now be able to understand

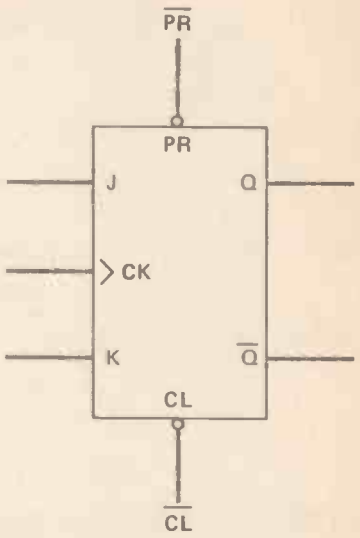

Figure 6. Circuit symbol for a JK master-slave bistable.

the function table. The first three rows indicate that the $\overline{PR}$ and $\overline{CL}$ inputs override all other inputs (that's why the CK and D inputs are shown as **X**: because X = don't care). Thus the outputs Q and $\overline{Q}$ are dependent primarily upon the logic states of the $\overline{PR}$ and $\overline{CL}$ inputs.

However, when the $\overline{PR}$ and $\overline{CL}$ inputs are both high, control of output becomes the prerogative of the CK and D inputs. For example, when the clock is low the output Q = Qo ie, it remains the same as it was — no matter what the logic state of the D input (because D = X, gerrit?). On the leading edge of the clock pulse, however, output Q follows the logic state of the input D: whether high or low. So a D-type bistable acts like the simpler S-R type but with extra controlling inputs.

Another type of bistable is shown in **Figure 6** and is the JK master-slave bistable, it is similar in operation to the D-type bistable but the D type input has been replaced by two separate controlling inputs, J and K. A function table applicable to the J-K master-slave bistable is shown in **Figure 7** and you can see how it works from this. The same sort of operations occur as with the D-type bistable but with two main differences:

- the operations take place on the falling edge of the applied clock pulse
- the last row of the function table shows a bistable operation known as toggling ie, the output state changes from whatever state it is, to the other state.

Altogether Now, Vs One At A Time

Underlying the study of bistables which we've looked at so far this month is something far more important than it would first seem. We have actually seen the changeover, from the category of digital electronic circuits known as combinational, to the category of sequential digital circuits. The difference has been that the inputs of

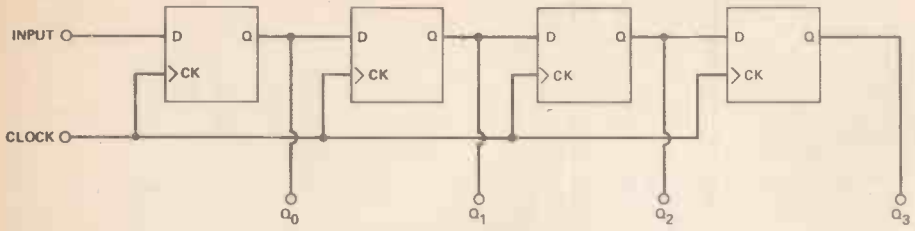

Figure 8. Four-bit shift register using four, D-type bistables.

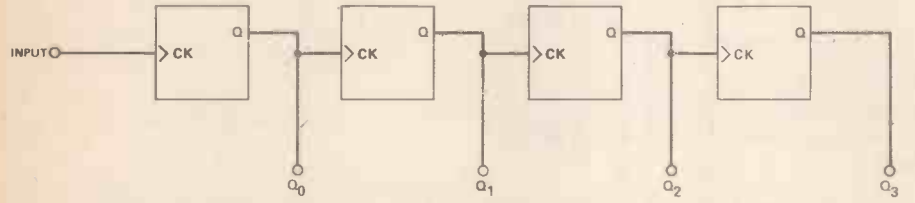

Figure 9. Four-bit binary counter using four, JK-type bistables.

combinational circuits are instantaneous and the outputs occur as a direct consquence of the inputs. In sequential circuits, however, the inputs have to occur at the correct times for the outputs to be correct — ie, they have to occur in a set sequence. It is the combination of the clock pulse (providing the sequence) and memory (to enable inputs to be at the right place at the right time) which allows these sequential circuits to operate. And it is these very bistables which we have seen which form the basis of electronic memory. If you can imagine a network of literally thousands of such bistables then you have pictured a simple memory bank: the information stored inside of which may be changed at will by altering the control inputs.

Of course, things are not quite as simple as that. A collection of bistables gives us a method of storing information, yes. But such a collection will not necessarily guarantee that the information is organised. For instance if a certain string of binary digits (known as bits) is stored in the memory bank; how do we know when a string is retrieved, that it is the correct one? What we need is some way of ensuring the information out is the same as we fed in.

The way to do this is to store the information in regular formation — rather like a platoon of soldiers. If one line of soldiers is our stored 'information' then that line can move about all over the parade ground and as long as they remain in line ie, soldier 1 before soldier 2, soldier 2 before soldier 3 etc, then the 'information' will not be lost or jumbled. In electronic memory the information we wish to store is entered as a row of bits (called a byte or sometimes a word) and kept within the memory in that order.

One way of doing this is with a number of D-type bistables, as in **Figure 8**. By connecting the output of the first bistable to the D input of the second, and the output of the second to the D input of the third etc, a shift register is created. The shift register of **Figure 8** has four bistables therefore a byte of four bits can be stored. If a longer byte is required to be stored we use more bistables.

On every clock pulse the output of each bistable in the shift register takes the previous state of the bistable to its left. Thus, is a logic 1 was applied to the input, the outputs of all four bistables at each clock pulse is:

after the first pulse	1000
after the second pulse	1100
after the third pulse	1110
after the fourth pulse	1111

Alternatively, if a four-bit type is applied to the input; each bit applied separately, one bit at a time corresponding to each clock pulse (this is known as serial information) then the outputs at each clock pulse will be, for example using an applied serial byte 1001:

Inputs	Outputs
1	1000
0	0100
0	0010
1	1001

That is, after four clock pulses the serial information entered has been stored in the shift register. This information can be retrieved: serially by applying four more clock pulses and taking the information from the last bistable's output or; as a parallel byte by taking the output of all four bistables simultaneously. The latter is known, obviously, as serial-to-parallel

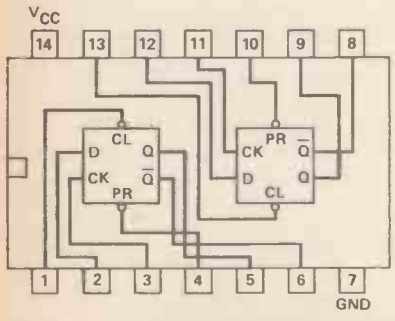

Figure 10. 7474 TTL dual, D-type bistable.

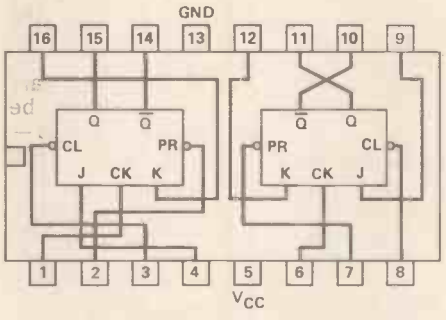

Figure 11. 7476 TTL dual, JK-type bistable.

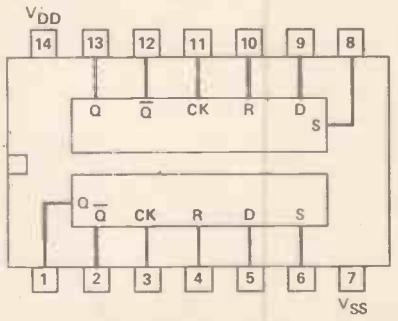

Figure 12. 4013 CMOS dual, D-type bistable.

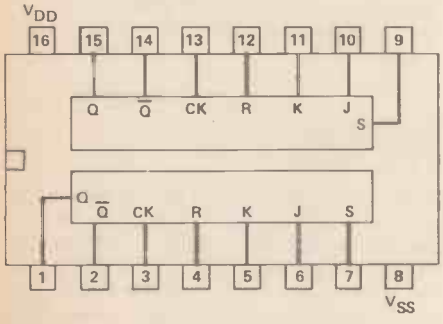

Figure 13. 4027 CMOS dual, JK-type bistable.

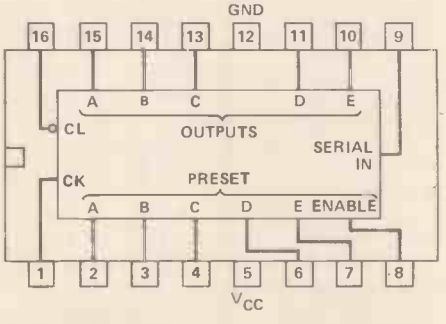

Figure 14. 7496 TTL five-bit shift register.

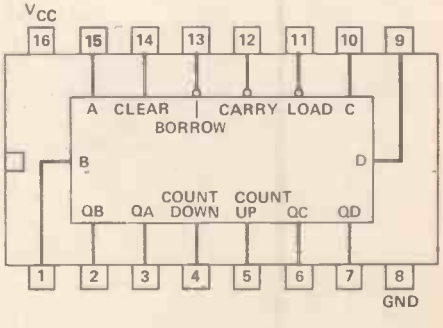

Figure 15. 74193 TTL binary counter.

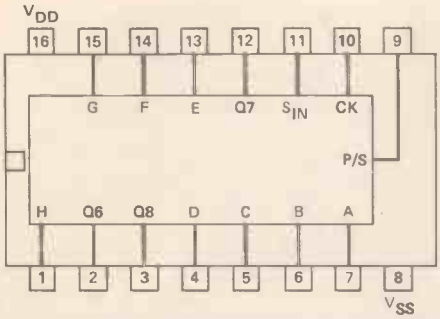

Figure 16. 4014 CMOS eight-bit shift register.

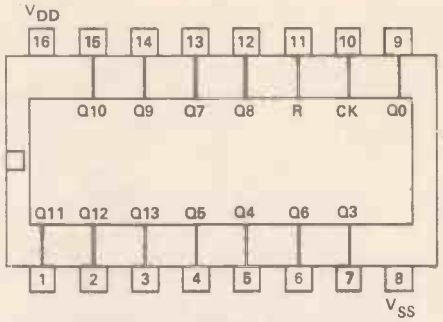

Figure 17. 4020 CMOS 14-bit binary counter.

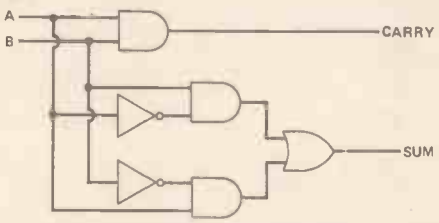

Figure 18. A half-adder circuit using combinational logic gates.

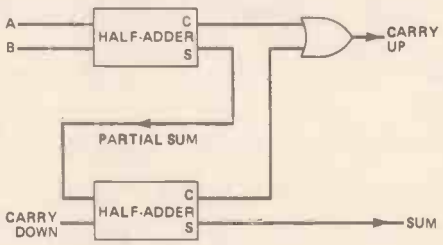

Figure 19. Truth table for a half-adder circuit.

A	B	SUM	CARRY
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Figure 20. A full-adder circuit using two half-adders and an OR gate.

conversion and is an often used procedure in some complex digital circuits.

Counting

Binary mathematics is very similar to ordinary mathematics (ie, denary — to the base of 10) in that there are times when we want to be able to count using it. Simple counters can be made using J-K type bistables and one is shown in **Figure 9**. In denary, all counting is to the base of 10, ie 0 - 1 - 2 - 3 - 5 - 6 - 7 - 8 - 9 - then go any further we prefix the digits with a 'carry' ie 10 - 11 - 12 - 13 - etc. Then a 'carry 2' ie 20 - 21 - 22 - 23 - etc etc.

However, in binary mathematics the base is 2, so the number system progresses 0 - 1 - 10 - 11 - 100 - 101 - 110 - 111 etc. **Figure 9** shows a four-bit counter which can count, for example, input pulses. The corresponding outputs at each input pulse are:

start	0000
after the first pulse	0001
after the second pulse	0010
after the third pulse	0011
after the fourth pulse	0100
	etc.

You will notice that I have reversed the order of the counted bits — this is so the least significant bit (LSB) is on the right as it should be and the most significant bit (MSB) is on the left.

Now, although bistables can be formed with individual gates, it is more usual to see them as part of an IC. For example the layout of the 7474 TTL IC is shown in **Figure 10** and consists of two D-type bistables. The 7476 TTL IC is shown in **Figure 11** and consists of two J-K master-slave bistables. The CMOS version of both these ICs, the 4013 and the 4027 are shown in **Figures 12** and **13**.

Likewise, shift registers and binary counters would not normally be constructed using separate bistables — **Figures 14 and 15** show a 7496 TTL shift register and a 74193 TTL binary counter, and **Figures 16 and 17** show a 4014 CMOS shift register and a 4020 CMOS counter.

Addition and Subtraction

Just as digital circuits can be used to perform functions like counting and storing, they can also be used for other, more usual, mathematical functions like adding and subtracting. For, example, **Figure 18** shows a circuit for adding together two bits of binary digits. Now, we should be able to draw up a table from our knowledge of binary numbers giving us the outputs of this circuit and such a table is shown in **Figure 19**.

This is exactly the same as denary arithmatic where two numbers, say 2 and 3, give a sum 5; but two numbers, say 6 and 4, give a sum 0 and a carry 1 — creating the two-digit number, 10. The circuit of **Figure 19** is known as a half-adder because it only performs addition of two inputs. There may be, however, occasions when three inputs require addition — say if a preceding addition stage has produced a carry output. Well, now we use a full adder as in **Figure 20**, consisting of two half adders and an OR gate.

Subtraction can be performed using the exact same circuits; after a modification to the number being subtracted. The modification is called "creating the two's complement" of the binary number by inverting every bit and then adding one to that number. In this way, the two's complement of the byte 1010 would be formed.

Number 1010 ⟶ Invert 0101 ⟶ Add 1 0110

So, 0110 is the two's complement of 1010 and the binary subtraction

1101 minus 1010

is the same as

1101 plus 0110

Go Forth And Multiply

Multiplication is easily performed and best demonstrated with denary numbers, but the process is identical in binary. If, say, the two numbers to be multiplied are 60 and 4, we can arrange the statement 60 x 4 to read 60 + 60 + 60 + 60, and then use an adder to perform this addition. Division is similar. If the division to be performed is 60/4, we can re-arrange this to read 60 x ¼ = 60 x 0.25, a multiplication, which can be performed as an addition sum, as above.

I haven't spent a lot of time explaining the different mathematical functions in binary, because it isn't necessary that they be learnt. The only thing you need to remember and understand is that all the mathematical functions can be broken down into much simpler steps based on additions and counting. In this way, because digital circuits are very fast in operation, high — speed mathematical calculations are easily performed. We have invented the calculator!

More complex digital circuits have been developed known as arithmetic logic units (ALUs) which performs all the arithmetic functions detailed here plus the standard logic functions of AND OR, etc. ALUs form the core of the digital computer, and a modern micro-processor IC (yer actual microchip) contains among other things, an ALU within its body, allowing the micro-processor to perform the arithmetical functions according to instructions.

The instructions which a microprocessor follows are collectively known as the program and form, literally, step-by-step recipes for the microprocessor to act upon. This program must be stored in electronic memory for it to be at hand, so the microprocessor can read each instruction as required. Thus, what we have seen in this month's *All About Electronics*, ie bistables, counters, adders, ALUs etc, will form the basis for a future month when we learn about computers themselves.

H

Bernard Babani (publishers) Ltd., who supply the HE Bookshelf, ply their trade direct.

Robots, railways, radio and rockers assemble under Hammersmith Flyover for the electronics exhibition of 1983.

"Go West, Young Man" ("Man" being a technical term for a person of either sex and indeterminate age) came the cry from our organisers for 1983, Argus Specialist Exhibitions. So west we went, all the way to Hammersmith and the Cunard International Hotel. There.

Having attempted to run the gauntlet of the traffic in Hammersmith Broadway, I eventually lost my nerve and went via the underpass — a ten-minute detour. I infiltrated the hotel, waved my pass at the security men, and was confronted at once by a display of computer-controlled railways.

Dave Holladay of Precision Relays Ltd. showed me round his simple, two-track, points-switching system, worked by magnets carried under the trains, and Reed switches embedded in the chipboard beneath the track. Apart from the engines themselves, the most [illegible] aspect of this set-up was the use of five enormous computer-[illegible] relays in the centre of the track, and the Commodore 64 which was being used to control them.

The other, more spectacular railway layout was laid out and built by the Fratton Bargain Shop in Portsmouth, using both a Hornby Zero One model railway controller and a Hammant and Morgan 6000 and featuring a two-directional reverse loop. The two control units used constant, but different voltages, and the trains themselves included engines with and without fitted microprocessor control modules.

Heave To

Meanwhile, back on the Electronics stand, we were kept busy heaving fresh bales of December's **HE** and January's **ETI** (the lucky blighters were just in time to get their new issues out in time for Breadboard, while we had to keep explaining that Hobby Electronics wasn't due out for another fortnight . . .) and flogging back issues and copies of **Ham Radio Today** and **Digital And Micro Electronics** — one gent from Sweden bore away almost an entire set of HRT backissues, saving himself quite a few quid compared with postal ordering. Breadboard is, after all, the only place where you can buy the year's backissues still at the cover price — and inspect them into the bargain!

Editor Ron Keeley set up the HE Programmable Joystick on a space-invaders type game, and ETI's technical department, Phil Walker, connected up ETI's Graphic Equaliser to a loud-speaker, and provided sound effects in the form of a computer controlled speech synth which recited "Happy Birthday, Dear Christopher" in an endless loop, more or less loudly depending on who was playing with the equaliser! HE's Quizmaster added a few bleats and flashes to the proceedings, and when one gentleman wanted to know why we didn't have the HE

The HE editorial team, hard at work (You distract the [illegible] while I find out what's causing that stripe on the [illegible]'s head.).

The ASP computing stand is besieged by earnest enthusiasts ready to have a go on one (or several) of the micros on trial.

Bassman up and running, we had to explain that it was because we couldn't stock enough batteries to have everything going at once. The real reason may have had something to do with the noise level on the stand.

On the next-door stand, Steve Ireland G3ZZD, Ham Radio's Editor was chiefly engaged in operating the special station, GB4 HRT, which they had set up for the show, along with a band of helpers. Conditions on the first day proved poor for DX calling, so they put the station to good use by calling out to vistors in transit, and guiding them in to the exhibition.

On the other side of the exhibition hall, the Computer magazine staff were manning their own stand, including several micros for visitors to try out for themselves.

Opposite our stand, the British Amateur Electronics Club's stand, courtesy of ASE, featured among other devices a magnificent custom amplifier for keyboards or guitars, complete with flanger, chorus, octave and two kinds of fuzz, with a complete set of equalisation controls for each of the two channels. The builder, Tony Kozary, who had used circuits from various sources, gave us a demonstration using a clef synthesiser and then let me try my guitar on it. This brought a lot of closet guitar players out of the woodwork, including man-of-many talents Phil Walker, ETI's Ian ('I really only play the mandolin') and your own editor, who knew three chords, all very loud!

Anyone interested in the BAEC can find their address in Monitor this month.

Trial And Triumph

BP Oil's display consisted of several winning robots from their **Builderobot Competition 1983**, and a continually-running video showing the actual finals of the competition, a human drama plumbing the depths of despair as complicated and lovingly-crafted pieces of machinery failed to operate to order despite last minute surgery, and the pinnacles of triumph, not to mention incredulity, as the winning robot completed its course, captured the cube and returned to its starting point faster than most eyes could follow it. The winning time was slighrly over four seconds. Note for designers: the more closely the robot is tailored to the task designated, the more likely it is to work! While many a sophistication proved fodder for untimely breakdowns.

At the back of the hall, the Micro Robotics Arena set up by the Association of London Computer Club's Micro-Robotics Group showed off a number of small robots in an enclosure, presumably to stop them from escaping and terrorising the crowd (a function amply fulfilled by the Tomorrow's World Radio Controlled car racetrack a few stands away). Alongside, several magnificent fantasy models including a two-foot high Dalek, and the Dalek commander, Davros, in his chariot, sculpted by the King of the Beasties, Robin Hill, were on display.

In the lunch hour the band from the stand took it in turns to sneak off, grab a sandwich, have a pint, and circulate among the stalls looking out for hardware bargains, tamper with Clef Products' range of keyboards (it failed for the second consecutive year to get any recognisably musical sound out of their microsynth, which in other, more skilful hands can sound like a whole band), queue patiently for a go on the bank of arcade games supplied by C.B.S. ColeVision and meet up with visiting authors.

I didn't actually attend any of the lecture program which ran throughout most of each of Breadboard's three days, but others who did tell me that there were plenty of searching questions coming from the audiences, and quite a few answers from the blackboard end. Major attractions were electronic music and holographics, and indeed there was a steady hum of music all the time from one or another the stands with keyboards or musical equipment on show.

On Sunday afternoon, we wiped the whole business out by offering obsolete ETI and HE projects (as seen) to anyone showing a current issue of the magazine in question. Lucky comers got away with anything from a piece of bench equipment to a miscellaneous circuit board with a few components clinging to it — none of it, of course, supposed to be working, but who knows? One or two people actually bought extra copies to have a second go at the lucky dip. This unannounced extra came about because of the change of offices: we had a lot of cupboards to empty. So don't expect it every year . . .

What of 1984? Where and when? We don't know yet, but you can expect to see an expanded Breadboard this year, with emphasis on practical demonstrations of hardware, and more electronic bargains — so start planning your November expedition now, because this is our chance to meet the readers unhampered by the paraphanalia of the office, quite apart from any other of numerous benefits. Who says the staff aren't there to enjoy themselves?

Right: The Fratton Bargain Shop's multi-track railway layout, closely watched by its constructors.

Left: Davros and Dalek, two feet high, and modelled by HE's cartoonist Robin Hill.

Right: Trevor Butler G6LPZ drives Ham Radio Today's special station.

BUYLINES

Sinewave Generator

The variable resistor RV1 is specified as having a single-pole single-throw switch. These types are not usually available, but a component with a DPDT switch may be used. Not included in the Parts List is the battery holder; this is a standard type and may be obtained from **Bicc-Vero**.

LP1 is given a type GE 1835: this will be difficult if not impossible to obtain! A near equivalent can be had from **Maplin** under the number WL74R, but it may be necessary to alter the value of R7 to obtain the best results.

The frequency determining capacitors require a special mention. Capacitors C3 — C14 require to have their values matched to within one per cent of the stated value. So for example, take C14: the nominal value is 100pF, which means the value must lie within the range 99 — 101pF if the stated frequency range and stability is to be achieved. Similarly with the other capicitors. Note that the capacitor tolerance itself need not be small; ten to twenty per cent components would be acceptable.

One source for the components is **Maplin**, and a careful check through the capacitor index page will reveal the types to obtain. For C2, 7, 8, 16, 18, 20, types given as "Monocap" are suitable; for C3 to C6, "reversolytic" may be use. Other capacitors may also be found in this manner. The estimated cost, less case and battery holder (which may be omitted if required), is £5.

Metronome

No real buying problems here. All the components are standard and can be obtained from the majority of suppliers who advertise in HE. For constructors with shallow pockets, a smaller and cheaper loudspeaker, such as **Maplin** YW53H can be used without losing performance.

Estimated cost is around £5. This figure does not include the case or PCB, and includes the cost for the cheaper loudspeaker. The PCB, as usual, is available from HE's PCB service.

Chess Timer

A number of components require mention but most are not too difficult to obtain. The first is the 4060 type IC This type is not widely advertised but can be obtained from **Enfield Electronics**.

The **Maplin** piezo buzzer is an unmounted device, which means that wire connections must be made very carefully, to avoid damage. An alternative is to use a ready mounted device such as the PB2720. This is available from **Electrovalue**. The switch used is of the miniature type and generally available.

The cost for the project is estimated at £4, excluding the case and the PCB. The PCB is available from HE's own PCB service, if you care not to make your own.

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3Hz—3Mz Sine Wave Generator

Based on a Wein bridge, this sine wave oscillator will give you a wide range and clean output in return for easy construction and an economical price. Sounds like a good deal.

J E Aman

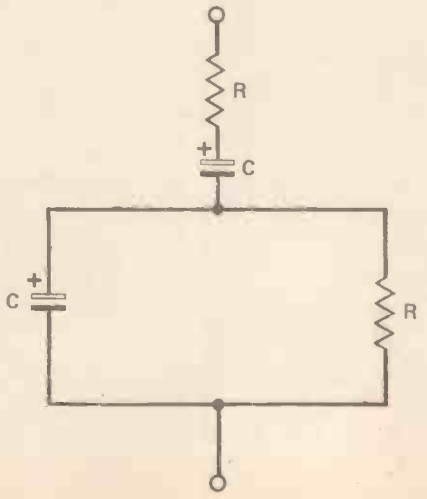
PROBABLY the least complicated and most reliable sine wave generator is the Wien bridge type. It incorporates a bridge network, usually in the feedback loop, to determine the frequency of oscillation (Fo).

The bridge itself is an R-C network (Figure 1), which consists of both a series and a parallel R-C circuit. By using a two-stage amplifier to produce a complete phase shift (360°), a circuit can be constructed using a Wien bridge in a positive feedback loop that will oscillate at a frequency determined by the formula fo = $1/2\pi RC$.

A certain amount of attenuation or loss of the positive feedback signal results from the bridge circuit design. The reactive branch of the bridge constitutes an AC voltage divider so that, at the frequency of oscillation, it creates a lead/lag voltage cancellation, and hence no effective phase shift.

But at any other frequency there is a phase shift and, as a result, the attenuation of the positive feedback is too great to sustain oscillation. Since only part of the signal is fed back to the input, the amplifier needs to have a specific gain that will counteract the effect of the Wien bridge attenuation. The loss in the bridge can be calculated, and it turns out that the network attenuation brings the positive feedback signal to ⅓ the level of the output. So, the gain of the amplifier must be at least three to sustain oscillation.

Figure 1. The R-C network which makes up the Wein bridge oscillator.



This gain is controlled by means of a second feedback loop. Since the first amplifier has an open loop gain of many hundreds, the second feedback loop is negative and this holds the overall gain at three.

At frequencies other than fo, the positive feedback will be too small to sustain oscillation. The negative feedback, which is resistive and always in phase, will then dominate.

The circuit of Figure 2 shows an oscillator that will sweep over a large frequency range up (from below 3Hz to 3MHz) with low distortion (typically les than 0.2% at 1kHz). It operates from a PP3 9V battery and delivers approximately 2.5 volts peak to peak, drawing around 10mA. From the battery the frequencies covered by the six ranges are:

1. 3 — 30Hz
2. 30 — 300Hz
3. 300 — 3kHz
4. 3kHz — 30kHz
5. 30 — 300kHz
6. 300Hz — 3MHz

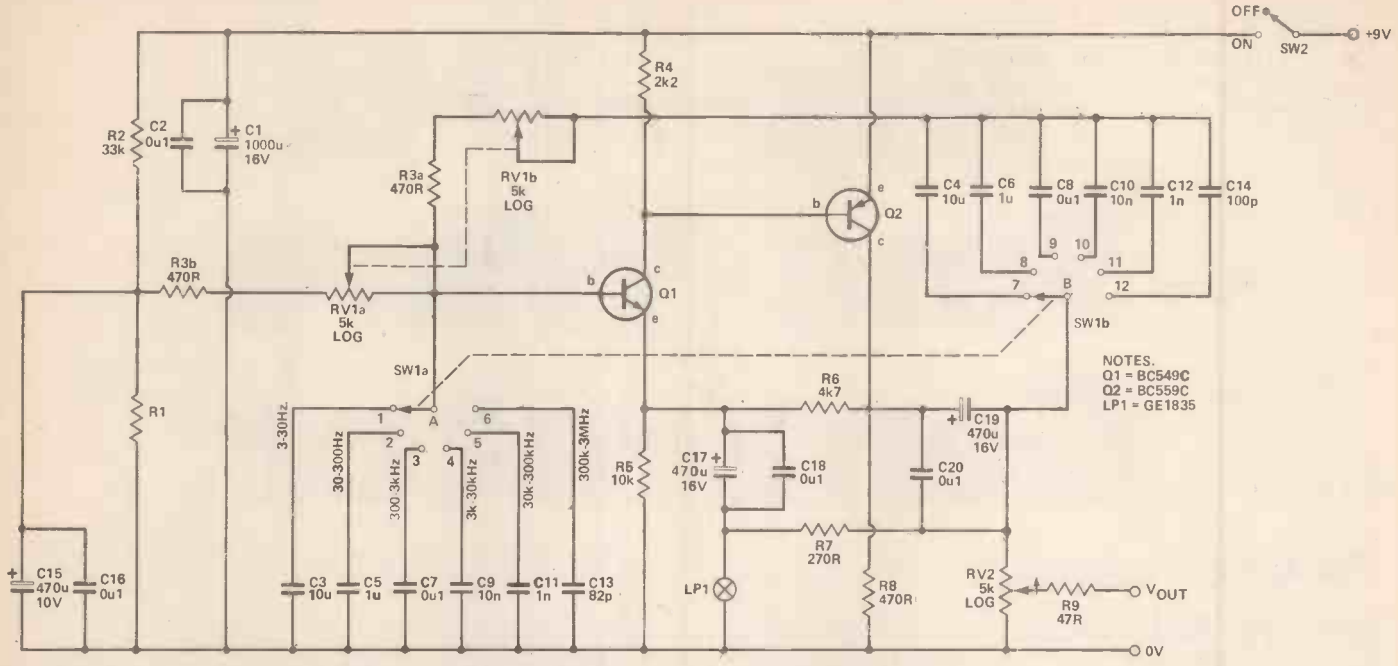


Figure 2. The Circuit. Note that R3a and R3b are two separate resistors. This diagram shows the gain controlled by a filament bulb. See also Figure 3.

Circuit Design

With a 9V supply line in mind, Q2 is selected for power and current capability, together with wide bandwidth and low noise. The BC559C was chosen since it meets all the requirements, ie 200MHz bandwidth, low noise and high gain.

Collector current for Q2 is set by R8, which is chosen to drop half the supply voltage while passing 10mA. This current is low enough to keep noise at a reasonable level and still drives peak currents into, say a 600 ohms load: therefore 4V5/10mA ≅ 470R.

Q1's collector current should be a small fraction of that of Q2, for low noise; say, a few percent. This transistor also wants to be a low noise type. Its collector current, Ic, is again set by its collector resistor, R4. The resistor should not be too large, though, as this would multiply the effects of stray capacitance. A 2k2 seems a good compromise, because since R4 has about 0V6 across it from the base emitter junction of Q2, the collector current is 0V6/2k2 ≅ 300uA, or 3% of Q2. R5 is chosen so that Q1 emitter is a volt or two below Q2 collector, ie 3V, therefore its value is 3V/300uA ≅ 10k.

Considering the current gain of Q1, R1 and R2 are chosen to bias its base at around half the supply. Their values are not critical, but the current through R1 should be five to ten times the base current of Q1. R1 is bypassed with C15, which is large enough to be a virtual AC short circuit at the lowest frequency, while C16 effectively bypasses any inductance that C15 may exhibit at high frequencies. C18 and C20 perform the same function.

R6 provides current feedback to improve stability and is chosen for the lowest value that won't load the output. The negative feedback, and hence the gain, is controlled by a variable resistance. This variable can take the form of a thermistor, a pair of diodes, a low current lamp filament, or even an FET in more sophisticated circuits. Two arrangements are shown here — the thermistor and the filament lamp. Both work very well by increasing the negative feedback when the output signal increases. The filament is much less expensive than the thermistor but may be harder to find!

The bulb used, a GE 1835 has a cold DC resistance of approximately 110 ohms, and together with R7 (equal to 270 ohms), provides the necessary gain of three to establish oscillation. Both devices change temperature and resistance according to the amount of current flowing through them.

The Rs and Cs of the Wien bridge circuit are chosen to give a 10:1 range on each selected position. A dual 5k pot was chosen to vary the frequency because, as a relatively low impedance, it allows the use of slightly larger capacitors: these, won't be so affected by stray capacitance at the high frequency end. The 470 ohm resistors R3 a, b set the maximum high frequency on each range.

Construction

No great problems here. In fact this project, for its performance, is incredibly easy to build. The PCB helps this, as well as keeping the response more uniform. The capacitors should be close tolerance or selected for the Wien bridge, to keep the frequency dial accurate on all ranges. Leads from the Wien bridge pots and switch should be as short as is practical.

Figure 3. A different method of gain control, where R7 and LP1 are replaced with an R53 thermistor.

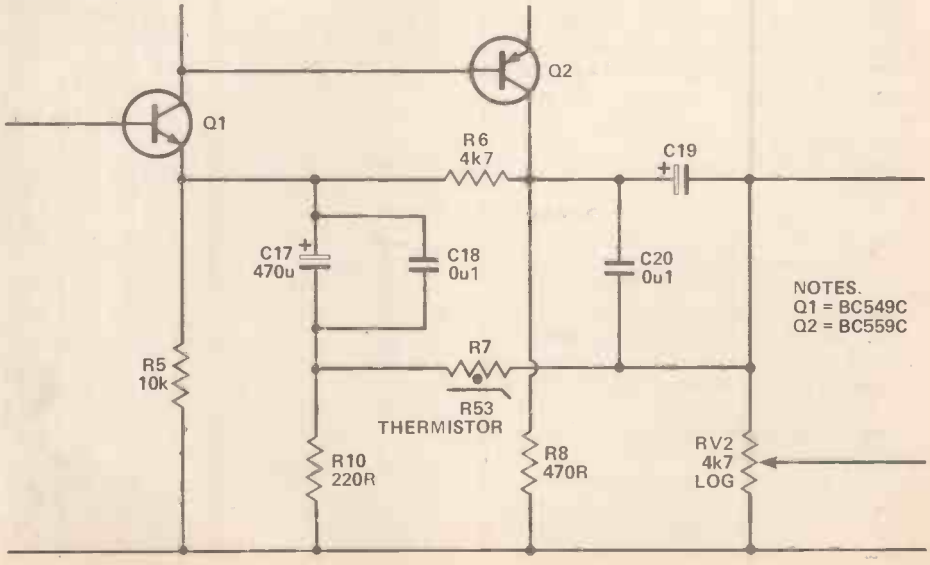
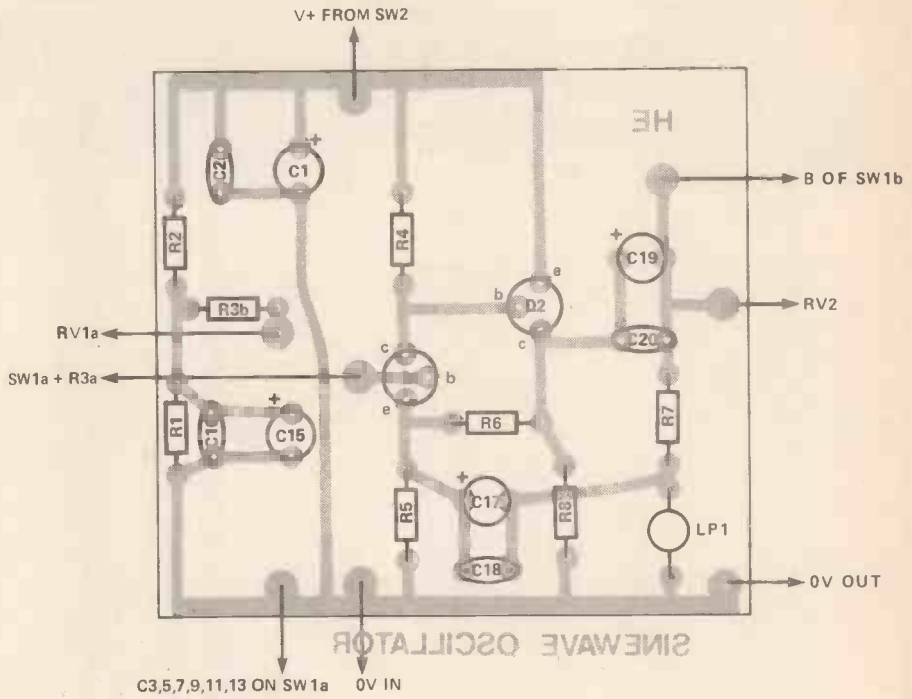


Figure 4. The PCB overlay, showing the LP1/R7 arrangement. Note the cluster of components mounted on SW1a, shown in the picture below.



Parts List

RESISTORS
(All ¼ watt 5% carbon film)
R1 ..... 47k
R2 ..... 33k
R3a, b, R8 ..... 470R
R4 ..... 2k2
R5 ..... 10k
R6 ..... 4k7
R7 ..... 270R *
R9 ..... 47R
R10 ..... 220R *
(* See Figure 3)

POTENTIOMETERS
RV1a, b ..... 5k dual long pot
RV2 ..... 5k log pot with SPST mains switch

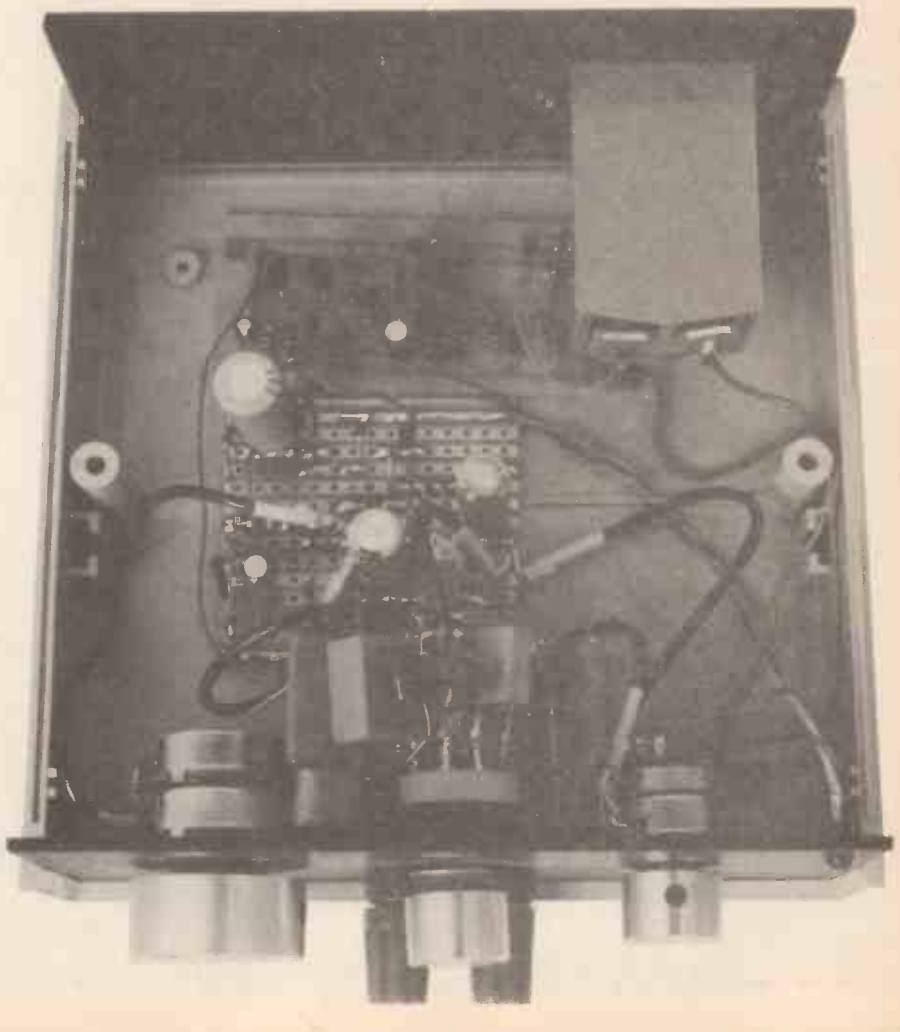
CAPACITORS
C1 ..... 1000u 16V radial electro
C2, 7, 8, 16, 18, 20 ..... 0u1 ceramic
C3,4 ..... 10u 16V non-radial electro
C5, 6 ..... 1u 16V non-radial electro
C9, 10 ..... 10n polyester
C11, 12 ..... 1n polyester
C13 ..... 82p ceramic
C14 ..... 100p ceramic
C15, 17, 19 ..... 470u 16V radial electro
(NB: Wien bridge capacitors, C3—14, should be selected to values within 1% of that specified.)

SEMICONDUCTORS
Q1 ..... BC549C
Q2 ..... BC559C

MISCELLANEOUS
SW1a, b ..... 2-pole, 6-way rotary
Case, 159 x 154 x 64mm; PCB; knobs; PP3 battery and clips; terminals, wire, solder etc.

BUYLINES ..... page 26

This photograph shows the author's sine wave generator, which works for its living. The circuit here is built on Veroboard; the small PCB is an auto power down circuit which we have not included in the project. Note the cluster of Wein bridge components mounted on SW1. The grey box, top right, contains the battery — a simple modification.



ENFIELD ELECTRONICS

208 Baker Street, Enfield, Middlesex. EN1 3JY. Tel: 01-366 1873

ACCESS · BARCLAYCARD VISA

TRANSISTORS

AC125	30p	BC183C	12p	MJE2955	110p	ZTX303	20p	2N1304	80p		
AC126	30p	BC183L	12p	MJE3055T	80p	ZTX304	20p	2N1305	80p		
AC127	30p	BC183LB	12p	MPSA06	25p	ZTX330	35p	2N1307	70p		
AC128	30p	BC184	12p	MPSA56	30p	ZTX500	18p	2N1308	80p		
AC132	90p	BC184B	12p	MPSU05	65p	ZTX501	18p	2N1613	36p		
AC141	30p	BC184L	12p	MPSU56	60p	ZTX502	18p	2N2222A	30p		
AC142	30p	BC186	30p	OC22	150p	ZTX503	18p	2N2369A	28p		
AC176	30p	BC187	30p	OC23	150p	ZTX504	30p	2N2646	68p		
AC187	30p	BC212A	14p	OC26	100p	ZTX531	30p	2N2904A/5A	30p		
AC188	30p	BC212L	12p	OC28	200p	ZTX550	30p	2N2906A	60p		
AD149	80p	BC213	12p	OC36	220p	2N696	35p	2N2907A	30p		
AD161	45p	BC213B	12p	OC41	75p	2N698	45p	2N2926G	12p		
AD162	45p	BC213L	12p	OC42	75p	2N699	40p	2N2926R	12p		
BC107	12p	BC214	12p	OC70	60p	2N706A	26p	2N2926Y	12p		
BC107A	14p	BC214B	14p	OC76	60p	2N708	30p	2N3053	30p		
BC107B	14p	BC214L	12p	OC81	60p	BC237	18p	2N3054	75p		
BC108	12p	BF194	14p	OC82	60p	BC238B	18p	2N3055E	60p		
BC108A	14p	BF195	14p	OC84	50p	BC307	18p	2N3442	150p		
BC108B	14p	BF198	14p	TIP29	30p	BC308	14p	2N3615	200p		
BC108C	14p	BF199	14p	TIP29A	35p	BC327	16p	2N3702	12p		
BC109	12p	BF200	35p	TIP29B	50p	BC328	16p	2N3703	12p		
BC109B	14p	BF224B	20p	TIP29C	45p	BC337	16p	2N3704	12p		
BC109C	14p	BF244B	35p	TIP30A	40p	BC338	16p	2N3705	12p		
BC140	35p	BF256	35p	TIP30B	50p	BC441	36p	2N3706	12p		
BC141	35p	BF257	35p	TIP30C	45p	BC461	36p	2N3707	12p		
BC142	35p	BF258	35p	TIP31	38p	BC477	40p	2N3708	12p		
BC143	35p	BF259	35p	TIP31A	40p	BC478	40p	2N3710	12p		
BC147	12p	BF594	40p	TIP31B	40p	BC517	45p	2N3711	12p		
BC148	12p	BF595	30p	TIP31C	45p	BC547	15p	2N3771	200p		
BC157	12p	BFR39	20p	TIP32A	40p	BC548	15p	2N3772	200p		
BC158	12p	BFR79	30p	TIP32C	40p	BC549	16p	2N3773	200p		
BC159	12p	BFR80	30p	TIP36C	140p	BC556	20p	2N3819	25p		
BC160	50p	BFX29	30p	TIP41A	50p	BC557	16p	2N3820	45p		
BC161	45p	BFX84	30p	TIP41B	50p	BC558	16p	2N3823	50p		
BC167	15p	BFX85	30p	TIP42A	60p	BC559	16p	2N3866	100p		
BC168	12p	BFX87	30p	TIP42B	65p	BCY70	20p	2N3903	15p		
BC169	12p	BFX88	30p	TIP120	80p	BCY71	20p	2N3904	15p		
BC170	20p	BFY50	28p	TIP121	80p	BCY72	23p	2N3905	15p		
BC171	13p	BFY51	25p	TIP142	120p	BD131	50p	2N3906	15p		
BC172A	12p	BFY52	25p	TIP2955	70p	BD132	50p	2N5172	30p		
BC173	13p	BFY90	80p	TIS43	36p	BD133	60p	2N5194	80p		
BC177	20p	BRY39	40p	TIS44	40p	BD135	50p	2N5457	42p		
BC178	20p	BSX20	30p	TIS90	30p	BD136	40p	2N5458	48p		
BC179	25p	BSX29	35p	TIS91	30p	BD137	40p	3N128	85p		
BC181	23p	BU105	170p	VN10KMA	75p	BD138	40p	3N140	85p		
BC182	12p	BU205	200p	VN66AF	95p	BD139	45p	3N141	85p		
BC182B	14p	BU208A	220p	VN88AF	110p	BD140	45p	3N163	110p		
BC182L	12p	MJ2955	90p	ZTX107	12p	2N914	36p	3N201	110p		
BC183	12p	MJE340	50p	ZTX108	12p	2N918	30p	3N202	125p		
BC183B	12p	MJE371	90p	ZTX109	12p	2N930	30p	40406	80p		
				ZTX300	15p	2N1131	30p	40407	80p		
				ZTX301	18p	2N1132	30p				
				ZTX302	20p	2N1303	80p				

TTL

7400	18p	7417	28p	7447	75p	7486	35p	74119	70p	74160	65p	74190	58p
7401	18p	7420	20p	7448	55p	7489	140p	74121	35p	74161	55p	74191	55p
7402	18p	7422	28p	7450	21p	7490	37p	74122	41p	74162	46p	74192	55p
7403	18p	7425	28p	7451	20p	7491	45p	74123	41p	74163	46p	74193	55p
7404	18p	7426	28p	4753	21p	7492	40p	74126	70p	74164	46p	74194	52p
7405	18p	7427	30p	7454	21p	7493	41p	74132	65p	74165	60p	74195	52p
7406	32p	7428	30p	7460	21p	7494	41p	74135	50p	74166	60p	74196	55p
7407	32p	7430	26p	7470	25p	7495	41p	74141	51p	74167	185p	74197	55p
7408	25p	7432	26p	7472	25p	7496	41p	74144	250p	74170	195p	74198	95p
7409	25p	7433	35p	7473	30p	7497	60p	74145	575p	74173	120p	74199	95p
7410	18p	7437	30p	7474	35p	74100	95p	74147	125p	74174	65p	74221	60p
7411	25p	7438	30p	7475	40p	74104	58p	74148	65p	74175	65p	74279	60p
7412	26p	7440	23p	7476	35p	74105	58p	74150	70p	74176	46p	74284	95p
7413	26p	7441	51p	7480	30p	74107	30p	74151	46p	74177	55p	74285	95p
7414	37p	7442	40p	7481	110p	74109	30p	74153	46p	74180	50p	74366	64p
7416	28p	7443	71p	7482	70p	74110	41p	74154	81p	74181	121p	74390	325p
		7444	95p	7483	58p	74111	70p	74155	46p	74182	70p	74393	100p
		7445	71p	7484	81p	74116	70p	74156	46p	74184	105p		
		7446	71p	7485	75p	74118	65p	74157	35p	74185	105p		

LS TTL

74LS00	17p	74LS27	21p	74LS83	51p	74LS138	40p	74LS169	98p	74LS243	81p	74LS293	46p
74LS01	17p	74LS28	21p	74LS85	52p	74LS139	39p	74LS170	86p	74LS244	65p	74LS353	71p
74LS02	17p	74LS30	21p	74LS86	23p	74LS147	121p	74LS173	63p	74LS245	86p	74LS362	110p
74LS04	17p	74LS32	21p	74LS90	39p	74LS148	86p	74LS174	58p	74LS247	65p	74LS365	35p
74LS05	17p	74LS33	21p	74LS93	39p	74LS151	46p	74LS175	52p	74LS248	66p	74LS366	35p
74LS08	18p	74LS37	21p	74LS95	46p	74LS153	52p	74LS181	115p	74LS249	66p	74LS367	35p
74LS09	20p	74LS38	21p	74LS96	109p	74LS154	120p	74LS183	201p	74LS251	40p	74LS368	35p
74LS10	20p	74LS40	21p	74LS107	46p	74LS155	46p	74LS190	58p	74LS253	46p	74LS373	70p
74LS11	20p	74LS42	37p	74LS109	35p	74LS156	46p	74LS191	55p	74LS257	40p	74LS374	70p
74LS12	23p	74LS49	63p	74LS112	32p	74LS157	40p	74LS192	55p	74LS258	43p	74LS375	52p
74LS13	28p	74LS51	21p	74LS113		74LS158	40p	74LS193	55p	74LS259	67p	74LS386	130p
74LS14	32p	74LS54	21p	74LS114	32p	74LS160	40p	74LS194	52p	74LS260	30p	74LS390	55p
74LS15	21p	74LS55	21p	74LS122	46p	74LS161	40p	74LS195	52p	74LS266	32p	74LS393	55p
74LS20	21p	74LS63	138p	74LS123	46p	74LS162	40p	74LS196	52p	74LS273	63p	74LS395	98p
74LS21	21p	74LS73	25p	74LS124	166p	74LS163	43p	74LS197	52p	74LS275	145p	74LS398	310p
74LS22	21p	74LS74	25p	74LS125	37p	74LS164	48p	74LS221	63p	74LS279	40p	74LS541	130p
74LS26	21p	74LS75	28p	74LS126	35p	74LS165	60p	74LS240	81p	74LS280	110p	74LS629	200p
		74LS76	25p	74LS132	41p	74LS166	81p	74LS241	75p	74LS283	46p	74LS669	160p
		74LS78	25p	74LS136	28p	74LS168	97p	74LS242	80p	74LS290	60p	74LS670	120p

CMOS

CD4000	15p	CD4015	46p	CD4035	55p	CD4054	100p	CD4093	40p	CD4503	46p	CD4569	80p
CD4001	15p	CD4016	30p	CD4038	125p	CD4060	80p	CD4099	140p	CD4511	52p	CD4572	80p
CD4002	15p	CD4017	40p	CD4040	50p	CD4066	30p	CD4160	75p	CD4512	60p	CD4581	80p
CD4006	60p	CD4018	52p	CD4041	50p	CD4068	20p	CD4161	75p	CD4514	140p	CD4582	80p
CD4007	16p	CD4019	30p	CD4042	45p	CD4069	20p	CD4162	75p	CD4515	200p	CD4583	60p
CD4008	45p	CD4020	52p	CD4043	46p	CD4070	16p	CD4163	75p	CD4516	65p	CD4584	60p
CD4009	30p	CD4021	46p	CD4044	46p	CD4071	18p	CD4175	75p	CD4518	52p	CD4585	110p
CD4010	35p	CD4022	46p	CD4045	120p	CD4072	18p	CD4402	75p	CD4520	60p	CD40100	200p
CD4011	15p	CD4023	20p	CD4046	55p	CD4075	25p	CD4412	75p	CD4528	81p	CD40106	80p
CD4012	20p	CD4024	40p	CD4047	46p	CD4076	60p	CD4419	75p	CD4538	100p	CD40109	100p
CD4013	25p	CD4025	18p	CD4048	45p	CD4077	30p	CD4445	75p	CD4539	78p	CD40114	200p
CD4014	55p	CD4026	100p	CD4049	30p	CD4078	25p	CD4446	75p	CD4541	100p	CD40174	80p
		CD4027	25p	CD4050	30p	CD4081	25p	CD4449	75p	CD4555	60p		
		CD4028	45p	CD4052	70p	CD4082	25p	CD4501	35p	CD4561	110p		
		CD4029	55p	CD4053	60p	CD4085	72p	CD4502	70p	CD4568	80p		

LINEAR

CA1310E	185p	CA3090	415p	LM339	80p	LM3911	140p	SAA5020		TDA1008	347p	TL074	117p
CA1350E	90p	CA3130	105p	LM348	90p	LM3914	285p	SN76013N	295p	TDA1022	570p	TL081	40p
CA3020	230p	CA3140	52p	LM358	62p	LM3915	285p	TAA621A	290p	TDA1028	120p	TL082	65p
CA3028	110p	CA3240	125p	LM380	85p	LM3916	285p	TAA661B	175p	TDA2002	150p	TL083	92p
CA3035	270p	ICM7555	105p	LM381	170p	MC1458	70p	TBA120B	70p	TDA2003	345p	TL084	65p
CA3043	305p	ICM7556	200p	LM382	130p	MC1488	80p	TBA120S	68p	TDA2020	350p	UA748	40p
CA3055	85p	LF347	200p	LM384	160p	MC1489	90p	TBA120U	98p	TDA2030	340p	ZN414	95p
CA3065	150p	LF351N	55p	LM386	100p	NE555	20p	TBA540Q	161p	TDA2102		ZN424	150p
CA3080	80p	LF353N	100p	LM387	140p	NE556	55p	TBA651		TDA2522		ZN425	400p
CA3081	225p	LM301	30p	LM389	110p	NE564	405p	TBA800	95p	TDA9400		ZN426	345p
CA3085	145p	LM308	100p	ILM732	55p	NE566	173p	TBA810S	110p	TL061	50p	ZN427	715p
CA3086	65p	LM311N	81p	ILM747	75p	NE567	161p	TBA820	81p	TL062	75p	ZN1034	230p
CA3089	230p	LM318N		ILM1458	45p	NE570	391p	TBA920Q	175p	TL064	150p	ZN1040	750p
		LM324	50p	ILM3900	70p	NE571	387p	TCA270S	171p	TL071	50p		
				ILM3909	92p	SAA5010		TDA1004	345p	TL072	60p		

RIBBON CABLE

(Priced per 33cm)

COLOUR WAYS	
10	26p
20	53p
26	76p
34	100p

D CONNECTORS

PLUGS	SOCKETS
9 way 90p	125p
15 way 125p	190p
25 way 190p	230p

DIODES

AA119	15p	OA200	9p	1N5060	18p
AA215	16p	OA202	9p	1N5062	20p
BAX13	10p	1N823	5p	1N5400	11p
BY100	30p	1N914	5p	1N5401	12p
BY127	18p	1N916	6p	1N5402	14p
BY133	20p	1N4000	5p	1N5403	15p
BY206	30p	1N4001	5p	1N5404	16p
BY207	30p	1N4002	5p	1N5405	17p
BY299	40p	1N4003	6p	1N5406	18p
BYX10	18p	1N4004	6p	1N5407	22p
OA47	10p	1N4005	7p	1N5408	25p
OA90	8p	1N4006	7p	1S44	5p
OA91	8p	1N4007	8p	1S921	7p
OA95	8p	1N4148	5p	1S922	7p
		1N4448	6p	1S923	7p

I.C. SOCKETS

LOW PROFILE		TURNED PIN	
D.I.L Type	Price	D.I.L. Type	Price
8 pin	10p	8 pin	35p
14 pin	12p	14 pin	50p
16 pin	14p	16 pin	60p
18 pin	18p	18 pin	65p
20 pin	24p	22 pin	75p
22 pin	25p	24 pin	80p
24 pin	30p	28 pin	100p
28 pin	32p	40 pin	150p
40 pin	35p		

ZENER DIODES

BZX61C/1.4 watt: 3V3, 3V6, 3V9, 4V7, 5V6, 6V2, 7V5, 8V2, 10V, 11V, 12V, 13V, 15V, 18V, 20V, 22V, 24V, 27V, 30V, 33V, 36V, 39V, 43V, 47V, 56V, 68V, 75V, 82V, 100V, 180V, 200V **16p each**

BZY88C/0.4 watt: 1V3, 2V7, 3V, 3V3, 3V6, 3V9, 4V3, 4V7, 5V1, 5V6, 6V2, 7V5, 8V2, 9V1, 10V, 11V, 12V, 13V, 15V, 16V, 18V, 22V, 24V, 27V, 30V, 33V, 36V **10p each**

LEDs

5mm: Red	10p	113: Red	
Green	13p		20p
Yellow	13p	Green	25p
3mm: Red	10p	Yellow	25p
Green	13p	323: Tri	
Yellow	13p	Red	20p
COX21: Red flashing	65p	Green	25p
251: Rect/stack		Yellow	25p
Red	20p	503: Square	
Green	25p	Red	20p
Yellow	25p	Green	25p
		Yellow	25p

REGULATORS

LM304H	180p	UA723C	77p	78H12 (3A/5V)	
LM309H	80p	7805A	50p		460p
LM309K	130p	7812A	50p	78L05	35p
LM317K	350p	7812Kc	121p	78L12	35p
LM317T	130p	7815A	50p	78L15	35p
LM320/5	65p	7818A	50p	78L18	35p
LM320/12	65p	7824A	50p	78L24	35p
LM320/15	65p	7905A	55p	78L62	35p
LM320/24	65p	7912A	55p	79L05	45p
LM337T	180p	7915A	55p	79L12	45p
LM1469	324p	7918A	55p	79L15	45p
UA78P (8A/5V)	450p	7924A	55p	79L18	45p
				79L24	45p

RECHARGEABLE BATTERIES

HP2, 1.2v, 4.0AH	£3.95
HP2, 1.2v, 1.2AH	£2.60
HP11, 1.2v, 1.2AH	£2.40
HP7, 1.25v, 500mAH	£1.00
AAA, 1.2v, 180mAH	30p
PP3, 8.4v, 110mAH	£4.50

ALUMINIUM BOXES

3⅛" x 1⅝" x 9⅛"	
80 x 50 x 25	80p
100 x 65 x 50	1.20
100 x 70 x 40	1.20
100 x 100 x 40	1.20
135 x 70 x 40	1.20
135 x 105 x 40	1.40
180 x 125 x 65	1.95
205 x 155 x 75	2.50

VERO PLASTIC BOXES

White 71 x 49 x 25	60p
Blk 71 x 49 x 25	60p
Blk 120 x 80 x 35	1.10
Blk 180 x 110 x 55	1.75

VERO BOARDS

127 x 63	1.10
95 x 63	95p
431 x 63	3.17
127 x 95	1.20
95 x 95	1.15
431 x 95	4.20
454 x 119	5.50
63 x 25 pk of 5	1.30

SOLDER

20 swg. 3 core

500g 495p

POTENTIOMETERS

Carbon track, ½ watt log & linear values:

Range	Price
470R-2.2MR (single track)	40p
4.7K-2.2MR (dual gang)	100p
4.7K-2.2MR (single gang D/P switch)	90p

SLIDER POTS

60mm track, log & linear values:

Range	Price
5K-500K	80p

PRESETS

Pre-set pots ½ watt

Range	Price
50R-4.7MR (mini vert. & horiz.)	10p

THYRISTORS

				600mA/200V	45p	5A/400V	60p
BT101	104p	T05 1A/400V	104p	1A/50V	40p	5A/600V	70p
BT102	104p	2N1599	40p	1A/100V	45p	5A/800V	80p
BT106	104p	2N4441	170p	1A/200V	50p	7A/100V	55p
BT107	132p	2N4444	150p	1A/400V	60p	7A/200V	60p
BT108	143p	2N5060	36p	1A/600V	75p	7A/400V	70p
TIC44	20p	2N5061	33p	1A/800V	90p	7A/600V	80p
TIC106D	40p	2N5062	42p	3A/50V	46p	7A/800V	90p
TIC106M	77p	2N5063	47p	3A/100V	53p	10A/50V	55p
TIC126D	99p	2N5064	47p	3A/200V	58p	10A/100V	60p
TIC206D	80p	600mA/20V	21p	3A/400V	71p	10A/200V	65p
TIC226D	90p	600mA/30V	24p	3A/600V	79p	10A/400V	70p
TIC246D	130p	600mA/100V	30p	5A/50V	99p	10A/600V	88p
					43p	10A/800V	115p

TRIACS

2A/200V	50p
2A/400V	60p
2A/600V	60p
4A/400V	60p
6A/100V	80p
6A/200V	80p
6A/400V	90p
8A/400V	80p
10A/100V	80p
10A/200V	100p
10A/400V	110p
10A/400P	100p

BRIDGE RECTIFIERS

1A/50V	30p	6A/50V	75p
1A100V	30p	6A/100V	75p
1A/200V	35p	6A/200V	80p
1A/400V	40p	6A/400V	100p
2A/50V	35p	10A/200V	200p
2A/100V	45p	10A/400V	200p
2A/200V	50p	25A/200V	250p
2A/400V	55p	25A/400V	300p

Dalo Etch resist £1.10

RESISTORS

High stability, ¼ watt, 5%		
Range	Price (1-99)	(100+)
1R-10MR	2p	1p
High stability, ½ watt, 5%		
Range	Price (1-99)	(100+)
1R-10MR	3p	1.5p

CAPACITORS

CERAMIC 1pF, 2p2, 2p7, 3p3 3p9, 4p7, 5p6, 6p8, 8p2, 10pF, 12pF, 15pF, 18pF, 22pF, 27pF, 33pF, 39pF, 47pF, 56pF, 68pF, 82pF, 100pF, 120pF, 150pF, 180pF, 220pF, 270pF, 330pF, 470pF, 560pF, 680pF, 820pF, 1000pF, 1n5, 1n8, 2n2, 3n3, 3n9, 4n7, 5n6, 6n8, 8n2, 10nF, 22nF, 47nF, 100nF 8p each

MYLAR: 100V 1nF, 2n2, 3n3, 4n7, 6n8, 10nF 7p each. 15nF, 22nF, 33nF, 47nF 9p each. 68nF, 100nF 11p each. 220nF 15p. 330nF 18p. 470nF, 20p.

POLYSTYRENE 22pF, 47pF, 68pF, 82pF, 100pF, 120pF, 150pF, 220pF, 270pF, 330pF, 390pF, 470pF, 680pF, 820pF, 1000pF, 1200pF, 1500pF, 1800pF, 2000pF, 2200pF, 3300pF, 4700pF, 5600pF 8p each

TANTALUM BEAD 3V: 100uF, 150uF, 220uF, 330uF 64p each. 470uF 110p. 680uF 160p. 6V3: 1000pF 27p. 1500pF 32p. 1800pF 42p. 2200pF 45p. 2700pF 48p. 3600pF 55p. 3900pF 68p. 4700pF 83p. 5000pF 98p. 6800pF 115p. 8200pF 120p. 10000pF 125p.

POLYESTER C280 250V .01, .022, .033, .068, .1 8p. .15, .22, .33 10p. .47 12p. .68 20p. 1uF 26p. 2.2 each. 33uF 33p. 47uF 40p. 68uF 63p. 220uF 110p.

16V: 2u2, 3u3 20p each. 4u7, 6u8 25p each. 10uF 32p. 22uF 35p. 16V: 33uF 40p. 47uF 60p. 100uF 95p. 220uF 105p. 25V: 15uF, 22uF 40p each. 47uF, 68uF 60p. 35V: 0.1uF, 0.22uF, 0.47uF 16p each. 1uF, 1u5 18p each. 2u2 25p. 3u3, 4u7 20p each. 6u8 30p. 10uF 40p. 47uF 60p.

ELECTROLYTIC Axial or Radial 16V: 10uF, 22uF, 33uF 10p each. 47uF, 68uF, 100uF 12p each. 125uF, 220uF 14p each. 330uF 18p. 470uF 24p. 680uF 36p. 1000uF 30p. 1500uF 40p. 2200uF 50p. 25V: 1uF, 10uF, 22uF, 47uF 10p each. 100uF 12p. 220uF 20p. 470uF 30p. 1000uF 40p. 2200uF 55p. 4700uF 115p. 35V: 120uF, 250uF 20p each. 40V: 6u8 10p. 470uF 30p. 1000uF 45p. 50V: 0.47uF, 1uF 8p each. 1uF (small) 12p. 220uF 35p. 63V: 1uF, 2u2, 4u7 7p each. 10uF, 22uF 10 each. 47uF 12p. 100uF 20p. 220uF 30p. 100V: 4.7F 48p. 160V: 10MF 32p. 250V: 0.01uF, 0.047uF, 0.1uF 10p each. 0.22uF 11p. 0.47uF 12p. 1uF 18p. 2u2 26p. 10uF 23p. 100uF 35p. 400V: 0.47uF 35p. 600V: 0.022uF, 0.047uF 30p each. 0.22uF, 67p. 1000V: 0.0022uF 27p. 0.022uF, 0.1uF 39p each.

POLYESTER C280 250V .01, .022, .033, .068, .1 8p. .15, .22, .33 10p. .47 12p. .68 20p. 1uF 26p. 2.2 50p.

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The definitive key to every article published in Hobby Electronics from November 1978 to December 1983.

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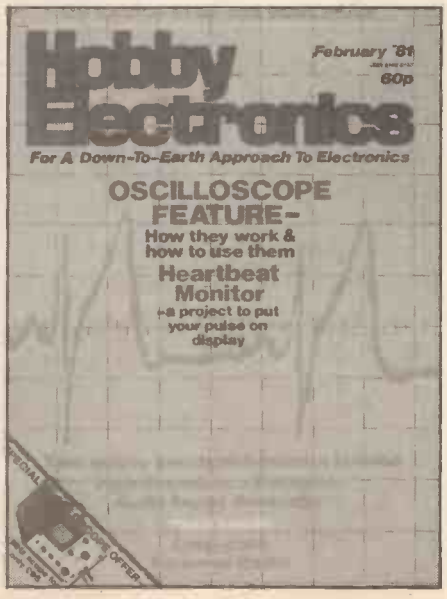

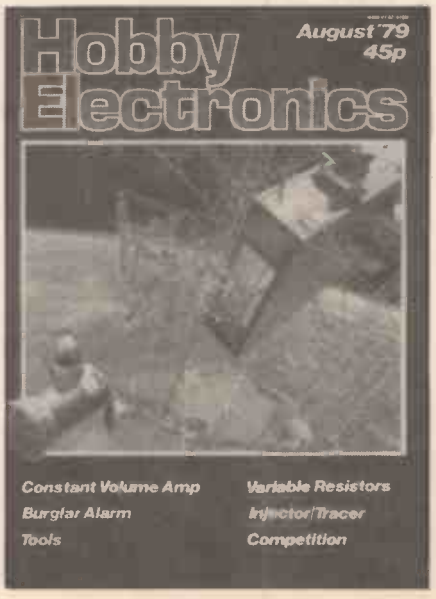

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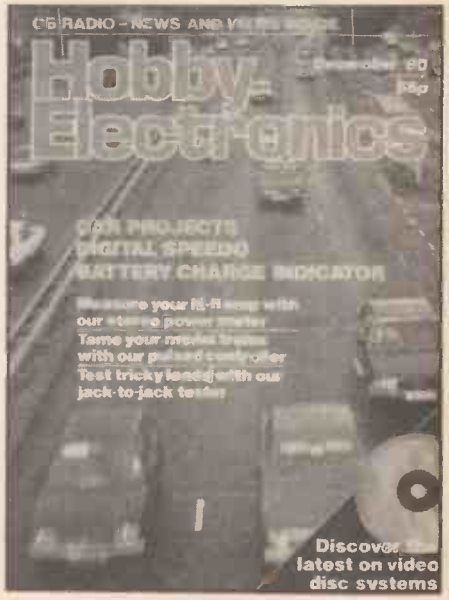

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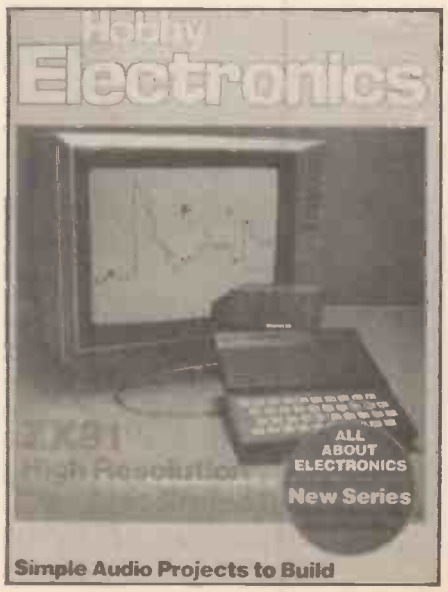

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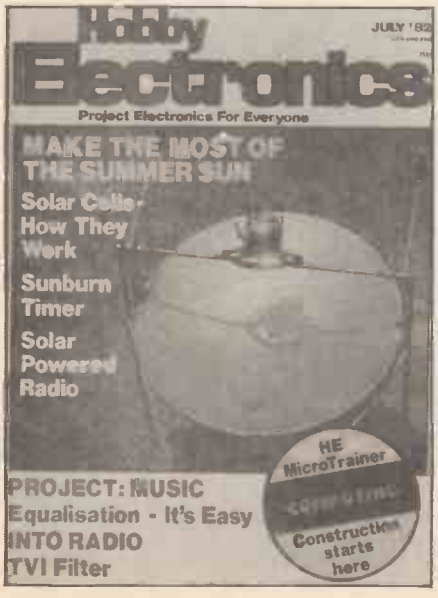

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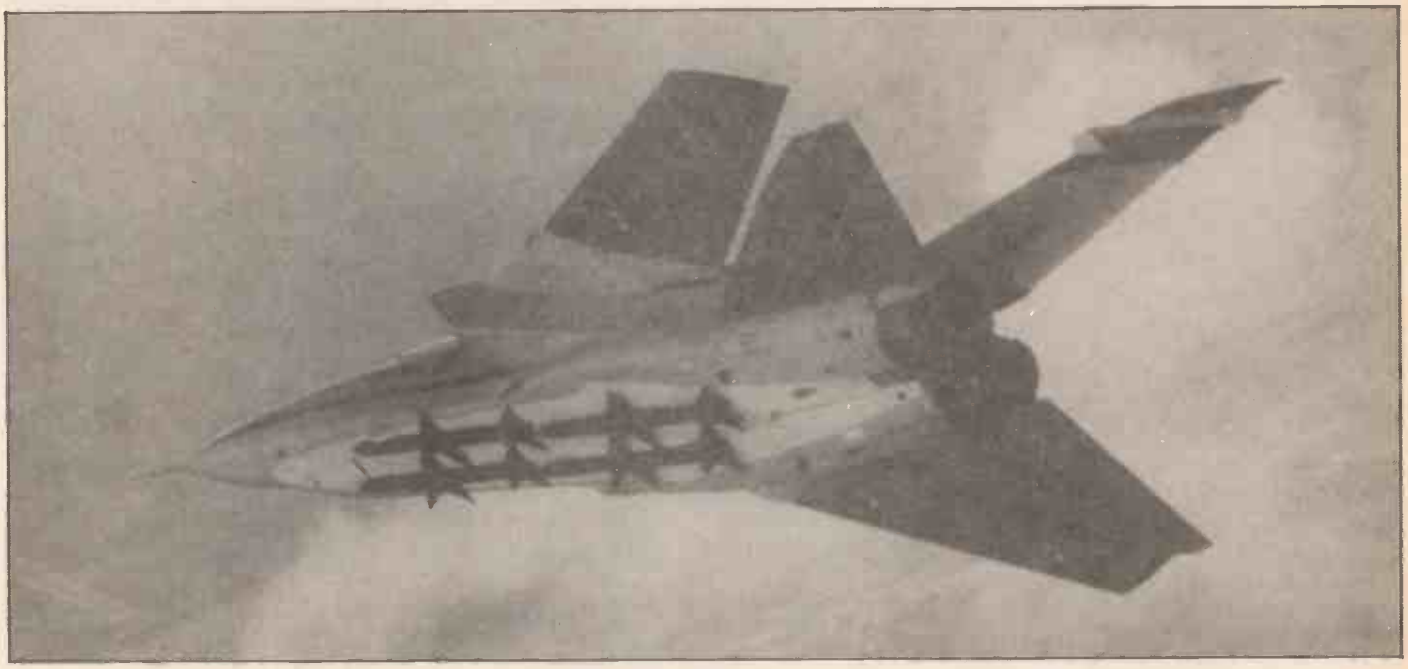
CAREERS IN ELECTRONICS



We conclude our three-part look at electronics in the Armed Forces with the Royal Airforce, and a round up of addresses.

Helen Armstrong

Unsurprisingly, the **ROYAL AIR FORCE** also divides its engineering forces into three sections, in this case known as Aircraft Engineering, including and care and maintenance of the aircraft and heavy weaponry, as well as the electrical systems; Electronics Engineering, which includes the care of all communications equipment, flight simulators, and the fine electronics of flight and navigation systems, and General Engineering, which covers carpentry, workshop crafts, ground equipment servicing and ground and vehicle electrical systems.

For engineering in the RAF, the roles are generally divided into Mechanics (who require no formal qualifications to be accepted for training) and Technicians (most of whom require two or four GCE O levels or the equivalent). Men are accepted at 16½ and women at 17, and most trades are open to both —although, in accordance with the tradition that women do not go into combat, flying jobs are closed to them. As usual, maths and physics are the prefered GCE subjects, and in some cases are essential. Entrants with four 'O' levels, and between 16 and 18½ can apply for Apprenticeship training. The upper age limit for training is 39, a bit higher than for the other two Services. This may reflect the fact that there is less emphasis on personal combat training in the RAF than in the Army or even the Navy: it is highly machine-orientated, the purpose being to get fighting, bombing and reconnaissance aircraft into the air, out to their mission, and safely back again. Even so there is an RAF Regiment whose job is to protect the airfields; all personnel have to undergo military training, and meet basic medical requirements, and some jobs — such as flying — are among the most physically and mentally demanding in any Service.

Technician training lasts from nine to eighteen months, depending on the previous level experience of the trainee (some come straight from school, others from industry) and those entering as Mechanics may be selected according to merit for training as Technicians later. People with, or expecting to get, four good 'O' level passes including Maths and Physics can apply for Apprenticeship training. This falls into Aircraft Engineering (which is mostly electrics and mechanics), Electronic Engineering (Flight Systems), or Electronic Engineering Technician (Air Communications/Air Radar), which titles are self-explanatory.

Electronic Engineering courses cover three years at RAF Cosford, near Wolverhampton. The first year of study is common to all Electronics students, and includes basic electronics, introductions to radio and computers, plus introductory RAF studies such as physical training, weaponry and RAF history. Work on BTEC studies begin.

In the second year, advanced electronics theory and practice is covered. Students begin to specialise, and learn about the specific equipment they will be working with; they also visit an RAF station to observe engineering in action, and sit BTEC examinations. In the third year, most time is spent in workshop practice and aircraft servicing within the student's specialisation, with more time at an RAF station. There is also a course in Junior Management, which is the first formal step towards

developing the ability to lead and supervise men, which could later lead to officer training to those with the ability.

At the centre of the course the level of BTEC Higher Diploma is achieved, and there are further opportunities to take higher qualifications and more demanding specialisations.

Unlike the Navy and the Army, Engineering Officers in the RAF do not have to be graduates. Acceptable qualifications however are still demanding, and are candidates are classified as "Qualified" or "Intermediately Qualified": Qualified candidates must have a degree in an appropriate subject (engineering, maths or science, to summarise), or membership, or the equivalent, of one of the engineering Institutions or the Royal Aeronautical Society (to the level of Chartered Engineer in the latter case) or a pass in Part 2 of the Council of Engineering Institutions examinations. Intermediately qualified candidates must have an HNC or BTEC Higher Certificate in Engineering or science, or a City and Guilds Full Technological Certificate in one of the four specified engineering subjects — plus 'O' level English.

This is a bald summary; there is a complex system of exemptions and equivalents to be taken into consideration. The RAF like all the Services aim to choose men and women suitable for the service and in the process see that they are qualified, or can be qualified, to do the technical job which will be demanded of them; they are not looking for a sheaf of paper qualifications.

In the RAF equal opportunitie exist for men and women in all engineering jobs, except apprenticeships. You'll get more details from their recruiting literature.

A test crew at Marconi Avionics put he tactical systems of a new Nimrod aircraft, due to come into service in the not too distant future, through its paces. This is the kind of equipment which RAF engineers must be able to maintain.

Sponsoring Schemes

While they do not have their own degree college, the RAF has a number of schemes for sponsoring. There is a Cadetship scheme for entrants about to go into a University or Polytechnic, and there is also sponsorship for the Air Transport Engineering Course at the City University in London.

The RAF also wants officers who have had experience in industry and, as for the ranks, the upper age limit for entrance is thirty nine.

All officers entering the service have an initial training of eight weeks at the Officer Training Unit at the RAF College, Cranwell. The subjects covered will be familiar to you by now: leadership, service history and knowledge, administration, tactics and defence, physical fitness and survival.

Subsequently, Engineer Officers train at Cranwell, although there are many other RAF training establishments for other branches. Non-graduate engineers receive Lead-in Training, comprising mathematics and electrical science, drawing, workshop practice and other academic subjects. This is followed, for everyone, by eight weeks Service Engineering Orientation Course, which covers the technology and management used by the RAF.

After this, officers specialise in either basic aerosystems or basic communications-electronics. Further education in these fields comes in the form of pre-employment training before each tour of employment for C-Es, and familiarisation training on the aircraft they will be working with for Aerosystems (this is similar to the standard pattern of pilot and aircraft engineer training in civil life, where the pilot or engineer must be specifically trained and qualified for one (or more) type of aircraft before he is allowed to work with it).

The initial Professional Training course lasts about twelve months, after which the officer goes into employment, but both technical and management training continues as the officers progresses.

As the majority of RAF engineering officers neither fly operationally nor engage in front-line combat, most jobs are open to women as well as men provided they have the same qualifications. But whereas it's fair to say, "Why join the Navy if not to go to sea?", it's not fair to say "Why join the RAF if not to fly?". Comparatively few RAF personnel actually fly, or fly in, the aircraft — the majority of them either service the aircraft, or administrate the service. It is possible to learn flying, though, as indeed it is in the Navy or the Army.

To join the RAF as an Officer you must be interviewed and selected by either the Air Board (aircrew), the Ground Board (most other personnel) or the Cadetship Board, which selects candidates for University Cadetships. Selection procedures take place at RAF Biggin Hill (home of the Biggin Hill Air Show) and last between three and four days. A permanent commission is initially for sixteen years either from the age of 21 or up to the age of 38 there are also Short Service Commissions of varying length. Promotion is by merit.

Pros And Cons

This article so far has laid out a rough map of the opportunities and commitments which exist in the Armed Forces for people interested in pursuing a career in electronics at any level. I hope I have been able to distinguish between the three services enough. Although they are all run along similar lines and have similar aims I am left with the impression that each has its particular advantages and disadvantages, from small things such as the exact age limits for entry to large

A different aspect of defence work: two operators on the main computer at RAF Brize Norton. Stressing the variety of defence work, operating the administration computer is as far from repairing a fighter aircraft as can be imagined, but it is still a vital part of the defence chain.

matters such as where you would be expected to serve and the opportunity to travel or otherwise.

All the services have the benefits and penalities of a somewhat closed community, as servicemen tend to live on or around bases with other people of the same service. It can be (but does not have to be) rough on family life, as it can involve a good deal of moving around, so that there is not the opportunity to settle into a local community (even a service one) for long periods. Some people find this interesting, others find it disorientating. On the other hand it gives a comparatively well-assured career (although servicemen, especially older ones, are not immune to redundancy; but this does not happen very often) with a good pension for people leaving after a full term career and training and experience (particularly in a technical field such as engineering) which are in demand in civilian employment.

To be eligible for service employment, you must be a British citizen and the child of British citizen parents (which does not mean that you or they have to be born in the UK but does mean that you must have been born within the Commonwealth. Again, as with most Forces regulations, exceptions can be made under the right circumstances. But applicants must be of British nationality on application.

Asking Questions

Career opportunities aside, the Armed Forces exist to defend the UK and territories associated with it against attack; years of peace can suddenly be punctuated by hostilities involving all three Services, as happened with the Falklands war. Engineers even when they are not actually doing the shooting, are occasionally likely to be shot at.

However, the Services are as keen to avoid employing people who are not happy with the conditions of service as those people are to avoid joining them. So it is worth asking questions, if possible visiting services establishments and meeting service people. Joining does not have to be a long-term commitment, so that it is possible to spend a few years in one of the services (the minimum is about three years in most cases) and then decide whether to stay or leave, by which time you will know what is involved and can make the choice with useful experience behind you, and no regrets either way.

Your first step in your investigation is to visit your nearest Services careers office, or to write to one of the addresses listed for brochures, which will tell you roughly what we have told you, and a whole lot more. Then go back to your careers office and start asking questions.

Now, if the RAF will just recognise the crying need for lady fighter pilots before I get to thirty-nine . . .

To find out more about engineering in the Army, write to:

The Engineer-in-Chief's Recruiting Liaison Office
Royal Engineers
Brompton Barracks
Chatham
Kent ME4 4UG

Lt-Col J. R. Ellis
Officer Recruiting Liaison Staff
School of Signals
Blandford Camp
Dorset DT11 8RH

The Recruiting Liaison Staff
Headquarters
REMEM Training Centre
Arbourfield
Reading
Berks RG2 9NN

These addresses all apply to officer training. For other ranks, locate your nearest Army Careers Office by consulting the Yellow Pages, local telephone directory, or local library.

Prospective Naval Officers should write to:

The Officer Entry Section
Naval Careers Service
Old Admiralty Building
Spring Gardens
London SW1A 2BE

For other ranks look for the Royal Navy and Royal Marines Careers Information offices in the phone book (listed under *Naval Establishments*). There are about sixty of these countrywide; you can phone them for initial information and literature.

For the RAF, you will have to refer to the nearest RAF careers office initially.

There are two other options to be considered: one is the Youth Training Scheme, for which the Services are now taking some entrants for twelve month engagements, which is a good chance for likely candidates between sixteen (seventeen for girls) and eighteen. The other is the Forces Reserves. Each Service has a Reserve force made up of ex-personnel and civilians who put a certain amount of their time into Service training every year in return for training and payment. Members acquire rank in the same way as regulars: it's a way of becoming involved in the Service without the full career commitment. Places are often limited. Reservists are the first to be called upon in time of war when the services need more personnel.

That concludes our summary: the rest is up to you. And, yes, the rumours that some trainee officers have been asked to obtain a tassel from a striptease dancer as part of their initiative test have been confirmed by our most reputable (ex-Armed Services) sources.

This feature ends Careers In Electronics *'83 as a regular series, but we shall be featuring other electronics careers every so often. Suggestions are welcome from anyone with a special interest that we haven't covered yet.*

HE

Sinclair's QL

A giant step forward . . . or a leap in the dark?

CLIVE SINCLAIR has just made a grand slam bid for another lion's share of the computer market. Although not without drawbacks, the new Sinclair QL ("Quantum Leap") is a very powerful machine which Sinclair confidently expects to equal the sales performances of the Spectrum. The QL will retail for just £399, including a set of four software packages from Psion. Mail-order deliveries are due at the end of February 1984, with retail sales planned in the year's third quarter. Ordering a QL should not be a problem, as a wide ranging advertising campaign has already begun.

As pointed out at the launch, there is no other computer offering anything like the power of the QL at anything near the price; the inclusion of four useful and well designed programs is a nice touch, and a sensible precaution against one of the most serious threats to a new computer — lack of software support. This is a marketing lesson which Sinclair has learnt thoroughly but which others absorb only at great cost.

But then marketing is largely what Sinclair Research Ltd are all about. The method is easily grasped, if not so readily followed by companies with less nerve. Somehow Sinclair manage to make and sell tomorrow's computer today, at yesterday's price. It is a leap-frogging process that reverses the normal procedure by which marketing-men take surveys to determine what the public wants, and then produce what they think the public needs. It is a technique (which has worked so far) whereby a new and innovative produce creates its own market: after all, was there really a demand for a small inexpensive home computer until Sinclair released the ZX80? The QL may well follow the same pattern.

The QL is very carefully positioned to bridge the gap (if there is one) between home and business computer users: on the one hand it is cheap enough to compete with the BBC Model B, Commodore 64 and the like, but also powerful enough (at least potentially) to compete with Apple, CBM and even the IBM PC. Yet Sinclair candidly admit that although they see the QL primarily as a business machine, they have no idea what uses the QL will ultimately find in the hands of the target 3.5 million users world wide. In other words having created a supply, they earnestly hope that demand will follow!

Certainly the QL has features to attract interest from all sections of the computer-buying public, and promises to be an interesting machine to explore.

Inside Story

The specification of the QL is worth considering in detail. The main processor is Motorola's MC68008, the baby of the 68000 family but neverthe less a most powerful CPU. It has a 32-bit internal structure and is fully compatible with 68000 code. The 20-bit wide address bus can directly access 1M byte of memory (or memory-mapped I/O), but the most attractive feature to Sinclair must have been its 8-bit data bus, which means the 68008 can be operated with standard byte-wide memories and support chips.

As well as the 68008 the QL includes an Intel 8049 8-bit CPU with 2K ROM and 128 bytes of RAM on the chip. This handles the keyboard, sound generation and the RS232C receive function. In addition, two custom chips are employed: one is dedicated to memory management and the display, while the other looks after the two microdrives, the local area network and RS232C transmission. A real-time clock is also included, maintained by a back-up battery — a most useful facility which, in the age of digital watches, is inexplicably missing from most computers.

Internal RAM stacks up at a fairly massive 128K, of which 9K is free to the user; an 0.5Mbyte expansion board is promised, which will take total RAM to 640K! The 32K ROM contains the new QDOS operating system, which promises to be very interesting, and an enhanced version of Sinclair BASIC, dubbed SuperBASIC.

QDOS is described as ". . . a single user multi-tasking, time-sliced system . . ." and was developed to take advantage of the power of the 68008 CPU. Multi-tasking (the ability to handle several jobs simultaneously) allows the QL to run several programs at once, each with an independent screen window — a feature normally available only on far more expensive computers.

SuperBASIC offers several improvements over the old Sinclair BASIC. For a start it incorporates the structured PROCedure format made popular by BBC BASIC; it is also said to be user-extendable and to run at a constant speed, so that program execution time does not depend on the length of the routine. Other features include easy interfacing to machine code, and access to the QDS operating system.

In And Out

The QL's keyboard has a full sized QWERTY layout with sixty five keys including a space bar, five function keys and four separate cursor controls. It is, apparently and at last, a proper keyboard!

Two microdrive units are built in, and a futher six can be daisy-chained onto the expansion socket. However

these must be QL Microdrives; those made for Spectrum cannot be used, though the cassettes themselves are compatible if formatted for the QL.

A port at one end of the computer accepts ROM cartridges up to 32K in capacity, but once more ZX ROM cartridges are not suitable.

The QL offers alternative display outputs. Best quality is obtained from the Monitor port, which will drive either an RGB or a monochrome monitor. Two graphics resolution modes are available: 512 x 256 pixels with a choice of four colours (red, green, black, white, plus a 'stipple' feature) or 256 x 256 with a palette of eight colours. Normal character format on a monitor display is 25 rows x 85 columns.

The UHF TV output display modes are similar, but the use of the stipple feature is not recommended and the character format is typically forty six characters, depending on software.

Other features built into the QL include a local area network (QLAN) providing a link-up for up to sixty-four QLs or Spectrums, two RC232C ports and two joystick ports.

Onwards And Outwards

In addition to the 0.5Mbyte memory expansion, an interesting list of peripherals and extensions is planned for the QL. The most important of these are the 68000 assembler, the analogue/digital interface, Winchester (hard disc) interface, modem and the parallel printer interface.

Finally there is the manual. A preview copy was released to interested journalists at the press launch, and while it would be unfair to criticise it at this stage it is plainly incomplete, with large sections either missing or very skimpy; one hopes that the final style is less opaque than that of the draft version. Bad documentation is unforgivable and a sin which infuriates reviewers and often leads to unfavourable comment on the computer itself.

Software

The 'software suite' supplied with the QL was written and licensed from Psion and consists of four integrated programs: QL Abacus, a spreadsheet; Archive, a data management/filing system; Easel, a graphics design program; and Quill, a wordprocessor.

All four are supplied on Microdrive cassettes and make extensive use of the QDOS operating system's capability for separate screen windows. At the top of the screen is a Control window, which at all times displays a list of current options available, to the user; few lines of the screen to show information about the work in progress; and the Display window, a large area across the middle of the screen, shows the work.

The screen format is identical in all four programs, as is the command structure, so the learning curve for the complete suite is likely to be quite short. In addition data is transportable from one program to another so that, for example, business graphics can be generated from data imported from the spreadsheet.

Many other tasty features are listed in the documentation, including many found only on up-market business computers, so the indications are that the QL software suit will be a joy and a delight to use — Murphy's Law permitting.

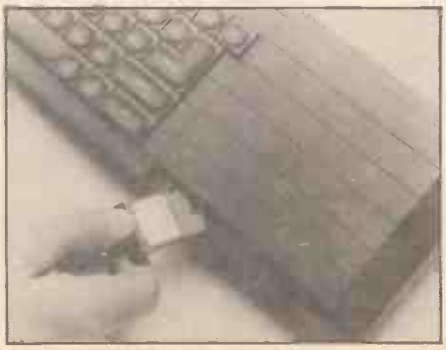
Paper Tigers

Lest readers begin to think that the QL is all things bright and beautiful, a flawless example of computing engineering unmatched by any other, it has to be said that the QL does have a few shortcomings. Indeed the sceptics have already compiled a list of them.

The most serious criticism is the complete lack of a facility found on every computer in the QL's price range . . . a cassette interface (its worth mentioning that a floppy disc interface is missing, too).

The implication of this is that cheap software is unlikely to be available for some time, because blank Microdrive cassettes currently cost around £5.00 at retail prices, and the medium is not suitable for high speed duplication either. Taking a slightly longer view, though, it will probably not be too long before add-on cassette and/or floppy interfaces are available. Another possiblity is that software houses will go for ROM-based programs, though this development must wait on the release of the 68000 assembler.

The Microdrive system itself is not yet proven to the satisfaction of many buyers. However the QL Microdrives



may prove more efficient than those made for the Spectrum: according to the provisional manual, QDS routinely stores as many files as possible in spare memory, reducing wear and tear on the tape and greatly increasing access time. And the 0.5M byte RAM pack provides a very substantial amount of spare memory! Another serious, albeit temporary problem, is the lack of a parallel printer interface.

The remaining criticism of the QL (so far) have about them a faint aroma of sour grapes. Complaints have been made about the use of the 68008: its data bus is only 8-bits wide rather than 16, so it will be only a quarter as fast as the 68000 because it has to perform four times as many fetches; and with a clock speed of only 7.5MHz the QL will be slower than some of the faster 8-bit computers. Well I wouldn't bet on it.

In fact both the 68000 and the 68008 fetch instruction in pairs of bytes (words), so there is not all that much difference between them, and Motorola data shows that on a 'quick sort' bench-mark test the 68008 clocks in only 10 milliseconds slower (30%) than the 68000 CPU running with a memory management unit. And at first appearances, the 68008 instruction set looks extremely powerful and compact (a point made several times by Motorola in comparing their 68000 family CPUs with other 16-bit processors), so machine code programs should run very quickly on the QL.

The remaining criticism to date concerns the choice — or rather the lack of choice — of colours in high resolution graphics mode. This criticism is relevant only to dedicated games-players, and even so its ultimate strength will depend on the effectiveness of the stipple feature in producing shades and tones.

Of course there will undoubtedly be other valid criticisms of the QL (it would be too much to expect any computer to be perfect) and these will show themselves when reveiw models become available. Then experience will tell whether or not the QL lives up to its specification. The QL will not win kudos for the missing cassette interface, but this is not an insoluble problem: where Sinclair leads, others tend to follow, and if fast performance is any guide the QL and its add-ons will be every bit as successful as earlier Sinclair computers.

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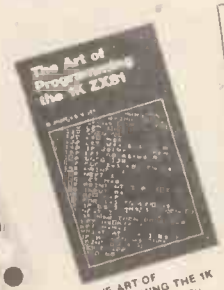

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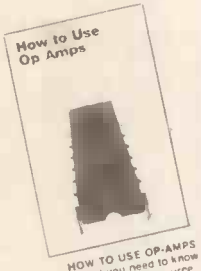

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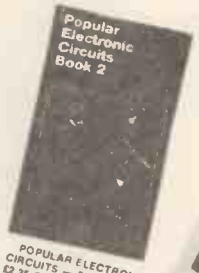

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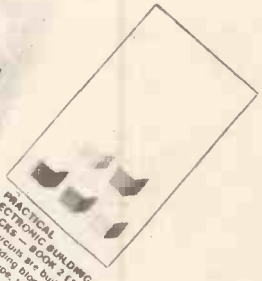

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FORWARD BIAS

Questions, answers and errata from readers and writers.

Fog Horn *(HE June '80)*

The PCB (**Figure 3**) was the wrong one: the correct one is shown here, right size.

The mercury switch mentioned in **Buylines** was a mistake (this was for the Eggtimer).

Guitar Phaser *(HE September '80)*

In **Figure 1**, there should not be a link where R9 to 'orange' crossed C10 to +9V (C10 is a decoupling capacitor across the supply). The resistor from the gate of Q1 should be R14; the capacitor from the link of R6 and R8 to OV is C9.

In **Figure 3**, Q1 and Q2 are shown with the drain and source reversed. The pin-out diagram beneath Figure 1 is correct.

In the **Parts List**, RV2 should be 470k antilog as in Figure 1.

Audio PSU *(HE February '84)*

Last month's **Audio Power Supply** module had a couple of misprints in it. Under the heading *A Choice Of Power* the four diodes are described as "N4000"; this should read **1N4000**. Further down the same section, a "50uF" and a "100uF" capacitor are mentioned: these should be **500** and **1000uFs** (as accurately described in the **Parts List**).

Further down the article, on page 23, an equation is given for the calculation of the output voltage resistor values. This should read: **10V8 x 120R/1V2 gives 1080R as the value for R2.**

Heading In The Wrong Direction — Veroboard Warning *(HE January '83*

A little mix-up at the type department resulted in all the Veroboards being incorrectly orientated in our Veroboard layouts in last months HE. The tracks should, of course, run *across* the page, not up and down. Building the projects as shown would result in everything shorting out to everything else, a fact which should normally become abundantly clear before completion of the project.

Short Circuit Authors

Please will contributors G. Foote and B. Adams get in touch with us.

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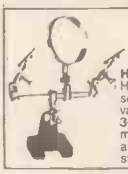

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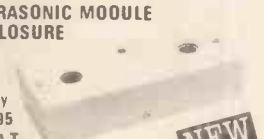

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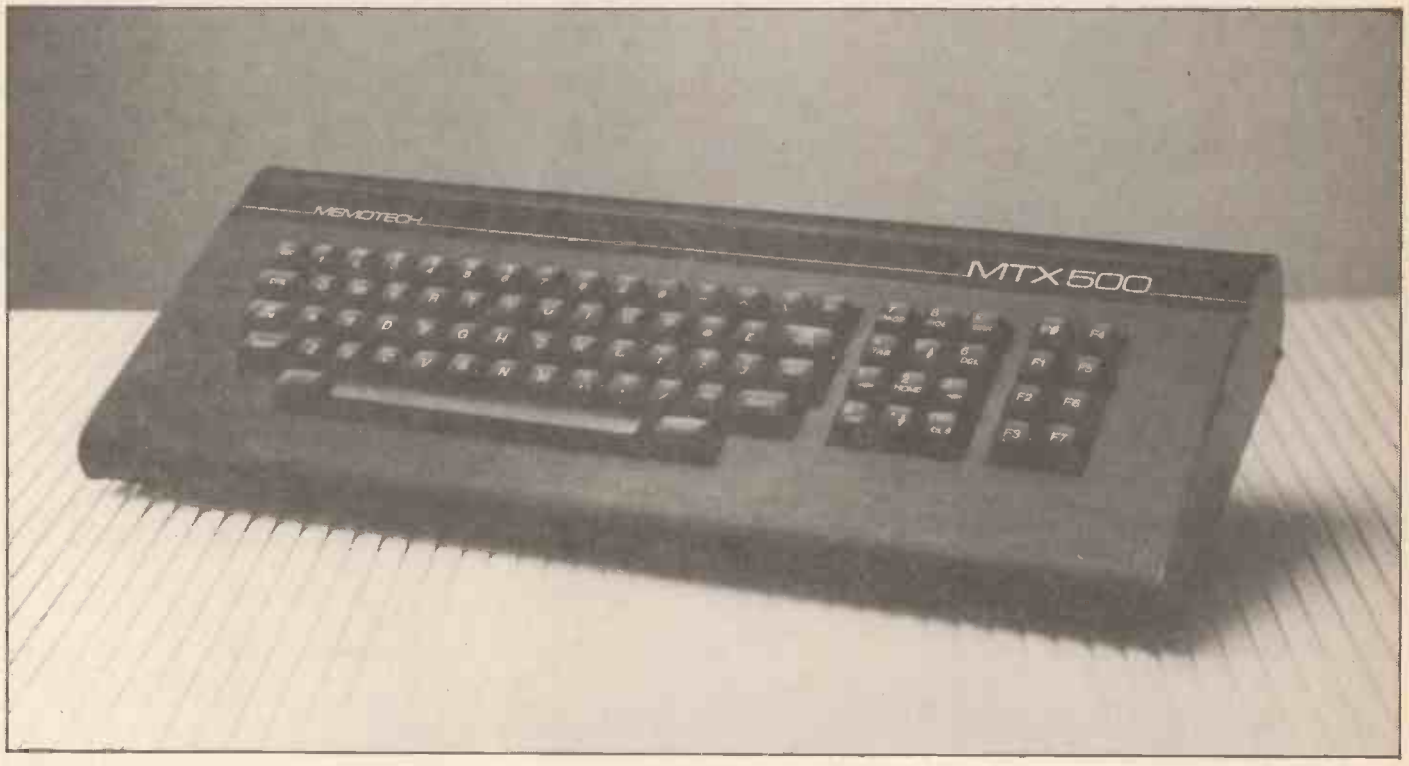
MEMOTECH 500/512



An impressive new computer from a company best known for ZX peripherals.

David Norman

Memotech has served a long apprenticeship in the field of microcomputers as a manufacturer of high quality ZX81 peripherals, and now they are set to take a slice of the home and business market with their MTX range of computers.

The MTX 500 is their basic machine which has an all-inclusive price of £275, which puts it squarely into the highly competitive area presently dominated by the BBC and Commodore machines. The specifications of the MTX look impressive and now that the machine is in the shops the real tests and comparisons will determine if Memotech have got it right.

If first impressions are important, then Memotech have scored highly — their product comes beautifully packed and presented. The micro itself is cased in black anodised aluminium and carries a total of 79 keys which have a crisp and positive feel to them. The power supply is a separate unit, equally stylish, and rated at 1A. All the usual cables and documentation are in the box but as you dig in deeper you will find no fewer than five cassettes. There is the introductory tape, a cassette-cleaning tape and a C15 blank tape from Memotech, and games tapes "Toado" and "Draughts" from Continental Software who have produced the first batch of games and utility software for the MTX range.

"Toado", which is a very good frog-crossing-dangerous-things type of game, was responsible for delaying this review for an hour or so, but the introductory tape, which I believe is only the first rush version, leaves a great many things to be desired and is way behind the standards set by the Spectrum's introductory tape by Horizon. However, having spent your £275 you are in no danger of having to spend any more cash on peripherals to compensate for shortcomings in the basic package and that is something you cannot say about some of the Memotech's competitors.

RAM Is RAM

The MTX 500 is a 32K machine, period, No matter what type of graphic mode you choose you have 32K of user RAM; the graphics screen has its own memory and you won't find your precious program space shrinking away to a few kilobytes. However, if 32K is insufficient for your purpose, you have the option of buying the MTX 512 which is identical to the 500 except that it is provided with a 64K of user RAM, or you may buy add-on memory boards for the 500 which fit inside the case. Lack of memory is certainly not going to be a problem for MTX users.

Plenty Of Ports

The MTX is a wide computer — about 19in — so there is plenty of room along the back for a multitude of connectors. They are generally high quality sockets, but deeply recessed and therefore difficult to get at, though this won't matter if the machine is going to stay in one place most of the time. The cassette sockets are the 3.5mm jack type which I think become slack and unreliable after some months of constant use, but they do seem to be popular with computer manufacturers these days. There is a phono socket so that the sound output from the computer can be sent to a hifi. In normal use the sound channels, of which there are four, will pass through the television and can therefore be easily adjusted to the volume of your choice.

Thankfully, the keyboard doesn't beep every time a key is pressed, though doubtless it could be made to do so if you wished. Monitor and printer outputs are present, as are two joystick ports which will accept the popular "Atari" type of joystick. All the important CPU signals are available on an edge connector, though this is normally blanked off in the interests of safety (the machine's safety by the way, not the user's!), and two RS232 interfaces are available as an optional extra. As if this wasn't enough, there is also an uncommitted 8-bit I/O port on the PBC itself, just sitting there as a 16 way IC socket and waiting for the home constructor to pop in a 16 pin header on some ribbon cable so that the micro can start running that proverbial power station.

Up And Running

Connecting the MTX to cassette and television is straightforward. The DIN power supply connector was a *very* tight fit it its socket, but fortunately once it is in there is no need to disconnect. Not only is there an illuminated switch on the power supply but there is also a reset button on the computer to bring you out from all crashes, infinite loops and other software nightmares. It is as well that there is a light on the power supply since the MTX runs silently, without hums or buzzes. "Toado" loaded easily and quickly from a cheap tape recorder, but loading a program which I had previously saved proved trickier and it took quite a few saves and loads to get the volume levels correct. The cassette baud rate is set at a fast 2400, but since it is under software control it may be changed.

The display on a Hitachi 12in colour TV was steady and the colours true, though the TV did need retuning after a warm-up period of about half-an-hour. There was no "dot-crawl" on either stationary or moving characters. The format of the screen in character mode is 40 x 24 and in general the text is clear and of pleasing proportions. However, I didn't much care for the lower case g so I used the GENPAT command to redefine it. Any character in the standard ASCII set (codes 32 to 127) can be redefined in this way, and you may also define 26 new characters (or graphics) for codes 128 to 154, *and* type most of them into the computer using the special function keys marked F1 to F8. In graphics mode there are 32 characters on a line, so there is more space between each character. You can use the keyboard to change the character set to Spanish or German, in which case the specialised European symbols occur in place of the English keyboard's square-brackets and so on.

All the video work is done by one chip, the Texas 9929. This is a standard video Display Processing (VDP) chip capable of producing four display modes, 16 colours and up to 32 sprites, about which more will be said later. It is also responsible for producing oval circles on British televisions, which is a problem first encountered by ORIC. Oric solved the problem eventually, and I have no doubt that Memotech will do so as well, but I daresay they will have to suffer a lot of flak from other computer manufacturers until they get it right. One other possible source of complaint is that the leading character position in each line may be lost in the television

Table 1

ABS	ASC	ATN	LN	CHR$	CLEAR
CLS	CONT	COS	DATA	DIM	EDIT
EXP	AND	GOSUB	GOTO	INKEY$	IF-THEN-ELSE
INPUT	INT	LEFT$	LEN	LET	LIST
LLIST	LOAD	LOG	MID$	NEW	FOR-STEP-NEXT
OUT	PAUSE	PEEK	POKE	PRINT	ON/GOSUB
RAND	READ	REM	RESTORE	RETURN	ON/GOTO
RIGHT$	RND	RUN	SAVE	SGN	SIN
SQR	STOP	STR$	PI	TAN	USR
VAL	VERIFY	OR	NOT	MOD	LPRINT

Table 1. Standard BASIC commands and functions.

TABLE 2

BAUD	CLOCK	INK	PAPER	PAUSE	NODDY
PLOD	CSR	PANEL	SOUND	ASSEM	ATTR
COLOUR	EDITOR	DSI	SDBUF	TIME$	GR$
SPK$	ROM	CRVS	VS		

Table 2. The extended BASIC group.

margin. This is not noticeable at first, since the software places print statements a couple of spaces on from the beginning of a line. I put the MTX UHF output onto an old Ferguson 12in black and white TV and obtained perfect alignment of the screen, with both the start characters and the end characters of each line clearly visible. The general advice must be to try always to buy a TV or monitor with a horizontal hold, accompanied by a plea to the manufacturers to start putting these controls back onto their television sets!

High Command

The MTX has 24K of ROM, so there is plenty of space for some powerful and sophisticated commands. The manual supplied with the review machine is a provisional version: it runs to 250 pages of A4 paper and contains a wealth of technical information, but even so it is evident that a more comprehensive manual or book will be necessary to enable the user to get the best out of this computer. The ROM contains the BASIC, an interactive language called NODDY and a Assembler/Disassembler with powerful debugging facilities. The MTX BASIC has extra commands to enable the user to handle colour, sound, graphics and sprites without recourse to PEEKs and POKEs (Commodore please note!) and it should please most people. The basic BASIC seems to have most of the standard commands (see **Table 1**) You may be disappointed to see that PROCEDURES and DO . . . UNTIL constructions are missing, but on the other hand you should be pleased to find that syntax is checked at the time of entry, and that keywords may be entered in a shortened form.

The MTX doesn't like the user to miss out spaces, and requires LET to be used when assigning variables. Listings will therefore look neat and be readable and in any event with so much memory there should be no need to compact the program. To make up for the extra keyboard-bashing, Memotech have provided an AUTO facility whereby your listing has the line numbers entered for you in increments of your choice. In my option this is far more useful than RENUMBER which the MTX doesn't offer, perhaps on the grounds that if you're a using a Memotech computer your listings aren't going to get into the messes that RENUMBER sorts out. It is when you are entering and editing BASIC that the MTX auxilliary keypad comes into use. Insertions and deletions can be undertaken with the minimum amount of fuss and bother. It always

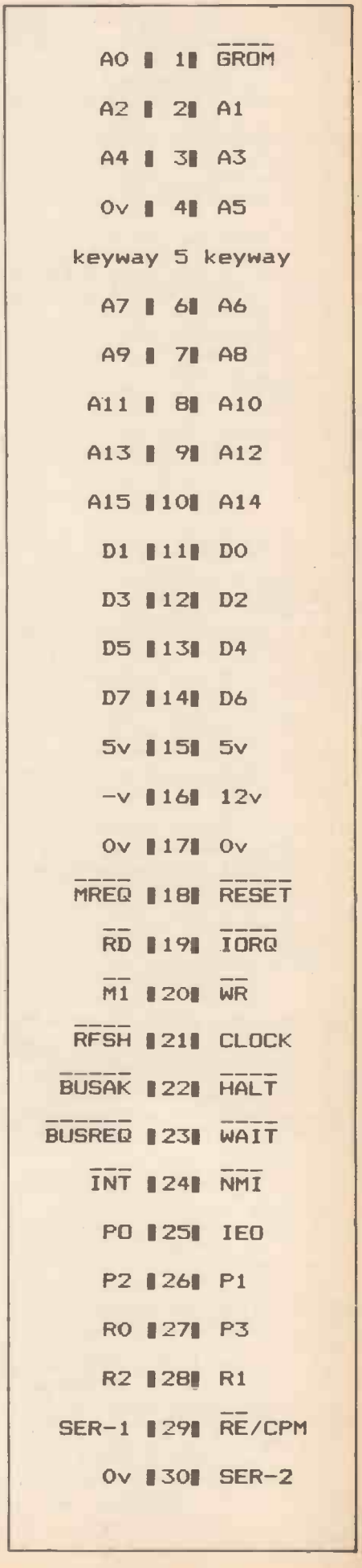


Figure 1. The MTX expansion bus.

takes some time to get used to a new keyboard, and different users have their own personal preferences. Most touch typists, I am told, would prefer the RETURN key to be larger, but its size doesn't bother me. CLS (clear screen) is more of a problem — like the other editing keys it is available as an unshifted key, yet to press it by accident would wipe as many as 960 characters from the screen, and that could be very annoying . . .

Looking now at the extra BASIC commands, shown in **Table 2** the power of the MTX should begin to become apparent. NODDY, ASSEM and ROM calls up the NODDY language, the assembler and extra ROMs respectively.

The ROM could contain another language such as FORTH and Memotech clearly have the expansion prospects for this machine well planned out: the ROM cartridges are designed to plug into the CPU bus at the side of the machine.

Assemble, Please

The assembler is called from BASIC, and it assembles the code in situ, as part of the BASIC listing. The assembler itself is fairly basic, but it is easy to use and to edit. Numbers may be entered in either hex or decimal, and addresses are printed out in hex. Address labels are obviously accepted, but lables equated to numeric values are not supported. Define Space and Define Byte (incorporating Define String) can be used, but Define Word is absent. The BBC computer has a assembler incorporated in its BASIC which enables easy machine-code programming of the 6502 processor and Memotech have thus created a similar facility which will help programmers get to grips with the Z80 processor.

NODDY is a new language designed to simplify text handling. It has only 11 commands, but can be incorporated into BASIC in such a way that the two languages work together. Coupled with the MTX editing keys it should take the drudgery out of creating programs with a large textual content. Applications are obviously going to suggest themselves in areas of the school curriculum, in the fast-training of personnel in commerce, and in adventure-game writing. Time will tell how useful NODDY will be, and Memotech are to be congratulated for incorporating it into their computer — it's an experiment on their part and a challenge for the software writers to make something of it.

PANEL calls up the front panel display and puts the user directly in control of the MTX monitor at machine code level. There will be many people who have seen a front panel display on the 380Z computer in secondary schools or colleges, and the MTX panel is very similar. Basically it is a window looking in at the registers and memory locations of the computer and it is an invaluable aid to all users interested in writing and debugging program and control of I/O devices at machine code level. To have it already in the machine, and not to have

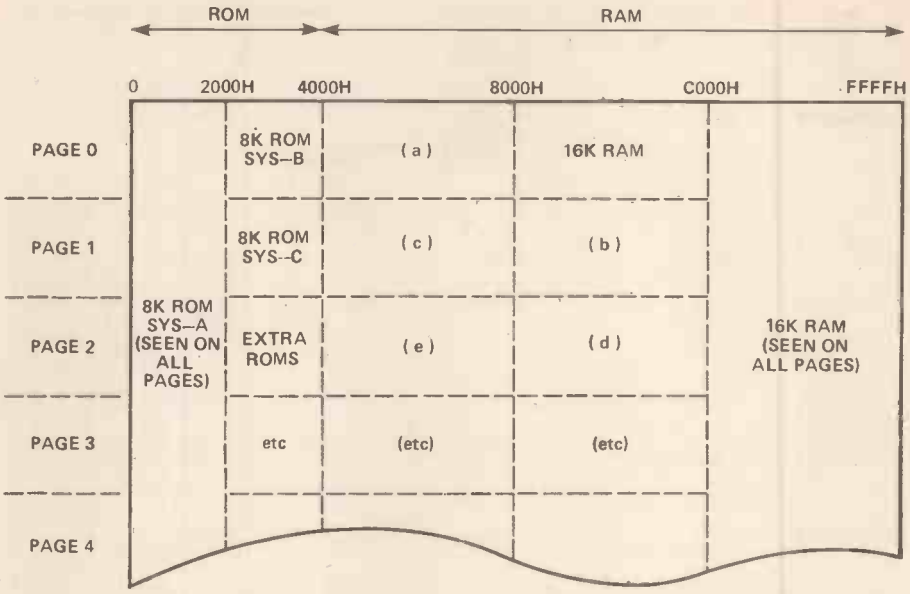


Figure 2. The MTX features a paged memory system, allowing extra ROM and RAM to be added. The diagram shows the basic MTX 500 configuration; RAM is added in the order (a), (b), (c), and so on.

Table 3

CIRCLE	DRAW	PLOT	ARC	LINE	ANGLE	VIEW
PHI	SPRITE	MVSPR	ADJSPR	CTLSPR	GENPAT	

Table 3. The graphic and sprite group; powerful instructions for multi-level, highly mobile screen displays.

Table 4

PAGE : Toggles scrolling of screen data.

EDL : Deletes from cursor to end of line.

BRK : Break out from program.

TAB : Advance cursor 8 spaces.

DEL : Delete character at cursor and close up the line.

HOME : Put cursor to top left of Virtual Screen.

INS : Insert text, expanding line to suit.

CLS : Clear screen.

ENT : Enter (Return).

CURSOR LEFT : CURSOR RIGHT : CURSOR UP : CURSOR DOWN.

In addition certain controls keys and certain sequences of key presses give other useful functions:

CTL W	tabs in a backwards direction.
CTL	turns the cursor off.
CTL D,n	sets the background colour to n.
ESC,B,2	sets the English character font.
ESC,K	duplicates a line.

Table 4. The MTX provides a number of control and command instructions particularly useful for editing.

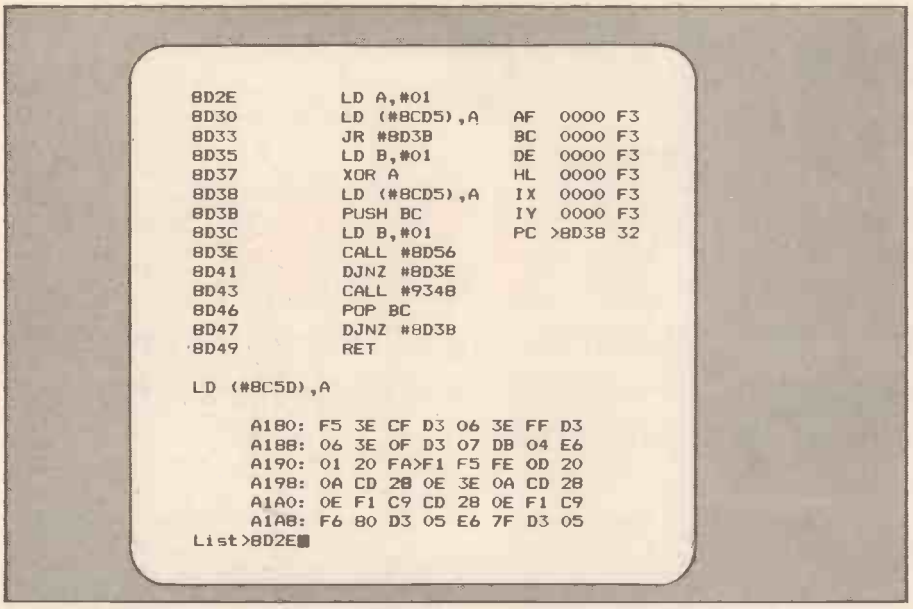


Figure 3. The MTX "front panel" will be very helpful when de-bugging machine code programs.

to wait until a software house produces a debug/monitor at a price of between £10 and £20, must be a bonus for which Memotech should get considerable credit.

Other interesting commands in this group are the COLOUR, PAPER, INK and ATTRibutes which set up the various colour and printing options: the CLOCK and TIMES which handle a real-time clock in hours, minutes and seconds format, and the SOUND command that passes either 3 or 7 parameters to the Texas 76489 sound chip. This, incidentally, is the same chip that is used in the BBC computer so we can, I hope, look forward to hearing the same richness of tones that that computer is capable of producing.

Virtual Screens

The MTX has an inbuilt method to allow you to create smaller screens within your TV screen. These are called virtual screens, and up to eight are allowed. All print commands are relative to the screen you are using. For example, while you are in BASIC, four virtual screens have already been defined for you, and you are in fact using them. Message errors come up on VS 7, a screen one row deep at the bottom of the TV. BASIC lines which you are entering or editing are constructed as on continuous line in VS 0 which is four rows deep. The program is listed on VS 1 which is the rest of the TV at nineteen rows deep. When you RUN a BASIC program, you default to VS 5, which at 24 rows deep is the entire TV screen. This takes some getting used to when you first encounter the MTX, but it is undoubtedly a useful function to be able to isolate and work on just part of the TV screen. RML's 480Z has such a function but that is a computer which costs considerably more than the MTX 500.

Sprites And Things

The graphics screen has a resolution of 256 x 192 pixels and the graphic commands are listed in **Table 3**. PLOT, LINE and CIRCLE are fairly standard point and line drawing commands, but there is also ANGLE, PHI, DRAW and ARC and these are used together to determine the direction of lines and patterns drawn in the style of LOGO's TURTLE graphics. The provisional manual gives short examples of how to handle these advanced graphics, and it is to be hoped that further instructions will be provided in the final version of the manual.

And so now to the Sprites: "Up to 32 independently controllable user definable sprites, plus pattern plane and backdrop plane" to quote the specifications, but what exactly does this mean? Think of the TV screen as a drawing board with a small piece of paper on it. The paper represents the physical size of the video screen, 256 x 192 pixels and can be a colour of your choice. This is the "backdrop-plane". Onto that paper, that screen, goes the text and/or graphics shapes in any ink colour you choose. This is the "pattern-plane". Consider the paper and the ink as a landscape. Now imagine a large piece of cellophane, 8192 x 8192 pixels in size, on which you have placed a small object called a sprite. The cellophane is your "sprite-plane". You can see the landscape beneath the cellophane, except where the sprite obscures it. Furthermore, you can move the sprite across the cellophane (with sprite) relative to the landscape. Finally, imagine that you could have up to thirty-two separate sheets of cellophane all piled on top of the landscape, and each with a moving sprite on it. *That's* how sprites help to achieve animation effects, and the commands such as MVSPR (move sprite) and CTLSPR (control sprite) help to set up the operating conditions. Once set, the sprites move around independently of the BASIC program, until such time as their parameters are altered. Collisions between sprites are detected, and can be checked upon by a PEEK to a register in the VDP chip.

Conclusion

The MTX 500 is well designed and carefully constructed, and has hardware and software features that make the £275 asking price eminently reasonable. It seems to be suitable for both the home market and the educational market, and to novices and experts alike. If Memotech can correct just a few minor problems, and get their promised CP/M and other extensions along on schedule, they will have an excellent all-purpose machine, and 1984 could be a very good year for them. **HE**

Lightning Chess Timer

Designed for use in chess tournaments, HE's Chess Timer can be set anywhere between 1.5 and 96 seconds for any timed-move game.

Mike Vince

AS the only electronics engineer in Leighton Buzzard Chess Club it was natural that I should be asked to make a 'buzzer' for a Lightning Chess Tournament — and thus save £30 to £40 of club funds! But since I had never played in a lightning chess tournament, I first had to try to inviegle a detailed definition of the required operation of a chess buzzer. A brief description of how chess is played in a lightning tournament may help those who are as unsure as I was.

A player has to make his move on the 'buzz', leaving the interval to the next 'buzz' as his opponent's thinking time. If a player makes his move late he would be reducing his opponent's thinking time unfairly, and if a player moves prematurely he would be giving his opponent an unnecessary advantage. This enforced rhythm of play is quite unlike anything one meets in normal chess.

A period of about ten seconds between buzzes was requested, but as this seemed rather approximate and and arbitrary I decided to provide a wide control range so that it could be adjusted on the night.

Another requirement was that the unit should be small and battery powered, with the battery having a minimum of a ten hour life but preferably much longer.

Overview

For a battery powered unit, low current consumption becomes the prime design consideration. A good choice of an audible output device, with low current consumption and a high output sound level, is one of the many piezoelectric transducers currently available. Whilst glancing through the Maplin catalogue recently I saw a transducer that can be driven by a 3-10kHz square wave and since this sells for about 30p, it seemed ideal.

The block diagram of the basic functions required are shown in **Figure 1**. An oscillator with a variable period covering the 1.5-12 second range is possible; however, it seemed easier to me to design a circuit using a higher frequency oscillator with its output being divided down to give the required period. The 4060 is a combined CMOS oscillator-and-divider IC available at a reasonable price, and this was the obvious choice for the application. The monostable is used to give a short output pulse whose length is independent of the input frequency.

Circuit Description

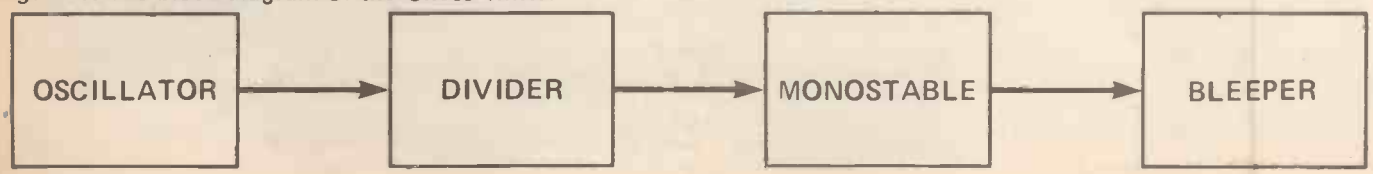
The full circuit diagram is shown in **Figure 2**, and for clarity the oscillator section has been redrawn in **Figure 3** showing some of the internal gates of the 4060.

As can be seen, the oscillator is a standard circuit often used in HE projects, and the values of C2, R1, R2 and RV1 have been chosen to give an output frequency in the range 40-320Hz. The rest of the 4060 is a 14-stage binary counter with the ouputs from every stage being available — except for stages 1, 2, 3 and 11.

Since so many outputs are available I chose to provide two speed ranges by utilising the Q9 and Q12 outputs. For the fast range this gives intervals between 'buzzes' of approximately 1.5 — 12 seconds, and for the slow range of approximately 12 — 96 seconds.

Choosing to use different outputs of

Figure 1. The block diagram of the Chess Timer.



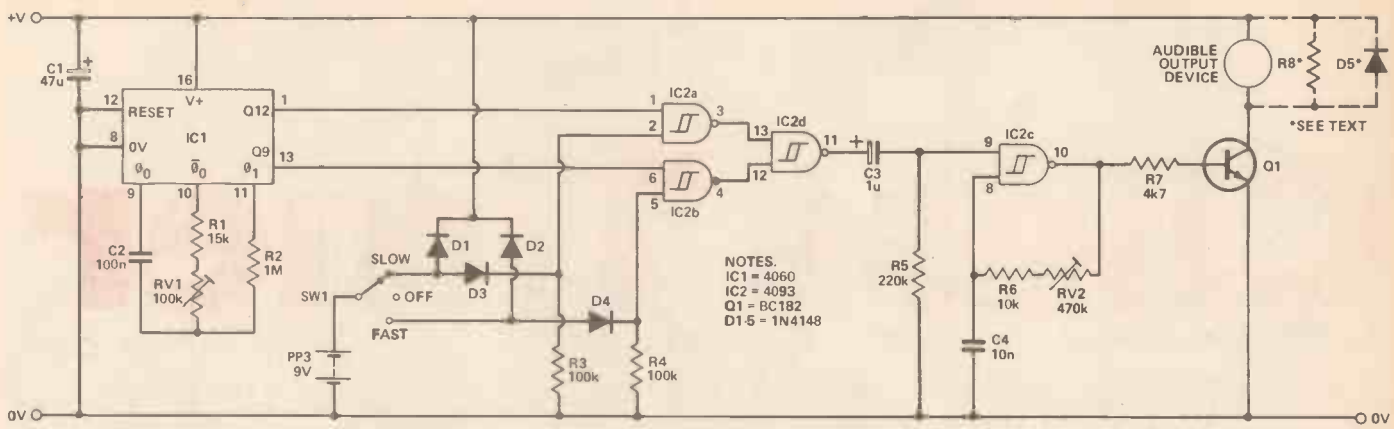


Figure 2. The circuit. R8 and D5 are optional components which may be required according to the exact method used to give the audible tone.

the 4060 one can of course have other ranges if one wished, Q10 giving half the speed between Q9 and Q12 is achieved by IC2a and IC2b.

Diodes D1, D2, D3 and D4 are included so that a single pole centre-off switch can act as both speed-range select and on/off. When the switch is in the slow position power supply current flows through D1 and pin 2 of IC2a is taken to a high logic level via D3.

The truth table for a NAND gate is given in **Table 1**, and from this it can be seen that if one input of a NAND gate is held high (lines 3 and 4), then the output level is the inverse of the second input. Similarly if the first input is held low (lines 1 and 2), the output is high irrespective of the level on the second input.

Thus IC2a output, pin 3, has the inverse of the waveform from Q12, whilst IC2b output, pin 4, will be high since pin 5 is held low by R4. IC2d then re-inverts the signal and thus its output, pin 11, has the same waveform as Q12.

A similar process applies with the switch in the fast position; in this case IC2d output has the same waveform as Q9.

Next, C3, R7 and IC2c form a monostable circuit, which is triggered on the rising edge, rather than the falling edge, of the divider output square wave.

IC2c, C4, R8 and RV2 form a gated oscillator and when pin 9 is at a logic high level, a short audio tone will appear at pin 10 (**Figure 4**). RV2 is

Table 1

	A	B	$\overline{A.B}$
1	0	0	1
2	0	1	1
3	1	0	1
4	1	1	0

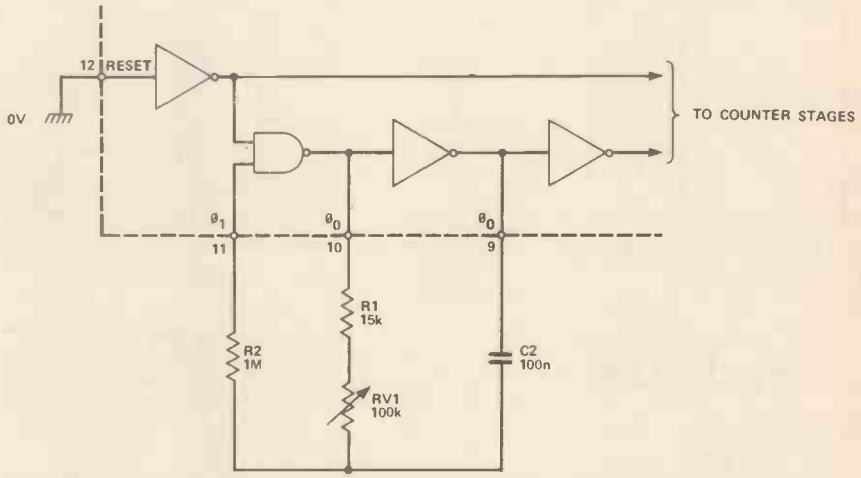


Figure 3. The choice of timer intervals is determined by the outputs of IC1. This is a close-up of some of IC1's internal gates.

required to adjust the frequency of this audio tone, since this type of circuit is very sensitive to component tolerances.

If the output of the unit is to be taken to an external amplifier the output may be taken directly from IC2c pint 10. However, the signal level will be about 8V peak-to-peak, and one should check whether an attenuator is necessary to reduce the signal level.

If a piezoelectric transducer is used it may be necessary to fit R8, and this will have to be chosen by experiment to match the chosen transducer. The other possibility is to use a small loud speaker, and under these circumstances R8 will become diode D5, and will need to be fitted as shown (dotted in **Figure 2**).

Construction

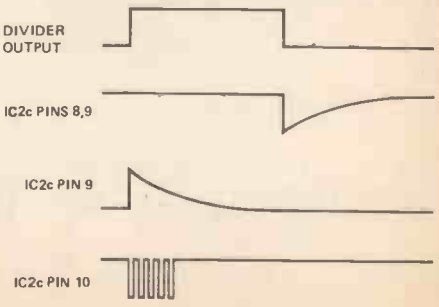
The circuit may be built on Veroboard, but I recommend using the PCB as this will produce a neater unit. The PCB overlay, **Figure 5**, shows the position and orientation of all components, and the ususal care should be exercised over the orientation of all diodes, C1, C3, Q1 and both ICs. Since semiconductors are the most likely components to be damaged by overheating they should be left to last.

(Normal precauctions should be taken when handling the CMOS ICs so as to prevent the possibility of damage due to static; it should be noted that static more often reduces the reliability of CMOS and that complete failure is a rarer problem).

For neatness, Veropins should be used for connecting the wires to the PCB.

The unit can be assembled into any box measuring 4¾" x 2½" x 1½" or larger. Before connecting the battery

Figure 4. Output signals from ICs, including the audio tone.



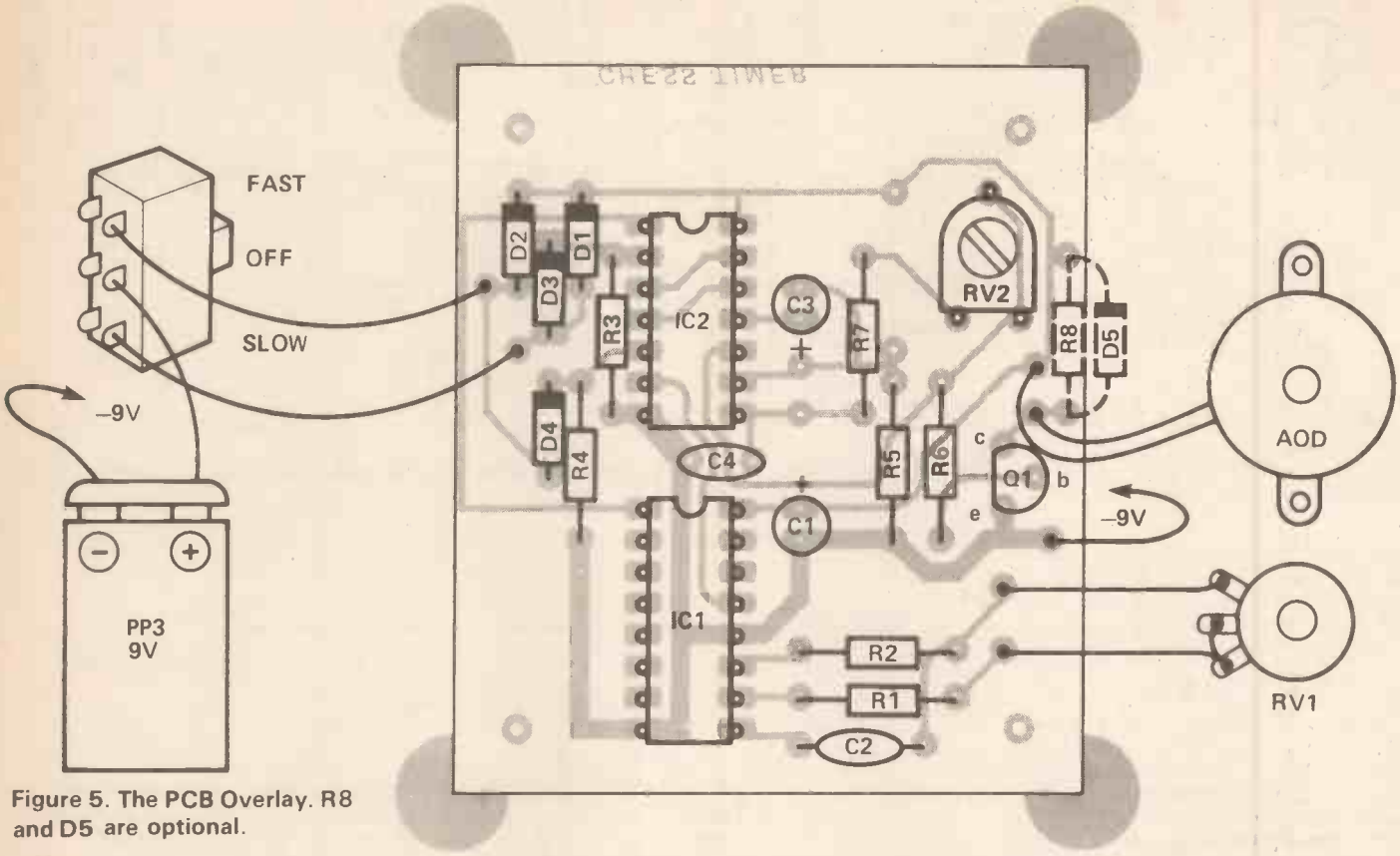


Figure 5. The PCB Overlay. R8 and D5 are optional.

Parts List

RESISTORS
(All ¼ 5% carbon)
R1 ..... 15k
R2 ..... 1MO
R3, 4 ..... 100k
R5 ..... 220k
R6 ..... 10k
R7 ..... 4k7
R8 ..... (see text)

POTENTIOMETERS
RV1 ..... 100k linear
RV2 ..... 470k horiz preset

CAPACITORS
C1 ..... 47u 10v radial electro
C2 ..... 100n polyester
C3 ..... 1u 10V radial electro
C4 ..... 10n polyester

SEMICONDUCTORS
IC1 4060
IC2 4093
Q1 ..... BC182
D1-5 ..... 1N4148

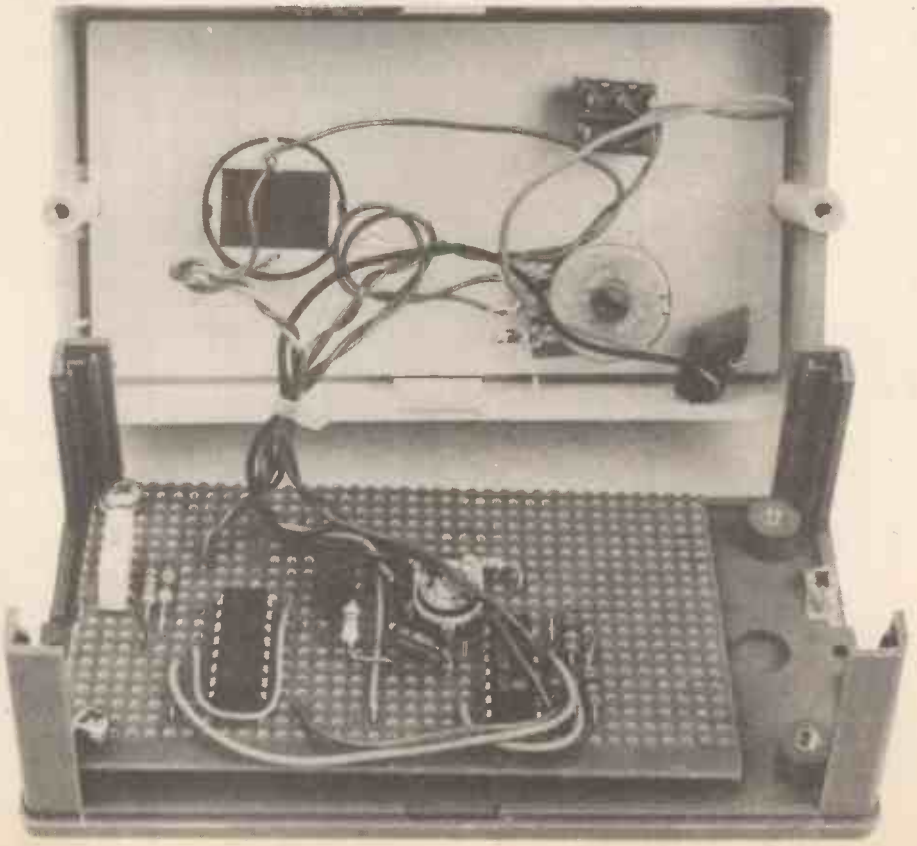
MISCELLANEOUS
SW1 ..... DPDT centre-off
PCB or Veroboard; case, 4¾ x 2½ x 1½ in; piezo buzzer (Maplin QY13P); Veropins, wire, solder etc.

BUYLINES ..... page 26

and turning on, check again for solder bridges or for components the wrong way round, and do check that the battery connections are correct. If you don't, you may need to buy some new components!

On the prototype the tranducer was fixed to the front panel with double sided adhesive tape, but before doing so make sure suitable holes have been drilled in the box to act as a sound outlet.

When ready to test, set the speed range switch to fast and the speed control to approximately half way. If properly built, the unit will now buzz about every six seconds. Check that both speed ranges work and that the control varies the speed. Now set up the chess board — and good luck!



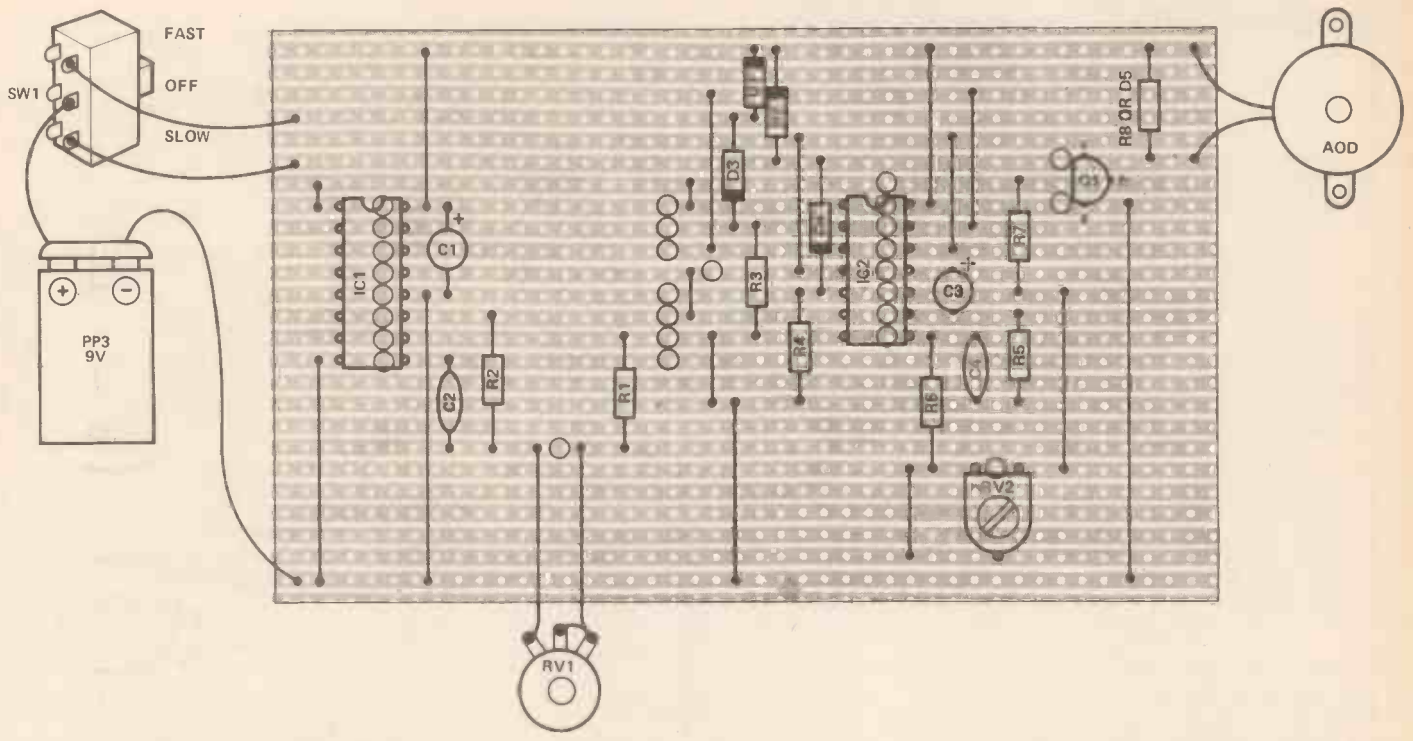
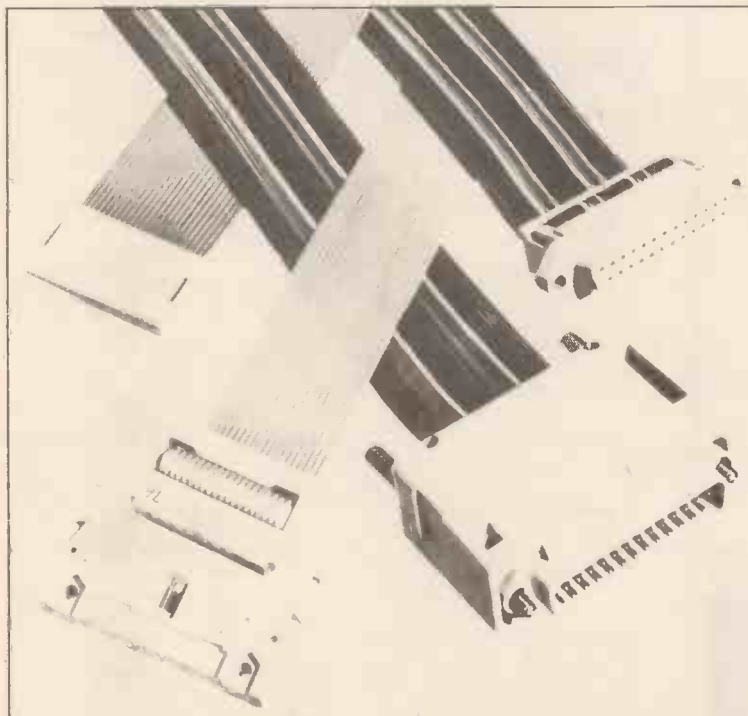


Figure 6. This Veroboard layout is untested and has been laid out without regard to size, to assist experimenters doing their own layouts. It is not the same as the Vero layout used in the original model (see picture, bottom left), which was constructed for a maximum saving on space. Also, the switch wiring in the unmodified model is different from the arrangement used in the project, so don't attempt to copy it. The Verolayout in the photo may offer some clues to anyone doing his own Veroboard.



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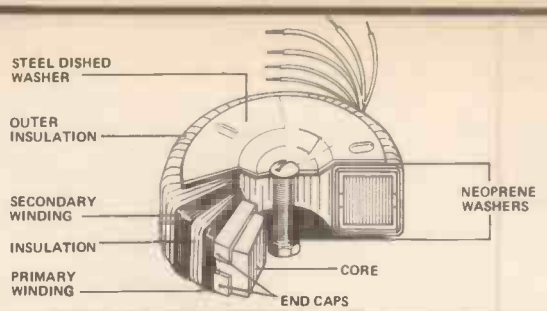

15 VA — 62 x 34mm — 0.35Kg — Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1.25
0x011	9+9	0.83
0x012	12+12	0.63
0x013	15+15	0.50
0x014	18+18	0.42
0x015	22+22	0.34
0x016	25+25	0.30
0x017	30+30	0.25

(encased in ABS plastic)

30 VA — 70 x 30mm — 0.45Kg — Regulation 18%

1x010	6+6	2.50
1x011	9+9	1.66
1x012	12+12	1.25
1x013	15+15	1.00
1x014	18+18	0.83
1x015	22+22	0.68
1x016	25+25	0.60
1x017	30+30	0.50

50 VA — 80 x 35mm — 0.9Kg — Regulation 13%

2x010	6+6	4.16
2x011	9+9	2.77
2x012	12+12	2.08
2x013	15+15	1.66
2x014	18+18	1.38
2x015	22+22	1.13
2x016	25+25	1.00
2x017	30+30	0.83
2x028	110	0.45
2x029	220	0.22
2x030	240	0.20

80 VA — 90 x 30mm — 1Kg — Regulation 12%

3x010	6+6	6.64
3x011	9+9	4.44
3x012	12+12	3.33
3x013	15+15	2.66
3x014	18+18	2.22
3x015	22+22	1.81
3x016	25+25	1.60
3x017	30+30	1.33
3x028	110	0.72
3x029	220	0.36
3x030	240	0.33

120 VA — 90 x 40mm — 1.2Kg — Regulation 11%

4x010	6+6	10.00
4x011	9+9	6.66
4x012	12+12	5.00
4x013	15+15	4.00
4x014	18+18	3.33
4x015	22+22	2.72
4x016	25+25	2.40
4x017	30+30	2.00
4x018	35+35	1.71
4x028	110	1.09
4x029	220	0.54
4x030	240	0.50

160 VA — 110 x 40mm — 1.8Kg — Regulation 8%

5x011	9+9	8.89
5x012	12+12	6.66
5x013	15+15	5.33
5x014	18+18	4.44
5x015	22+22	3.63
5x016	25+25	3.20
5x017	30+30	2.66
5x018	35+35	2.28
5x026	40+40	2.00
5x028	110	1.45
5x029	220	0.72
5x030	240	0.66

225 VA — 110 x 45mm — 2.2Kg — Regulation 7%

6x012	12+12	9.38
6x013	15+15	7.50
6x014	18+18	6.25
6x015	22+22	5.11
6x016	25+25	4.50
6x017	30+30	3.75
6x018	35+35	3.21
6x026	40+40	2.81
6x025	45+45	2.50
6x033	50+50	2.25
6x028	110	2.04
6x029	220	1.02
6x030	240	0.93

300 VA — 110 x 50mm — 2.6Kg — Regulation 6%

7x013	15+15	10.00
7x014	18+18	8.33
7x015	22+22	6.82
7x016	25+25	6.00
7x017	30+30	5.00
7x018	35+35	4.28
7x026	40+40	3.75
7x025	45+45	3.33
7x033	50+50	3.00
7x028	110	2.72
7x029	220	1.36
7x030	240	1.25

500 VA — 140 x 60mm — 4Kg — Regulation 4%

8x016	25+25	10.00
8x017	30+30	8.33
8x018	35+35	7.14
8x026	40+40	6.25
8x025	45+45	5.55
8x033	50+50	5.00
8x042	55+55	4.54
8x028	110	4.54
8x029	220	2.27
8x030	240	2.08

625 VA — 140 x 75mm — 5Kg — Regulation 4%

9x017	30+30	10.41
9x018	35+35	8.92
9x026	40+40	7.81
9x025	45+45	6.94
9x033	50+50	6.25
9x042	55+55	5.68
9x028	110	5.68
9x029	220	2.84
9x030	240	2.60

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120	4	11.73	625	9	31.63

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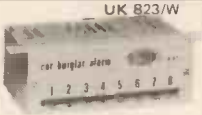

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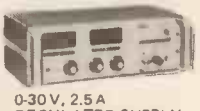

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Getting The Hobbit Habit

Helen Armstrong

A twelvemonth hath passed, and at least some devoted fans of J. R. R. Tolkien are still stuck in the Goblin's Dungeon. How do you rate their chances?

Just over a year and a day ago there appeared in the land a long-awaited adventure game for the Spectrum microcomputer. It was (an awe fell upon me, as the sages would say) based on Prof. J. R. R. Tolkien's fantasy classic *The Hobbit*. Not only "based on" was it, but sanctioned by the official keepers and guardians of *The Hobbit* since the Professor's death ten years ago. The arrival of the new game was hailed as a major advance in the art of computer adventure games, and being an old and proud member of The Tolkien Society, I decided to find out what the fuss was about. With *The Hobbit* now (or imminantly) available for the BBC Micro, Oric and Commodore 64, this seems like a good time to report back. Also, we hear rumours that *The Hobbit's* computer creators, Melbourne House, are starting work on the story's giant sequel, *The Lord Of The Rings* — in multiple parts.

Reactions to *The Hobbit* among my acquaintances depended on their previous experience with computer adventure games. Those who (like me) were used to shooting alien invaders and thinking afterwards were astonished by the sheer patience and caiculation needed to make any progress, while underestimating the ingenuity of the program we were communicating with.

Riddles In The Computer

For the uninitiated, an adventure game involves picking your way through a strange landscape in search of treasure, while solving a series of riddles or clues in order to survive. The locations in the landscape are described in text. The player is given a choice of possible routes (usually north, south, east, west, up and down) and, apart from selecting a route, can also give simple commands to the computer to manipulate objects described. For instance, encountering a door, the player could tell the computer to OPEN DOOR. If this doesn't work, which it usually doesn't (that would be too easy) options like UNLOCK DOOR, or FIND KEY or STRIKE DOOR can be tried. These, normally, are also too easy. The solution might be something like going S (south), to a location where you meet a barbarian warrior, finding a way to KILL WARRIOR who will be carrying a key; you then TAKE KEY, return N and UNLOCK DOOR. This is a simple sequence. You might have to find a sword, first, to kill the warrior and defend yourself from whatever lurks beyond the door. And so on.

The player can also ask the computer for HELP, in which case a cryptic clue might appear. Or might not.It makes the game easier. But not much.

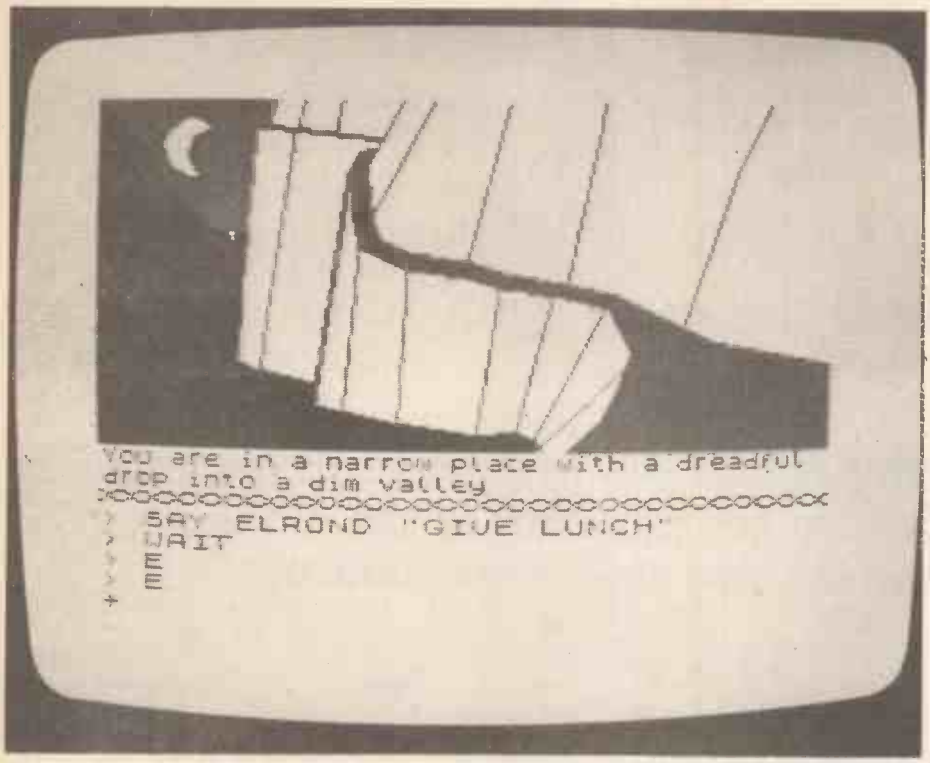
Adventure games require patience.

When *The Hobbit* came out, it was said to be revolutionary, for three reasons: firstly, thirty of the eighty or so locations are displayed in colour-graphic form; secondly, the commands accepted by the games are much closer to real English than usual. Strings of commands can be accepted as long as they are grammatical, and characters in the game can be asked to act for the players. Lastly, the characters in the game act independently of the player, moving around by themselves and appearing in unexpected places.

Vive La Difference

As a non-initiate into this kind of game, I didn't appreciate what a difference these things make until I had investigated one or two other adventure programs. Whether the difference is a pro or a con depends on your preference. If you don't like unpredictable adventures, don't play *The Hobbit*.

Melbourne House are very proud of the vivid colour graphics used, for which the 48K Spectrum is well suited. These cover the top two thirds of the screen, and were programmed to use much less than two-thirds of a full screen's worth of memory. They appear sketched quickly in line and then filling line by line with colour — a process which, although it does slow the game down, never *quite* loses its charm, even when



It is apparently advisable to be armed with lunch before facing the perils of the misty mountains. But make sure you eat some, as well.

you have been returned to the Goblin's Dungeon for the fourteenth time in succession.

The language which Melbourne House have developed for the game they call "Inglish" — it looks like English, but isn't, quite, English. One of the ongoing riddles in the game is to find out which words in English are acceptable in Inglish (and when). An unfamiliar word is greeted with the response I DO NOT UNDERSTAND SMITE (for instance). The instruction booklet gives a reasonable guide, but I found that some words listed were not

The Title Graphics, based on the game's cover picture (opposite page).

recognized in some situations.

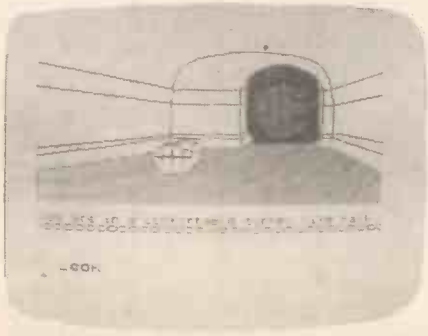
Others are acceptable in unlikely situations: Chris, a fellow Member of The Society, requested his computer, in a moment of frustration, to KILL LUNCH. His next inventory revealed SOME BROKEN LUNCH — at least it wasn't A DEAD LUNCH, but that would have been no surprise.

The most remarkable feature of the commands is that you can request other characters in the program to act on your behalf with the command SAY TO (x) "(command)". This process is a vital part of the game. You are, as the manual tells you, only a small Hobbit, and need the aid of a taller, stronger and more powerful character to accomplish your ends. In keeping with the game, the response of other characters is variable. Thus the request SAY TO THORIN "KILL THE GOBLIN" may lead to Thorin attacking the Goblin and killing it, attacking it and being captured, saying "No" and being captured or killed, or merely disregarding you (YOU SPEAK TO THORIN comments the computer), and being captured or killed. Sometimes it is better to ignore the goblins . . .

Try, Try, Try Again

The third feature is the most fascinating/irritating. As with the Inglish, we found we were trying moves just to see what would happen. Many of the characters have the ability to move and pop up randomly around the program. Thus, you may arrive in Rivendell to find

The Hobbit's hallway: probably the most familiar scenario to inexperienced players!



that Elrond has just been killed by a Warg, or meet Gollum unexpectedly at the bottom of the Deep Valley. My spies report that Gandalf has been known to kill Thorin, take Sting and refuse to return it, remove other vital objects and disappear into the program, never to return, or reappear after having earlier been killed. In one reported instance, he picked up the Green Door from Bag End and carried it throughout the game. (SAY TO GANDALF "HIT GOBLIN WITH GREEN DOOR"???). The more bizzare the incident, the less likely it is to occur, but they happen often enough to add interest to/foul up your progress, depending what your attitude is.

Melbourne House includes a note in the instruction manual: "Due to the immense size and complexity of this game it is impossible to guarantee that it will even be completely error free . . . If however any problems are found we would like to know about them so that future versions may be corrected." This

The Troll's Clearing appears in red and white for night-time, and blue and white black for daylight.

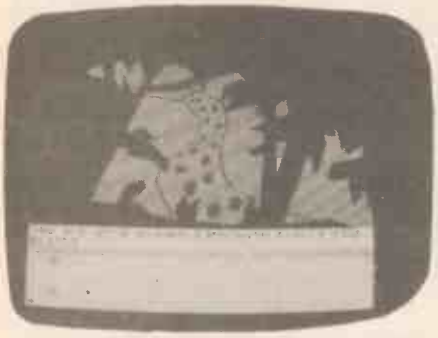
disclaimer is a bit like the labels in Indian cottons which say that "Variations in the weave and colour are part of the natural beauty of this garment" and musicians who say that bum notes are all part of the spontenaity. As I like Indian cotton and spontenaity (within reason) I normally enjoy the quirks of the program. However, after encountering the DARK in broad daylight as I struggled with another recalcitrant clue, I began to wonder whether I could stand that much natural beauty. As I said, adventures require heroic qualities, like not hurling your Spectrum at the telly.

Wait Or Pause?

Leaving this aside, for those who do not have the facilities to SAVE the game at problems points, it is possible to build up a reliable map and use it to work forward to the stick-point. Once there, put it on PAUSE, quickly; the game goes on playing itself otherwise, and the longer you wait, the more likely something unpleasant is to appear or happen. On the other hand, in some places, waiting is a necessary part of the game process.

The manual gives a number of hints on how to conduct the game. You are told to protect Thorin, as progress is

The sudden appearance of the Troll's footprints on the Troll's Path is the nearest thing to animation in The Hobbit's graphics.



impossible without him (and he will fight enemies who are bigger than you, a mere Hobbit). Choosing the right adverb (QUICKLY or CAREFULLY) with your instructions may be crucial. This sounds fascinating, and it does add interest, but as far as we can work out these factors usually only come into play once or twice during the game. Eventually Thorin became such a pest, purloining objects, running off on wild goose chases, refusing to fight and saying HURRY UP at regular intervals, that we killed him just to shut him up (and were immediately killed by two goblins. Whose side is Thorin on, anyway?). There is one point where Thorin appears to be essential, but one acquaintance regularly disposes of him after this point.

If a disaster such as A DEAD ELROND occurs, at random, there seems to be no way of recouping the loss: for instance, once the DARK appears (normally underground) there seems to be no way of extricating yourself. At least, I have yet to meet anyone who has done so. The logic of the Inglish, often a bit strained, breaks down, so that if THORIN ENTERS and you SAY TO THORIN "FIND LIGHT", the computer merely replies I SEE NO THORIN HERE. IT IS DARK. It dawns that you are not so much pitting your wits against the computer, as trying to catch it in the right mood.

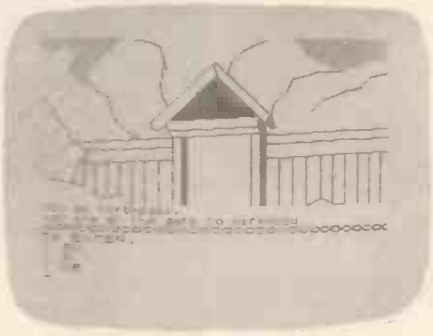
While I applauded the idea of making the computer respond directly to English commands (and it is very time-saving to be able to UNLOCK, OPEN, GO THROUGH DOOR), I found that I quickly started looking for ways to key in commands as briefly as possible. For instance, SAY TO ELROND, "GIVE ME SOME LUNCH PLEASE" (the manual says you must must be polite) resolved itself into SAY ELR "LUNCH". Elrond didn't seem offended.

The commands to enter the Troll's Cave can be given in one sequence, instead of three as shown here.

By The Book?

At the suggestion of Prof. Tolkien's executors, *The Hobbit* is being sold only with a copy of the novel attached. The idea is that the book will offer clues. This depends on how well you know the book. I found it useless, in fact very misleading. For instance, in the novel, Bilbo and Gollum have a long riddle contest, from which Bilbo escapes, by strategem, without harming Gollum, after obtaining the Ring. In the game, any attempt to converse with Gollum leads to instant strangulation, and the only solution is to take the ring, kill Gollum and run for it.

In the vicinity of Mirkwood, the Wood Elf appears; travellers report that your chances are better if you are captured.



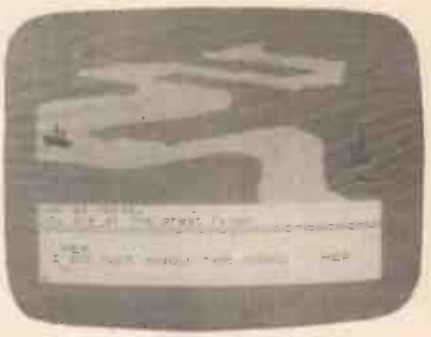
A number of solutions depend either on keeping someone alive till they have served their purpose, or killing them promptly. It sounds more like Conan than *The Hobbit*, and doesn't actually improve the quality of the game, either.

On the other hand, anyone who does not know the story will find it helpful to know that the Dragon lies to the East, that Elrond and Thorin are goodies and that Goblins are baddies, that Bard the Bowman can shoot dragons and that Sting can be found in a trolls' hoard. Looked at like that, the book is very helpful indeed.

One of our Members has succeeded in getting into the Lonely Mountain, disposing of the Dragon and returning with the treasure to Bag End. He scored 86.5%, so there are still riddles to unravel. He has found no use for the Small Golden Key. Some riddles seem to have no solution, and others, once solved, seem to give no further help in the game.

In their latest bout of publicity, Melbourne House point out that, as *The Hobbit* is so complex, people will discuss it. How right they are: I would say it's better as a conversation piece than it is as a game, because one player's experience is not the same as another's — which was always one of the attractions of Prof. Tolkien's writings. Playing the game is like working out a series of riddles where the rules occasionally change without warning. The random element makes the adventure something more than a challenge to make a successful map.

An attack of nerves stymies the traveller at the Great River.



The Melbourne House team have expended a great deal of love and care on *The Hobbit*, employing eighteen months and a number of specialists (an artist, a linguistics expert, etc.) to write it, packing as much into 48K of memory as possible. (The recently arrived version for the BBC Micro has, alas, no graphics, as the BBC has only 32K memory). It is going to seem a trifle unsatisfying to anyone who has played an adventure game on a mainframe with hundreds of Ks of memory, but for anyone who plays on micros, *The Hobbit* is unusually complicated.

It's a pioneering work in translating a story into a computer game, as well, and succeeds in capturing some of the flavour of the original. The long gestation period (and the combined sale with the book, no doubt) have bumped the price up to £14.95, but in terms of hours occupied it seems worthwhile.

Indeed, I was eventually driven forth from the Misty Mountains simply because I had no time left to go on searching — such are the demands of a non-hero's life. So I shall leave it to someone else to discover what happens if you THROW ROPE CAREFULLY ACROSS RIVER.

Sadly, the version for the BBC Micro has no colour graphics, owing to lack of memory space.

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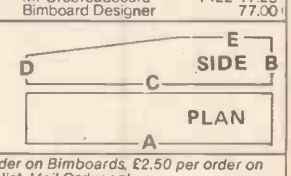

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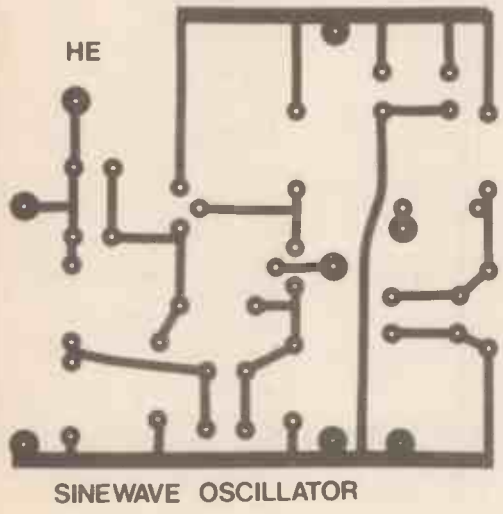

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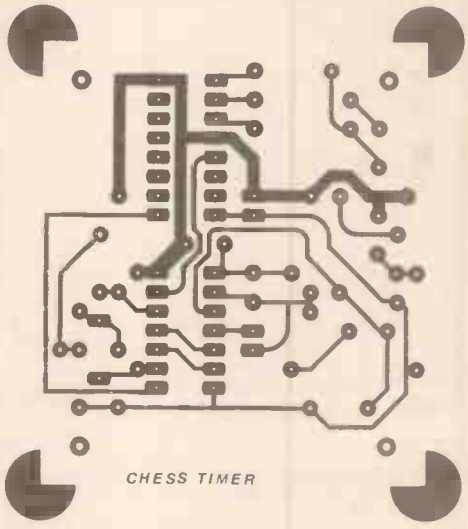

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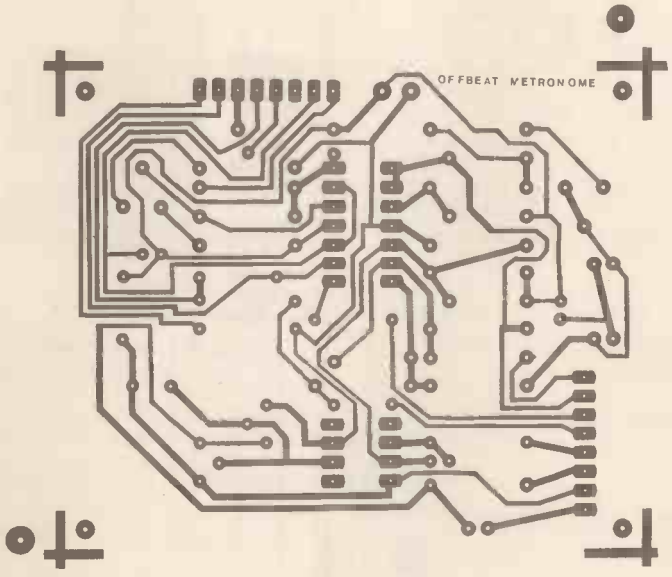

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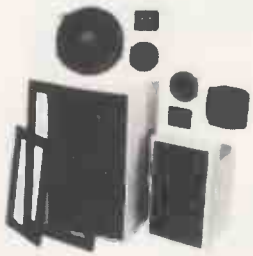
MULLARD SPEAKER KITS



Purposefully designed 40 watt R.M.S. and 30 watt R.M.S. 8 ohm speaker systems recently developed by MULLARD'S specialist team in Belgium. Kits comprise **Mullard** woofer (8" or 5"l with foam surround and aluminium voice coil. **Mullard** 3" high power domed tweeter. **B.K.E.** built and tested crossover based on Mullard circuit, combining low loss components, glass fibre board and recessed loudspeaker terminals. SUPERB SOUNDS AT LOW COST. Kits supplied in polystyrene packs complete with instructions.
8" 40W system — recommended cabinet size 240 x 216 x 445mm
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5" 30W system — recommended cabinet size 160 x 175 x 295mm
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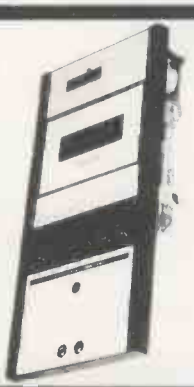
STEREO CASSETTE TAPE DECK MODULE



Comprising of a top panel and tape mechanism coupled to a record/play back printed board assembly. Supplied as one complete unit for horizontal installation into cabinet or console of own choice. These units are brand new, ready built and tested.
Features: Three digit tape counter. Autostop. Six piano type keys, record, rewind, fast forward, play, stop and eject. Automatic record level control. Main inputs plus secondary inputs for stereo microphones. **Input Sensitivity:** 100mV to 2V. **Input Impedance:** 68K. **Output level:** 400mV to both left and right hand channels. **Output Impedance:** 10K. **Signal to noise ratio:** 45dB. **Wow and flutter:** 0.1%. **Power Supply requirements:** 18V DC at 300mA. **Connections:** The left and right hand stereo inputs and outputs are via individual screened leads, all terminated with phono plugs (phono sockets provided). **Dimensions:** Top panel 5½in x 11¼in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram and connecting diagram. Attractive black and silver finish.
Price £26.70 + £2.50 postage and packing.
Supplementary parts for 18V D.C. power supply (transformer, bridge rectifier and smoothing capacitor) £3.50.

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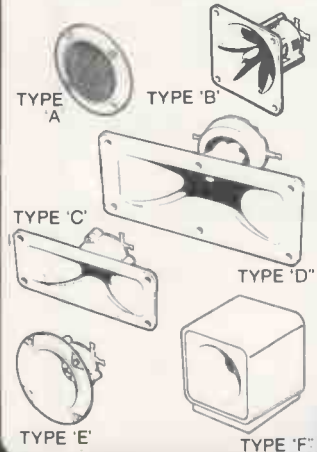
THREE QUALITY POWER LOUDSPEAKERS (15", 12" and 8" See 'Photo). **Ideal for both Hi-Fi and Disco applications.** All units have attractive cast aluminium (ground finish) fixing escutcheons.
Specification and Prices.
15" 100 watt R.M.S. Impedance 8 ohms. 50 oz. magnet. 2" aluminium voice coil. Res. Freq. 20 Hz. Freq. Resp. to 2.5KHz. Sens. 97dB. Price: £34.00 each + £3.00 P&P
12" 100 watt R.M.S. Impedance 8 ohms. 50 oz. magnet. 2" aluminium voice coil. Res. Freq. 25Hz. Freq. Resp. to 4 KHz. Sens. 95dB. Price £26.00 each + £3.00 P&P
8" 50 watt R.M.S. Impedance 8 ohms. 20 oz. magnet. 1½" aluminium voice coil. Res. Freq. 40Hz. Freq. Resp to 6 KHz. Sens. 92dB. Black Cone. Price: £9.50 each. Also available with black protective grille Price: £9.99 each. P&P £1.50.

12" 85 watt R.M.S. McKENZIE C1285GP (LEAD GUITAR, KEYBOARD, DISCO) 2" aluminium voice coil, aluminium centre dome, 8 ohm imo., Res. Freq. 45Hz., Freq. Resp. to 6.5kHz., Sens. 98dB. **Price £24.00 + £3** carriage.
12" 85 watt R.M.S. McKENZIE C1285TC (P.A., DISCO) 2" aluminium voice coil. Twin cone. 8 ohm. imp., Res. Freq. 45HZ., Freq. Resp. to 14KHz. **Price £24.00 + £3** carriage.
15" 150 watt R.M.S. McKENZIE C15 (BASS GUITAR, P.A.) 3" aluminium voice coil. Die cast chassis. 8 ohm imp., Res. Freq. 40Hz., Freq. Resp. to 4KHz. **Price £49 +£4** carriage. Cabinets fixings in stock S.A.E.

PIEZO ELECTRIC TWEETERS – MOTOROLA

Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series). **FREE EXPLANATORY LEAFLETS SUPPLIED WITH EACH TWEETER.**



TYPE 'A' (KSN2036A) 3" round with protective wire mesh, ideal for bookshelf and medium sized Hi-fi speakers. **Price £4.29 each.**

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TYPE 'C' (KSN6016A) 2" × 5" wide dispersion horn. For quality Hi-fi systems and quality discos etc. **Price £5.99 each.**

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TYPE 'E' (KSN1038A) 3¾" horn tweeter with attractive silver finish trim. Suitable for Hi-fi monitor systems etc. **Price £4.99 each.**

TYPE 'F' (KSN1057A) Cased version of type 'E'. Free standing satellite tweeter. Perfect add on tweeter for conventional loudspeaker systems. **Price £10.75 each**

P&P 30p ea. (or SAE for Piezo leaflets).

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Carriage: **£5 each £7 per pair**

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3 watt FM Transmitter

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P256 turntable chassis ● S shaped tone arm ● Belt driven ● Aluminium platter ● Precision calibrated counter balance ● Anti skate (bias device) ● Damped cueing lever ● 240 volt AC operation (Hz) ● Cut-out template supplied ● Completely manual arm. This deck has a completely manual arm and is designed primarily for disco and studio use where all the advantages of a manual arm are required.
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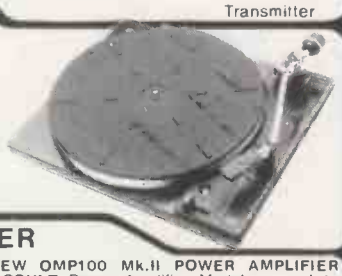
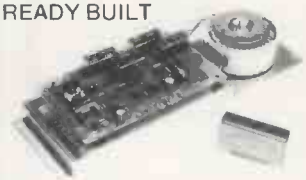


OMP POWER AMPLIFIER MODULE

READY BUILT



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Improved specification

NEW OMP100 Mk.II POWER AMPLIFIER MODULE Power Amplifier Module complete with integral heat sink, toroidal transformer power supply and glass fibre p.c.b. assembly. Incorporates drive circuit to power a compatible LED Vu meter. New improved *specification makes this amplifier ideal for P.A., Instrumental and Hi-Fi applications.*
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Output Power:— 110 watts R.M.S.
Loads:— Open and short circuit proof 4/16 ohms.
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T.H.D.:— 0.01%.
S.N.R. (Unweighted):— -118dB ±3.5dB
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Size:— 360 x 115 x 72 mm Price:— £31.99 + £2.50 P&P. Vu Meter Price:— £8.50 + 50p P&P.

MOSFET versions available up to 300W. R.M.S.

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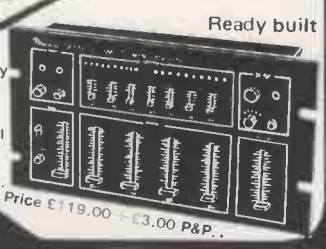
STEREO DISCO MIXER

Ready built



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